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SUSTAINABLE ENERGY FOR A RESILIENT FUTURE

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Sustainable Energy for a Resilient Future

Edited by
Lucelia Rodrigues

Architecture, Energy & Environment Research Group
Department of Architecture and Built Environment
Faculty of Engineering, University of Nottingham
University Park, Nottingham, UK - NG7 2RD

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LIST OF PAPERS

9: Effect of different seeding sludge on the energy recovery potential of food waste during anaerobic digestion

JUN WEI LIM[1], JASON TAN[2], KAI CHEE LOH[3], YANJUN DAI[4], YEN WAH TONG[5]

[1] NUS Environmental Research Institute, National University of Singapore, 5A Engineering Drive 1, Singapore 117411, eriljw@nus.edu.sg
[2] Department of Chemical and Biomolecular Engineering, National University of Singapore, 4 Engineering Drive 4, Singapore 117585, a0094613@u.nus.edu
[3] Department of Chemical and Biomolecular Engineering, National University of Singapore, 4 Engineering Drive 4, Singapore 117585, chelohkc@nus.edu.sg
[4] Institute of Refrigeration and Cryogenics, Shanghai Jiao Tong University, Shanghai, China, yjdai@sjtu.edu.cn
[5] NUS Environmental Research Institute, National University of Singapore, 5A Engineering Drive 1, Singapore 117411, chetyw@nus.edu.sg

Increasing food waste (FW) generation has been a growing environmental challenge for many countries. In Singapore, 796,000 tonnes of FW was generated in 2013, with only 13 per cent of the FW recycled. The recycling rate could be increased by adopting anaerobic digestion (AD), which is a biological process that efficiently converts organic matter into biogas. Due to the high degree of waste stabilisation and controlled methane generation, AD is regarded as a more sustainable treatment method for FW. Seeding sludge contains a consortia of microbes that are responsible for the conversion of organic matter to methane. A suitable seeding sludge can shorten start-up time and enhance biogas production. Therefore, the source of seeding sludge plays a crucial role in the fate of the AD process. The objective of this study was to compare the performance of two different seeding sludge for the AD of FW: (1) anaerobic sludge from water reclamation plants (WRP) in Singapore; and (2) anaerobic sludge from palm oil mill effluent (POME) digesters in Johor, Malaysia. This was achieved by comparing the evolution of bacterial and archaeal communities in anaerobic digesters inoculated with WRP sludge (R1) and POME sludge (R2) over 30 days. Biomass from R1 and R2 were sampled for terminal restriction fragment length polymorphism to detect the shift of microbes throughout the study. This study showed that WRP sludge (R1) took a shorter start-up time as compared to POME sludge (R2). The overall performance of R1 was also superior to that of R2. Information from both reactor performance and microbial community analysis suggested how the differences in the initial microbial consortia of WRP sludge and POME sludge affected the start-up and behaviour of FW anaerobic digesters. Knowledge gained from this study could aid future works in optimising the AD of FW through bioaugmentation.

Keywords: Microbial community profiling, Anaerobic digestion, Seeding sludge

11: EcoShopping: energy efficient & cost competitive retrofitting solutions for retail buildings

A review of best practice

ANDY LEWRY[1], ED SUTTIE [2]

[2]Building Research Establishment (BRE), Watford UK WD25 9XX, LewryA@bre.co.uk
[3]Building Research Establishment (BRE), Watford UK WD25 9XX, SuttieE@bre.co.uk

The "EcoShopping" project aims to produce a practical holistic retrofitting solution for commercial buildings, reduce primary energy consumption to less than 80 kWh/(m2.year) and increase the proportion of Renewable Energy Systems (RES) to more than 50% by using state of the art solutions.

The project intends to use and integrate available products and technologies; along with a network to accurately monitor the environmental and occupancy parameters to allow the Building Management System to have better control of the building and fully exploit the thermal mass.

This paper:

- *Introduces the EcoShopping project and the consortium carrying out the work.*
- *Describes the case study building and the initial targets for carbon reduction.*
- *Discusses the results of Work Package 2: which is an assessment of national building codes, Energy Performance Buildings Directive (EPBD) implementation, performance standards and good practice.*

This study identifies that building regulations and their associated codes lay down minimum levels of performance for non-domestic buildings but do not attempt to prompt best practice.

Best practice performance criteria were identified for the majority of technology areas. For such a case study, it is essential that the methodologies are comparable with those already in use and that technologies match or exceed best practice criteria already published. In addition, producing auditable numbers is essential to showing transparency in how the energy savings claimed are justified.

Keywords: ECOSHOPPING: energy efficient, retrofitting, Retail sector, shopping buildings.

15: A Comparison of Energy Usage between a Radiant Ceiling System, an Active Beam System and a Fan Coil System compared to a VAV System

PETER SIMMONDS[1], JASON KIRCHHOFF[2]

[1]Principal, Building and Systems Analytics LLC, Marina Del Rey and Hong Kong
[2]Technical Director, Energize Analytics, Delray Beach, Florida

In a quest to reduce the energy consumption in buildings there has been and introduction of different alternative conditioning systems, namely a Radiant Ceiling System and an Active Beam system which can be used to condition spaces. This paper will attempt to identify any energy and cost savings of these different systems, as well as occupant comfort conditions. As base case, we have used a traditional overhead Variable Air Volume system, a traditional Fan Coils system has also been included in this comparison. The building used for the simulation comparison is 200,000 ft2, 8 story building situated in both New York and Los Angeles. The base case model and the three alternatives have all been constructed in the simulation model in accordance with ASHRAE 90.1 -2013.

Key words: Energy Consumption, System Performance, Thermal Comfort

16: Applied Thermal Comfort Control

PETER SIMMONDS[1], ANDRE JONKER[2]

[1]Principal, Building and Systems Analytics LLC, Marina Del Rey and Hong Kong
[2]WSP Group, London

A large banking facility has three trading floors, each floor has 600 occupants. Since the commissioning of the building and its systems in 2003 there have been numerous complaints from the occupants regarding conditions on each floor. The complaints had escalated so far that senior management requested the comfort conditions relative to occupants be improved. But what were the conditions which were deemed to be "uncomfortable" and what conditions needed to be created to alleviate and further complaints?

There were on-going complaints received from occupants pertaining to environmental conditions on all three of the trader floors. The complaints varied from thermal issues;

- *Too hot*
- *Too cold*
- *Draft*

Detailed surveys were conducted to ascertain actual small power loads of equipment installed on a zone by zone basis. The results from these surveys in conjunction with the existing occupancy densities, lighting loads and the building façade fabric performance were recorded.

This paper will first describe the previous operating conditions and then will describe the analysis and proposed system modifications to remedy the situation. The revised HVAC system and controls would be capable of monitoring and operating zone conditions to PPD and PMV requirements.

Keywords thermal comfort:

18: A Study on the Application of Simulation-based Simplified PMV Regression Model in Office Buildings

SUNG-JUN YUN[1], JUNG-HO HUH[2]

[1] Parsons Brinckerhoff Korea, 741 Yoeongdong-daero, Seoul, Republic of Korea, yun.sungjun@pbworld.com
[2] University of Seoul, 90 Jeonnong-dong, Seoul 130-743, Republic of Korea, huhj0715@uos.ac.kr

Recently, the Korean Government enacted a new law aimed at reducing energy losses in buildings throughout Seoul. According to the regulation, buildings over a certain size must keep the indoor temperature above 26 ℃ during the summer season and below 20 ℃ in the winter season. However, these energy-savings were accompanied by thermal discomfort for occupants who work indoors, thus leading to reduced work efficiency. In order to address these problems, several recently published studies have investigated thermal comfort controls that can reduce air-conditioning energy use while also satisfying the thermal comfort needs of occupants. However, thermal comfort controls can prove more difficult to monitor than temperature controls due to the way the existing regulation is written, with far more variables involved in the former. This creates additional costs for multiple measuring sensors, additional time required for monitoring, and an overall greater likelihood for errors.

Thus, this study used EnergyPlus, a program with high accuracy for thermal comfort control prediction, to model an actual office building. A PMV regression analysis was conducted for this model based on a database of PMV variables. PMV regression model simplification was completed through sensitivity analysis, and the Energy Management System (EMS) in EnergyPlus was used to establish a simplified PMV regression analysis-based thermal comfort control.

Keywords: EnergyPlus, PMV, regression analysis, simplification, thermal comfort control

23: Experimental Investigation of CO2 Gas Cooler/Condenser in a Refrigeration System

KONSTANTINOS M. TSAMOS[1], YUNTING [1],
IDEWA SANTOSA[1], SAVVAS TASSOU[1]

[1] RCUK National Centre for Sustainable Energy Use in Food Chains, Brunel University, Kingston Lane, Uxbridge, UB8 3PH, UK, Konstantinos.Tsamos@brunel.ac.uk

Natural refrigerants including CO2 have been recognized as the most promising working fluids and have been widely applied in refrigeration systems over the last decade. Owing to its attractive thermo-physical properties and negligible environmental impact, the CO2 refrigerant can be used as a replacement for convectional HFC working fluids. Normally, CO2 refrigeration systems can be classified into three different groups as indirect, cascade and all CO2 transcritical booster structures. The CO2 booster system has some advantageous over the others in terms of functions and sizes etc. However, the performance of such system still requires further investigation and improvement.

This study focused on the experimental investigation into the performance comparison of two CO2 finned-tube gas coolers/condensers with different design structures and their effects on the overall performance of a CO2 booster refrigeration system. The integrated CO2 booster refrigeration system consisted of two variable speed semi-hermetic compressors, a gas cooler/condenser, a liquid receiver, electrically operated expansion valves, a medium temperature display refrigeration cabinet and an additional water/glycol load. The refrigeration system and especially the CO2 gas cooler/condenser had been comprehensively instrumented to enable detailed monitoring of the system and the heat exchanger at different operating states. Results for the system performance were obtained and analysed for different CO2 gas coolers/condensers. The results include the effect of heat exchanger designs and fan operations on the system performance. In addition, the controls of supercritical and subcritical pressures and cooling capacity are described.

Keywords: heat exchanger, CO_2 booster refrigeration system, COP, optimal designs, control strategies

25: Precast Ferrocement Hollow Core Slab Wall Panels

WAIL N AL-RIFAIE[1], AHMED M.A. SAKRAN[2]

1 Professor of Civil Engineering, Philadelphia University, Amman, Jordan, wnrifaie@yahoo.com
2 Research Scholar, College of Engineering, University of Tikrit, Iraq

A total of five full scale ferrocement multi-cell box slab panel were constructed and tested under flexural loads. The main parameters considered in present work were number of wire mesh layers at top and bottom flanges and webs and the positions of the intermediate diaphragms. The behaviour was monitored by reading deflections at mid-span and by observing the crack patterns and mode of failure. From the results obtained, it was found that decreasing number of wire mesh layers at the bottom flanges tend to decrease the load capacity and increase the lateral deflections. It is concluded that the precast ferrocement multi-cell box slab/ wall panels developed in the present work can be used as a building system and comparison of tests results with the standard design loads of buildings showed that the proposed system matches the design loads and can be used in construction of a wide range of buildings.

Keywords: precast, ferrocement, multi-cell box, energy, slab, wall.

26: JIC Green Initiative Project (GIP)

Toward an environment friendly college

MOHAMMED I. Y. ALEID[1], SHAREEF SHEKSHAKI[2] , MOHAMMED ABDUL BASEER[3] ,FOUAD ZAYADIN[4], MOHSEN AL-SHAKHOURI[5], VADREVU KAMARAJU [6], MOHAMMAD HANIFA [7], MOHAMMAD ABU AJRA[8],

[1, 3, 4, 5] Mechanical Engineering Department
[2, 6, 8] Electrical Engineering Department
[7] Chemical Engineering Department
Jubail Industrial College (JIC), Jubail Industrial City –Saudi Arabia

In Jubail Industrial College (JIC) a team of engineers and researchers started to lay out what is known as Green Initiative Project (GIP). The main objective of this project is to implement renewable energy technology in our routine life. The project intends to touch many different aspects of life in the coastal Industrial City of Jubail. JIC is an educational organization located in a very vital region in the Middle East and near giant Petrochemical Industries in what is known as Jubail Industrial City. Our location in Kingdom of Saudi Arabia made us to lay the foundation and initiate a special project. The project of its kind is unique, which chiefly focuses on environment protection utilizing renewable energy technology. It enables us to become a role model to all the educational Institutions and Industries around the globe.

A greener and pollution free atmosphere combined with hands on practical experience would lead us to utilize the power from the natural resources like wind and solar energy. This would strengthen the perception of future generations to implement renewable energy in their day to day life considering the environment. The project has eight major divisions, which include: 1- Solar Energy, 2- Wind Energy, 3- Zero Emission Campus, 4- Green Architect design of JIC campus, 5- Solid waste recycling, 6- Bio-gas plant, 7- Renewable Energy Centre, 8- Carbon footprint calculation.

An electronic survey was conducted on GIP involving one hundred and forty (140) faculty and staff members. The feedback of nearly 90 % of the members is quite encouraging and supportive, later the project has become the pool of innovative ideas and project team were inquired about its details interestingly.

Our team of members proposed to utilize solar energy which is very promising; we tried to gear three essential needs together, the need for parking lot, the need of shadow and the need of solar energy. We analysed the wind speed at different locations of coastal city Jubail and we found that renewable energy from wind is feasible in Jubail Industrial City in general. Bio-gas energy is to be produced from food and vegetable waste collected in JIC restaurants, canteens and dormitories as well as green grass clippings to generate a green fuel that is most friendly to our environment.

Keywords: Renewable Energy, Solar Energy, Bio-Gas, Renewable Energy Centre, Wind Energy, Zero-car emission

27: Exergy Analyses of an Integrated Solid Oxide Fuel Cell and Biomass Gasification System

JUNXI JIA[1], BAOZHI SUN[1]

[1]*College of Power and Energy Engineering, Harbin Engineering University, jiajunxi99@sohu.com*
[1]*College of Power and Energy Engineering, Harbin Engineering University, baozhisun@hrbeu.edu.cn*

An integrated process of biomass gasification and solid oxide fuel cells (SOFC) is investigated using energy and exergy analyses. A performance comparison of power systems for different gasification agents is given by thermodynamic analyses. Exergy analysis is applied to investigate exergy destruction in components in the power systems. When using air or oxygen-enriched air as gasification agents, the gasifier reactor causes the greatest exergy destruction.

For the case in which oxygen-enriched air as gasification agent, about 29% of the chemical energy of the biomass is converted into net electric power, while about 17% of it is used to for producing hot water for district heating purposes. The total exergy efficiency of combined heat and power is 29%.For the case in which steam as gasification agent, the highest exergy destruction lies in the air preheater due to the great temperature difference between the hot and cold side. The net electrical efficiency is about 40%. The energy combined heat and power efficiency is almost 36%, which is higher than that when air or oxygen-enriched air as gasification agent.

Keywords: biomass gasification; solid oxide fuel cell; exergy analysis;

30: Three-stage Anaerobic Co-digestion of High-solids Food Waste and Horse Manure

JINGXIN ZHANG[1], KAI CHEE LOH[2],
YEN WAH TONG [1,2*], WANGLIANG LI[1], JUN WEI LIM[1]

[1] NUS Environmental Research Institute, National University of Singapore, Singapore
[2] Department of Chemical & Biomolecular Engineering, NUS, Singapore
** Corresponding author. Tel: +65 65168467, Fax: +65 67791936, E-mail: chetyw@nus.edu.sg*

The hydrolysis and acidogenesis were the rate-controlling steps in the overall anaerobic digestion (AD) process. Considering the optimum conditions for different AD stage were diverse, the development of multi-stage AD system was likely to enhance each stage of AD through optimizing control respectively. This study developed a highly integrate three-stage anaerobic digester (HM3) to bond the advantages of dry AD and wet AD for anaerobic co-digestion of food waste and horse manure. The digester design was mainly comprised of three chambers i.e. high-solids hydrolysis stage, high-solids acidogenesis stage and wet methanogensis stage. Through comparing the treatment performance with other two control digesters, HM3 presented 11.2 ~22.7% higher methane yield. The improved methane yield was mainly attributed to the functionalized partitioning in this integrated digester, which significantly accelerated the solubilization of solid organic matters and the formation of organic acids as well as ammonia in the high-solids hydrolytic and acidogenic stage respectively. Additionally, HM3 also showed the highest volatile solids reduction rate among the three digesters. Real-time PCR and pyrosequencing analysis indicated that the abundance and biodiversity of microorganisms including bacteria and archaea in HM3 was much higher than that in the control reactors. Moreover, different dominant bacterial communities with various functions were enriched in the high-solids hydrolytic stage e.g. Lactobacillaceae and Pseudomonadaceae, acidogenetic stage e.g. Porphyromonadaceae and Enterobacteriaceae and wet methanogenic stage e.g. Aminobacterium, Clostridium and Proteiniphilum. The bioaugmentation and functional partition in this three-stage anaerobic digester enhanced the transformation from particulate organic matter to soluble substrate and methanogenesis, which is meaningful for its application in practice.

Keywords: Anaerobic; Three-stage anaerobic digestion; High-solids anaerobic digestion; Wet anaerobic digestion; Microbial community.

31: Novel Two-stage High-solid Anaerobic Digestion of Food Waste and Grass

WANGLIANGA LI[1], LOH KAI CHEE[2], TONG YEN WAH[*, 1, 2], PENGHUI GAO[1], ZHANG JINXINA[1], LIM JUN WEI[1]

a NUS Environment Research Institute, National University of Singapore, 5A Engineering Drive 1, Singapore 117411, Singapore
b Department of Chemical and Biomolecular Engineering, National University of Singapore, 4 Engineering Drive 4, Singapore 117585, Singapore
Corresponding author at: NUS Environment Research Institute, National University of Singapore, 5A Engineering Drive 1, Singapore 117411, Singapore. Tel.: +65 6516 8467; fax: +65 6779 1936. E-mail address: chetyw@nus.edu.sg (Y.W. Tong).

A high-solid two-stage process was proposed to increase biogas yield, to improve the efficiency and to stabilize the digestion process of horticultural waste (HW) and food waste (FW). In this two-stage process, high-solid codigestion of FW and chicken manure (CM) was carried out in the first stage and then, transferred and codigested with grass in the second stage. When volatile solid (VS) ratio of FW, CM and grass was 4:5:5, after 70 days, the cumulative methane yield was about 203 mL/g VS. The optimized operation parameter for the two-stage is VS ratio of FW/CM/grass as 4:5:5, duration of first stage as 3 days. Compared with the codigestion of FW, CM and grass, the biogas yield of the two-stage process increased by 28% and the duration of digestion was 52 days, 18 days shorter. Under the optimal condition, the VS removal exceeded 55%. The composition analysis revealed that cellulose and hemicellulose contributed to the production of biogas.

Keywords: Food waste; Yard waste; High-solid; Digestion; Biogas

34: Exergy analysis on the steam gasification of various biomass at the dual fluidized bed gasifier

XIAOMING LI[1], PENG LI[1],JIN BAI[2],JUNXI JIA[1]

[1] College of Power and Energy Engineering, Harbin Engineering University ,NO.145 ,Nantong street,Nangang District, Heilongjiang Province, China, lxmlily2014@126.com.
[1]College of Power and Energy Engineering, Harbin Engineering University, NO.145 ,Nantong treet,Nangang District, Heilongjiang Province, China,lipenglipeng@hrbeu.edu.cn
[2]Institute of Coal Chemistry, Chinese Academy of Sciences.NO.27,Taoyuan South Road. Yingze District, Shanxi Province.stone@sxicc.ac.cn
[1]College of Power and Energy Engineering, Harbin Engineering University,NO.145 ,Nantong Street,Nangang District, Heilongjiang Province, China,jiajunxi99@sohu.com.cn

Gasification of biomass is an attractive technology for combined heat with power production as well as for synthesis processes such as production of liquid and gaseous biofuels. Dual fluidized bed (DFB) technology offers the advantage of a nearly nitrogen-free product gas mainly consisting of H2, CO, CO2 and CH4.

Based on experimental data from literature, exergy analyses was performed for the DFB steam gasification process in this paper. The influence of operating parameters such as steam-to-fuel ratio, gasification temperature, catalyst on the exergy efficiency has been investigated .The results show that the higher gasification temperature results in significantly higher heat value of product gas. In addition, the exergy efficiencies are observed to be higher when steam-to-fuel ratio ratio is lower.With the increase of the bed material content in the catalysts, the exergy efficiency value will also become higher. And different kinds of catalysts always have different exergy ficiency values. The silica sand is suitable bed material for DFB gasifier.

Keywords: DFB biomass gasifier, exergy efficiency, catalyst, steam-to-fuel ratio, gasification temperature

38: Sustainability Aspect of Nuclear Fuel from Loading Recycled Spent Fuel in Fast Breeder Reactor (FBR)

SIDIK PERMANA[1], ABDUL WARIS[1], MISTUTOSHI SUZUKI[2], MASAKI SAITO[3]

1 Bandung Institute of Technology, Jl. Ganesha 10, Bandung Indonesia, psidik@fi.itb.ac.id
2 Japan Atomic Energy Agency, Ibaraki Japan, mitsutoshi.suzuki@jaea.go.jp
3 Tokyo Institute of Technology, Tokyo Japan, msaito@nr.titech.ac.jp

Sustainable energy program including operational energy utilization is one of the key issues for maintaining world energy demand, environmental aspect of energy utilization as well as economical point of view. In case of nuclear energy utilization, maintaining sustainability of nuclear fuel is one of the important issues, especially for the fourth generation of nuclear power plant which can be maintained by utilizing new fresh fuel resources, spent fuel resources as recycled fuel process, and obtaining nuclear fuel breeding resource in the reactors. Utilization of used fuel from recycling resources and fuel breeding resource become the key issue which affects to the reprocessing and refuelling facilities. The study analyses a fast breeder reactor (FBR) type as a reference based and utilizes an established reactor code system of JOINT-FR. Inventory ratio of actinides are evaluated including reactor criticality condition as well as the behaviour of heavy nuclide during reactor operations. Loading MA as trans uranium fuel type in comparing with mixed oxide fuel type gives a significant improvement for plutonium inventory ratio as well as MA inventory ratio. In term of reactor criticality condition, it shows a reduction factor for criticality condition for trans uranium fuel type as MA recycled fuel in comparing with MOX fuel type as a fertile material which absorbs more neutrons which affects to reduction value of criticality and in the same time, conversion process from absorption neutron will produce more fissile materials especially fissile material of plutonium. Recycled material from spent nuclear fuels can be used as new fuel which shows some significant benefits for nuclear fuel sustainability as well as a reduction factor of criticality condition of reactor operation as one of the safety concern in the reactor operation.

Keywords: recycled spent fuel, FBR, plutonium, inventiry ratio, sustainability

39: Technoeconomic Assessment of an Integrated Solar Combined Cycle Power Plant in Semi-arid Region in Algeria

BOUALEM ZEROUAL[1], ABDELHAFIDH MOUMMI[2], AREZKI SMAÏLI[3]

[1] Department of Engineering of Materials, Faculty of Sciences and Technology, University Dr. Yahia FARES of Médéa, Médéa (26000), Algeria, boualem.zeroual@gmail.com
[2] Laboratoire de Génie Civil, Hydraulique, Développement durable et Environnement, LAR-GHYDE, Université Mohamed Khider de Biskra, BP 145, RP, 07000, Biskra, Alegria, abdelhafidh.moummi@gmail.com
[3] Ecole Nationale Polytechnique, Laboratoire de Génie Mécanique et Développement, B.P. 182 El-Harrach, 16200, Algiers, Alegria, arezki.smaili@enp.edu.dz

A number of solar thermal power plants have been planned by the Algerian state for the horizon of 2030, for the purpose to achieve the self-sufficiency from solar electricity and its exportation. The main objective of the present paper is annual performance and economic assessment of an Integrated Solar Combined Cycle System (ISCCS-18) of 68.2 MWe with 18 MWe solar field, using parabolic trough collectors. This power plant has been designed and simulated through the software IPSEpro for Naâma site in Algeria. For this purpose five power plants cases have been investigated in terms of performance and economics analysis, namely, (i) Gas turbine, (ii) conventional combined cycle, (iii) ISCCS without fossil-fuel back-up system, (iv) ISCCS with fossil-fuel back-up system, and (v) Solar Electric Generating System (SEGS). The parameters of the annual performance analysis include annual energy production, net annual efficiency and capacity factor. The economic analysis includes environmental, investment, fuel and Operation and Maintenance (O&M) costs, and the Levelized Electricity Cost (LEC) calculation. The obtained results have shown that the LEC of the ISCCS-18 is 4.22 ¢/kWh; about 43% higher than the combined cycle with consideration of environmental cost, and saves around 21 million US$ in fuel consumption and reduces about 0.45 million tons in CO2 emissions in 30 years operating period in comparison with conventional combined cycle. Also, the results have shown that about 4 % improvement in the net annual efficiency of the ISCCS-18, as well as the annual solar share is 8.0 %. According to this solar share and to the Algerian regulations, the project owner will receive premium of 100 % of the LEC of the total produced electricity by the ISCCS-18.

Keywords: Solar thermal power plants; parabolic trough collector; combined cycle; economical assessment; performance analysis

40: Overall Energy Performance Analysis of a Living Lab Building in Denmark

ANA IONESI[1,*], MUHYIDDINE JRADI[1], CHRISTIAN T. VEJE[1]

[1] Center for Energy Informatics, Campusvej 55, Odense, Denmark
**Corresponding Author: ai@mmmi.sdu.dk*

Denmark aims to become independent of fossil fuels by 2050 through renewable energy integration as well as improving the efficiency of energy resources utilization. The building sector is one of the major targets where buildings in Denmark contribute to about 40% of the overall Danish energy consumption, mainly for heating, ventilation and lighting. It is estimated that energy savings of 70-75% could be attained in the Danish building sector by 2050 through the implementation of cost effective and energy efficient measures

This paper focuses on evaluating the energy performance under various conditions of a living lab building situated in Vejle, Denmark. An overall energy model for the whole building was developed taking into account the building envelope, construction materials, thermal properties and various building systems and services employed. EnergyPlus was used to model the building and simulate the overall energy performance under Danish regulations and weather conditions. Preliminary validation of the developed model is presented through comparison with real measurements.

Based on the data attained, the energy class in which the building lies will be identified. In addition, an analysis of the main factors that influence the energy performance will be conducted, highlighting the possible areas of improvements in the overall energy performance.

The building management system installed in the building is regularly updated and optimized, and therefore the development of such holistic energy model for the building is crucial to be directly integrated in the overall management strategy to improve the performance of the energy systems and to test different control and optimization strategies.

Keywords: energy efficiency, buildings, simulations, optimization.

46: Energy Valuation of the Abattoir Waste by Co-Digestion Process: Biogas Production

MAAMAR FEDAILAINE[1,2], KARIMA MOUSSI[1],
SABAH ABADA[1], MERYEM SABER[1]

1 Centre de Développement des Energies Renouvelables, CDER, B.P. 62, Route de l'Observatoire, Bouzaréah, Algiers, Algeria, m.fedailaine@cder.dz, k.moussi@cder.dz, s.ababa@cder.dz, m.saber@cder.dz.
2 Laboratoire de stockage et valorisation des énergies renouvelables, LSVER. Faculté de chimie, USTHB, BP 32 El Alia, Bab Ezzouar, Algiers, Algeria.

Anaerobic digestion is a natural process of organic substrates degradation using bacteria to produce biogas as renewable energy. Further to this clean energy, this process contributes to enssure a sustainable waste treatment process to protect the environment.

The aim of the present work is to study at laboratory scale, the biogas production from co- digestion of fatty acids of slaughterhouse waste and digested sludge from wastewater treatment plant. During this experience, we followed the parameters that influence directly the anaerobic digestion, namely the evolution of pH and the optical density. In addition, a kinetic production of biogas was daily measured. These tests were successful in obtaining the combustible biogas with a high rate of methane

Keyword: Biomethanisation, anaerobic co-digestion, slaughterhouse waste.

48: Simulation and Parametric Analysis of an Office Building Energy Performance under Danish Conditions

MUHYIDDINE JRADI[1,*], ANE ZORROZUA GAMBOA[1], AND CHRISTIAN VEJE[1]

[1] Center for Energy Informatics, The Maersk Mc-Kinney Moller Institute, University of Southern Denmark, 5230 Odense M, Denmark
** Corresponding author: Email: mjr@mmmi.sdu.dk*

Buildings in Denmark contribute to a large portion of the total energy consumption in the form of heating, ventilation and lighting. Therefore, improving the efficiency of the energy production and supply systems and enhancing the energy performance of buildings is indispensable to meet the ambitious Danish energy objectives. The current study provides an overall analysis of the energy performance of the Maersk office building located at the Odense Campus of the University of Southern Denmark, aiming to reduce the energy consumption and improve the overall energy performance. Energy Plus was employed to model the building and simulate the overall energy performance under the Danish conditions taking into account the construction topology, building envelope properties, HVAC systems, weather conditions and occupants behaviour. The 3D model of the building is created with Google Sketchup including 110 thermal zones, and Open Studio tool was used to establish the link between the 3D model and the Energy Plus simulation engine.

Using the developed holistic energy model, an overall energy simulation for the Maersk office building was performed showing that the heating energy accounts for about 50% of the overall consumption while the other half is used in the form of electricity mostly for lighting, electric equipment and ventilation. A parametric study was carried out to assess the effect of various factors on the building overall energy consumption including the construction material, insulation, windows design and lighting, and various suggestions were provided. It was shown that replacing halogen lights in the corridors with LED lights would bring an energy saving of 144 GJ per year. In addition, using triple pane windows instead of the current double pane windows would save 60 GJ on district heating. In addition, various building envelope configurations were suggested so that the building envelope would comply with the Danish BR 10 regulation for existing buildings.

Keywords: Energy Simulation, Parametric Analysis, Office Building, Energy Plus, Danish Building Regulation

51: Identification of chiller maintenance factors using Bayesian Markov chain Monte Carlo method

PEI HUANG[1], GONGSHENG HUANG[2]

1 City University of Hong Kong, Tat Chee Avenue, Kowloon, Hong Kong, Email: peihuang2-c@my.cityu.edu.hk
2 City University of Hong Kong, Tat Chee Avenue, Kowloon, Hong Kong, Email: gongsheng.huang@cityu.edu.hk

HVAC systems are used in modern buildings to provide indoor thermal comfort and acceptable indoor air quality. Aging and degradation are prevalent among HVAC systems. They inevitably lead to the decrease in the efficiency and maximum cooling capacity of HVAC systems. As a result, the annual energy use will increase and the risk that the HVAC system cannot provide enough capacity will be high. Hence aging and degradation always represent a crucial consideration for designers.

In the life cycle analysis or the performance prediction of HVAC systems, the level of aging and degradation of a HVAC system or component are quantified using maintenance factor (MF). In general, good maintenance will delay the aging and degradation effects, and will therefore have a small maintenance factor. Poor maintenance accelerates the aging and degradation and will have a large maintenance factor. A conventional analysis recommends that the maintenance factor should be 0.01 for systems or components that undergo annual professional maintenance, and 0.02 for those that are seldom or never maintained. It is known that those recommendations are mainly based on a rule of thumb, and may not be accurate enough to describe the degree of aging for a given HVAC plant.

This research therefore proposes a framework of identifying the chiller maintenance factor using available in-situ cooling capacity data. The proposed method firstly employs the Bayesian inference to produce the posterior distribution of the maintenance factor, and then the Markov chain Monte Carlo method to generate samples from the posterior distribution. Using these samples, the mean, the standard deviation and some other statistical characteristics of the maintenance factor can all be obtained. The calibrated maintenance can then be used to predict the chiller plant maximum capacity, which can be used in decision making on the maintenance scheme. Details of the identification process will be provided by applying the proposed method to a real chiller plant, and results will be compared with that of a conventional analysis.

Keywords: Degradation, HVAC, maintenance factors, Bayesian Inference, Markov chain Monte Carlo

52: Numerical Method to Select Chiller Sequencing Control Concerning Uncertainties

YUNDAN LIAO[1], GONGSHENG HUANG[2]

1 City University of Hong Kong, Tat Chee Avenue, Kowloon, Hong Kong. Email: ydliao2-c@my.cityu.edu.hk
2 City University of Hong Kong, Tat Chee Avenue, Kowloon, Hong Kong. Email: gongsheng.huang@cityu.edu.hk

Chiller sequencing control is used in multiple-chiller plants to switch on/off chillers according to building cooling load, aiming to achieve high energy-efficient while fulfilling the indoor thermal comfort demand. Various sequencing controls have been developed and implemented in practice, and typical ones include: total cooling load-based sequencing control, return water temperature-based sequencing control, direct power-based sequencing control, and bypass flow-based sequencing control. Each control uses a direct or an indirect indicator to represent building instantaneous cooling load and compares its indicator with pre-defined thresholds to determine sequencing action. Since different controls use different load indicators and thresholds, they suffer from different types of uncertainties and show different robustness to uncertainties.

To select the most suitable control for a given chiller plant, it is necessary to evaluate the performance of control alternatives and their robustness when subject to uncertainties. To this end, in-situ tests or detailed simulation should be carried out. However, in-situ tests may be time consuming and cost inefficient; while detailed simulation needs complex models of the chiller plant, which is knowledge/effort-intensive. To simplify the selection, a numerical method is proposed based on the fact that the sequencing is only determined by the load indicators and the switch-on/off thresholds and all the potential uncertainties can be shifted to the load indicators. Details of the numerical method will be given. Three performance indices, including chiller total switch number, under-cooling percentage and energy use, are used to quantify the performance and robustness of the typical controls. A multi-criterion decision making method is adopted to select the most suitable control. Case studies show that the proposed method can assess the performance of the candidate control strategies efficiently without any complex models of the chiller plant.

Keywords: chiller sequencing control, uncertainty shift, numerical method, decision making, robustness

53: A Study on the Effect of Ground Surface Boundary Conditions in Modelling Shallow Ground Heat Exchangers

MARCO BORTOLONI[1], MICHELE BOTTARELLI[2], YUEHONG SU[3]

1 ENDIF-Engineering Department in Ferrara, via Saragat 1, 44122 Ferrara, Italy, marco.bortoloni@unife.it
2 Department of Architecture, via Quartieri 8, 44121 Ferrara, Italy, michele.bottarelli@unife.it
3 Department of Architecture and Built Environment, The University of Nottingham, University Park, Nottingham NG7 2RD, UK, yuehong.su@nottingham.ac.uk

The effect on numerical solution of different thermal boundary conditions at the ground surface was analysed in modelling HGHEs. Boundary conditions of the 1st, 2nd and 3rd kind have been alternately tested by means of a finite element numerical code, solving the unsteady-state heat transfer problem in a 2D domain.

An energy balance equation at the ground surface (3rd kind BC) has been developed and implemented in the numerical model. A preliminary simulation has been carried out in absence of the HGHE operating using real weather data. The solution has been validated with experimental data, and assumed as reference. The calibrated GSEB equation proved to properly predict the temperature in the soil.

The resulting heat flux and temperature at the top of the domain have been considered respectively as the 2nd and 1st kind of equivalent boundary conditions for two new models. Finally, all three models have been solved with the supposed HGHE operating, to analyse how the different BCs affected the numerical solution.

The results have been compared in terms of average temperature at the HGHE wall surface and in the ground. The use of a heat flux as BCs at the ground surface appeared as an extremely precautionary approach due to the resulting thermal drift in the soil. On the contrary, to assign an energy balance equation or a temperature as BCs on the ground surface seemed to have a limited effect in terms of temperature at the heat exchanger and in the soil

Keywords: Ground surface energy balance, ground heat exchangers, numerical modelling, boundary conditions.

54: An Experimental Study on the Thermal Performance of Multi-Surface Compound Trough Solar Air Concentrators with Dual Collector Tubes

HAOSHU LING[1], CHAO CHEN[1], HONG QIN[2], NA LI[1], MINGXING ZHANG[1], HONGFEI ZHENG[3], SHEN WEI[4]

1 Beijing University of Technology, Beijing, PR China. Email: linghaoshu@163.com, chenchao@bjut.edu.cn
2 Guangzhou Vocational College of Science and Technology, Guangzhou, PR China
3 School of Mechanical and Vehicular Engineering, Beijing Institute of Technology, Beijing, PR China
4 School of Civil and Building Engineering, Loughborough University, LE11 3TU, UK

A multi-surface compound trough solar air concentrator (MCTSAC) with dual collector tubes (DCTs) was developed and introduced in the paper, in order to improve the thermal performance and the air flow rate of MCTSACs with a single collector tube (SCT). In the study, the thermal performance of MCTSACs with DCTs and those with a SCT was compared using real measured data. Additionally, the influence of factors, i.e. air velocity inside the collector tube, solar radiation, inclination angle and length of the MCTSAC, on the thermal performance of MCTSACs has been evaluated. Experimental results have reflected that comparing to MCTSACs with a SCT, MCTSACs with DCTs perform significantly better in both thermal performance and air flow rate, with an increase of 18% for both mean heat collection and mean thermal efficiency. Furthermore, solar radiation has shown a positive impact on the thermal performance, whilst inlet temperature performed a negative impact. When the air velocity inside the collector tube was around 1.8m/s with the inclination angle set as 23°, the MCTSACs with DCTs performed the best.

Keywords: multiple clamber trough solar air concentrator, dual collector tubes, thermal performance, influential factor, comparative experiment

55: Heating and cooling performance of a minitype ground source heat pump system

X.Q. ZHAI[1], R.Z. WANG[1]

[1] *Shanghai Jiao Tong University, 800 Dongchuan Road, Shanghai, China, xqzhai@sjtu.edu.cn*

A minitype GSHP system was designed and installed in the green energy building of Shanghai Jiao tong University for the purpose of satisfying the thermal environment of a meeting room with the covered area of 180 m2. The rated cooling capacity of the heat pump is 22.3 kW with the electricity consumption of 5.3 kW. Correspondingly, the rated heating capacity and electricity consumption in heating mode is 29.5 kW and 6.9 kW, respectively. The ground heat exchanger consists of 9 vertical boreholes. There is a single U-tube with the diameter of 32 mm in each borehole. The whole length of the U-tube is 580 m. The experimental investigation was carried out in both cooling mode and heating mode. After one year, the average temperature of soil was about 18 oC, which is nearly the same as the original soil temperature. The experimental results are instructive to the design and operation of GSHP systems in Shanghai and other cities with similar climatic feature.

Keywords: Ground source heat pump, Heating performance, Cooling performance

56: Method theory research on determining the phase-change temperature arrange of PCM integrated into building envelops

Theory analysis on the determination method

XI MENG[1], WEI ZHANG[2], CAIXIA WANG[3], YANRU LI[4], ENSHEN LONG[5]

1 Sichuan University, No. 24, First loop south first section, Chengdu, China, mengxihvac@163.com
2 Sichuan University, No. 24, First loop south first section, Chengdu, China, xskin821@163.com
3 Sichuan University, No. 24, First loop south first section, Chengdu, China, caixiawang11@163.com
4 Sichuan University, No. 24, First loop south first section, Chengdu, China, 429506492@qq.com
5 Sichuan University, No. 24, First loop south first section, Chengdu, China, longes2@163.com

PCM (Phase change material) can be integrated into building envelopes to decrease the building energy consumption, refine the indoor thermal comfort, shift and reduce the peak electricity load due to its relatively large latent heat. However, only when the phase change of PCM occurs can the phase-change heat storage property be played. Therefore, the reasonable selection on the PCM phase-change temperature arrange directly affects the PCM effect. At present, there always lacks of the relative method to determine the PCM phase-change temperature arrange due to its complexity and too many factors.

In this study, the determination method on the PCM phase-change temperature arrange is theoretically researched and proposed on the basis of the traditional wall heat transfer theories. This method couples all affecting factors including wall structure, material properties, outdoor climate conditions, indoor thermal environment and so on.

This method can provide some meaningful guides for the selection for the PCM phase-change temperature arrange in the engineering practices.

Keywords: PCM, Phase-transition temperature, Building envelopes

58: The Investigation of Practice on Green Residential Buildings in Shenzhen, China

LIQING ZHANG[1]; LIBEN JIANG[2]

1. University of Central Lancashire, Preston, PR1 2HE, UK. Email: lqzhang@uclan.ac.uk
2. University of Central Lancashire, Preston, PR1 2HE, UK. Email: ljiang2@uclan.ac.uk

Construction industry throughout the world has been one of the biggest contributors to the energy consumption and CO2 emission, while the world is facing serious energy resources shortage. Sustainable development of construction has been seen in the past years to reduce the negative impacts on the environment but at the same time to assure the function of buildings was properly delivered. Current literature showed that majority of studies focused on the commercial and public green buildings, while for the residential buildings, research was mainly focused in developed countries such as Great Britain, America and Australia. There were generally few studies on the specific high-rise residential buildings which are common in the big cities with high-density population in the developing countries. This paper will investigate the practice of green buildings for residents in Shenzhen, China, which is one of the six Tier 1 cities with urban population of more than 10 million and GDP of more than USD 24,000 per head. The study will investigate the attitude of potential customers and the satisfaction of existing customers towards them, and will identify the opportunities and challenges of green residential construction in Shenzhen from the point of view of developers and managers. The results will show some inside views of green residential buildings from driving forces (consumers), and provide additional suggestion for the developers and local governmental agency in the future development.

Keywords:

59: Performance Analysis of Heat Pipe-Based Photovoltaic-Thermoelectric Generator Hybrid System

ADHAM MAKKI[1], SIDDIG OMER[2], SU YUEHONG[3], SAFFA RIFFAT[4]

Department of Architecture and Built Environment, University of Nottingham, Nottingham, NG7 2RD, UK, [1]ezxam1@nottingham.ac.uk , [2]siddig.omer@nottingham.ac.uk, [3]yuehong.su@nottingham.ac.uk, [4]saffa.riffat@nottingham.ac.uk

Photovoltaic (PV) cells can absorb up to 80% of the incident solar radiation of the solar spectrum, however, only certain percentage of the absorbed incident energy is converted into electricity depending on the conversion efficiency of the PV cell technology used, while the remainder energy is dissipated as heat accumulating on the surface of the cells causing elevated temperatures. Temperature rise at the PV cell level is addressed as one of the most critical issues influencing the performance of the cells causing serious degradations and shortens the life-time of the PV cells, hence cooling of the PV module during operation is essential. Hybrid PV designs which are able to simultaneously generate electrical energy and utilize the waste heat have been proven to be the most promising solution. In this study, analytical investigation of a hybrid system comprising of a Heat Pipe-based Photovoltaic-Thermoelectric Generator (HP-PV/TEG) for further enhanced performance is presented. The system presented incorporates a PV panel for direct electricity generation, a heat pipe to absorb excessive heat from the PV cells and assist uniform temperature distribution on the surface of the panel, and a thermoelectric generator (TEG) to perform direct heat-to-electricity conversion. A mathematical model based on the heat transfer process within the system is developed to evaluate the cooling capability and predict the overall thermal and electrical performances of the hybrid system. Results are presented in terms electrical efficiencies of the system. It was observed that the integration of TEG modules with PV cells aid improving the performance of the PV cells through utilizing the waste-heat available, leading to higher output power. The system presented can be applied in regions with hot desert climates where electricity demand is higher than thermal energy.

Keywords: Photovoltaic, Hybrid Photovoltaic System, Heat-Pipe, Thermoelectric Generator

62: Carbon Neutral Fuel

TONY MARMONT

Air Fuel Synthesis Ltd, Energy House
Unit 2, Chesnut Street
Darlington, DL1 1QL

Fuels from Air, was formed five years ago by two Climate Change thinkers, Tony Marmont and Dave Benton, who have separate skills in hydrogen production and use, and in nuclear weapon construction. We spent three years designing and creating the pathway chemically, we then decided to build a pilot to make 5 L a day, to prove the concept. After two years we had the plant constructed and running. The first fuel methanol was produced on 28 May 2012 followed shortly by gasoline, we are now aiming to produce diesel and Jet A1, in the coming months.

The captured gases are then compressed and stored in tanks, for recompression at the stoichiometric mixture of three parts hydrogen and one part CO2, through a reactor with special catalysts which converts the resulting gaseous fuel into a hydrocarbon liquid, to be condensed out.

A further use is in the result of Anaerobic Digestions (AED). The output of this process is methane and CO2, CO2 is collected and compressed, to be used to make diesel, the methane is sorted cleaned and sold as heating fuel.

The resulting digestate is sent to a carboniser, and hydrogen is expressed to go with the CO2 already collected, th, and the resulting Char, becomes a 100 year fertiliser for the fields and the resulting grass grown feeds the cattle, which produce the A.D. which produces the CO2 and Hydrogen to make the diesel.

CCS process can be made, using our CO2 collection tower, but based remote to the power station chimney at the coast, to collect the same amount of CO2 the chimney emits, and then sequester in the North Sea Oil wells.

Keywords: synthetic methanol, carbon neutral fuel

63: A Brief Discussion on Current Vertical Greenery Systems in Hong Kong: The Way Forward

K.W.D.K.C. DAHANAYAKE [1], NADIA C.L. CHOW [2]

1 Department of Architecture and Civil Engineering, City University of Hong Kong, Hong Kong, China, kkiramawe2-c@my.cityu.edu.hk
2 Department of Architecture and Civil Engineering, City University of Hong Kong, Hong Kong, China, cheuchow@cityu.edu.hk

Fast growing cities consume natural resources in vast quantities resulting adverse effects to both human and natural environment. Integrating sustainable initiatives to development projects cannot be overlooked. Thus, vertical greening is gaining popularity throughout the world as a viable option of integrating greenery into urban inhabitants. Vertical greenery systems offer wide range of environment, economic and social benefits. Vertical greenery is merely use of vegetation on facades of the building. Growing climbers on building walls is not a novel perception; it has been a practice from ancient time. However, vertical greenery systems are being developing with new technologies allowing more design flexibility.

In Hong Kong, vertical greenery is gaining popularity among all sectors including commercial, institutional, government and residential. This initiative is a good answer for severe air pollution and heat island effect in Hong Kong. This paper discusses on environmental, economic and social benefits from vertical greenery systems, different classifications of vertical greenery systems, vertical greenery applications in Hong Kong, plant species used in vertical greenery in Hong Kong and codes and standards that can be adopted for vertical greenery systems. In Hong Kong, vertical greenery is still at its infancy stage which is yet to explore to maximize the benefits and to uplift the quality of built environment.

Keywords: Vertical Greenery, Green Facades, Living Walls, Hong Kong

64: Performance investigation on vertical diffusion multi-effect solar still with parallel feed

H SHARON[1], K S REDDY[2]

[1 ,2] Department of Mechanical Engineering, Heat Transfer and Thermal Power Laboratory, Indian Institute of Technology Madras, email id: 2ksreddy@iitm.ac.in Tel.:+91 44 22574702; fax: +91 44 22574652

Solar thermal distillation of saline water is an effective way to meet the clean water demands of remote and rural population. Multi-effect solar stills have been widely acknowledged for their high distillate productivity. Most of the multi-effect solar stills studied are of horizontal type which has reduced distillate yield compared to vertical multi-effect diffusion solar stills. In this work, a new configuration of vertical diffusion multi-effect solar still has been proposed and it has been optimized using transient mathematical modelling. The feed water separately heated in solar collector is distributed equally in all effects such that glass reflectors, heat pipes which were used for heating the first effect of previous configurations have been avoided which increases the safety and handling flexibility of the present unit. The optimum number of effects and diffusion gap was found to be 5 and 10 mm, respectively. The distillate yield from the unit was highly dependent on the diffusion gap, mass flow rate of feed water circulated through the solar collector and feed water salinity. Distillate yield was found to decrease with the increase in salinity of feed water and maximum distillate yield was recorded as 8.25 kg/m2-d and 6.07 kg/m2-d during summer for feed water with 0 and 10 wt% salinity, respectively. The yield from the unit supplied with hot feed water from evacuated heat pipe solar collector is higher than the yield from the unit supplied with hot feed water from solar flat plate collector.

Keywords: solar thermal; solar distillation; vertical still; water; multi-effect

66: The adaptability of night cooling technology under different climates

ZHONGZHE WU[1], SHENYI WU[1]

1Department of Architecture and Built Environment
University of Nottingham
University Park
Nottingham NG7 2RD, UK

The demanding for cooling in buildings significantly increases worldwide with living standard. In the last few decades, the energy consumption for cooling shared a large part of the total energy consumption in buildings and the trend is still on the rise. The night-time ventilation as a passive cooling method has a potential to reduce the energy consumption for buildings cooling. Employing night cooling ventilation technology can not only save energy, but also improve indoor air quality. However, the effectiveness of the night cooling ventilation is climate dependent. Location has a significant influence on the efficiency of this method. In this study, the adaptability of night ventilation cooling technology under different climate conditions was analysed from a macroscopic view. The analysis was based on the theory of "climate cooling potential" and "climate cooling demand" which is calculated from degree-hours of the difference between the ambient air and inside building temperatures without specifying building parameters.

This study examined the values of the climate cooling potential and the climate cooling demand in 34 cities located in different climate zones. It was found that the potential of night cooling ventilation in the east coast cities of the Pacific and the Atlantic Ocean were always higher than the same latitude cities in west coast.

The study also quantified the effectiveness of night ventilation cooling by simulating a nominal building in different cities with the energy consumption analysis software "design builder". The results showed that among different places, for every 10kh increase of the climate cooling potential, the corresponding indoor temperature could be reduced by approximate 0.12ºC. In the application of the night cooling ventilation combining with air-conditioning system in commercial buildings, the night cooling ventilation showed positive effect when the ratio of local climate cooling potential and demand is larger than 1, i.e., the reduction on HVAC energy consumption for cooling excesses the additional fan power consumed on night cooling.

Keywords: Passive cooling; Night-time ventilation cooling; climate cooling demand; climate cooling potential

73: Numerical study of laminar heat transfer and pressure drop of Phase Change Material Emulsion (PCME) in Coiled Tubes

JINGJING SHAO[1], JO DARKWA[2], GEORGIOS KOKOGIANNAKIS[3]

[1] Faculty of Engineering, University of Nottingham, University Park, NG7 2RD Nottingham, UK, epxjs5@nottingham.ac.uk
[22] Faculty of Engineering, University of Nottingham, University Park, NG7 2RD Nottingham, UK, J.Darkwa@nottingham.ac.uk
[3] Sustainable Buildings Research Centre, University of Wollongong, Wollongon NSW2522

Phase Change Emulsion (PCME) is a multifunctional fluid consisting of a Phase Change Material (PCM) and a carrier fluid. PCMEs have the potential of reducing energy consumption in air conditioning systems due to their higher latent heat capacities than water, which enable the same amount of cooling energy to be achieved at reduced flow rates. However optimum design of an integrated system requires a good understanding of flow behaviour and heat transfer characteristics of PCME in heat exchangers which cannot currently be readily deduced from manufacturer's data or published data. In this paper, the flow behaviour and heat transfer characteristics of a phase change emulsion (PCME) in coiled tubes have been investigated to establish its true potential as a heat transfer fluid in air conditioning systems. The result showed higher Nusselt number and heat transfer coefficient as well as reduction in flow rate by 20-40%. However, the pressure drop was found to be much higher than water due to its relatively higher viscosity which could affect the overall energy reduction capability of the PCME. Further enhancements are therefore recommended.

Keywords: CFD simulation, Phase change emulsion, heat exchanger, heat transfer, pressure drop

74: Experimental Evaluation of an Integrated Phase Change Material Blind System for Double Skin Façade Buildings

YILIN LI [1], JO DAKWA [2], GEORGIOS KOKOGIANNAKIS [3]

1 Faculty of Engineering, The University of Nottingham, University Park, Nottingham, NG7 2RD, epxyl11@nottingham.ac.uk
2 Faculty of Engineering, The University of Nottingham, University Park, Nottingham, NG7 2RD, J.Darkwa@nottingham.ac.uk
3 School of Mechanical, Materials and Mechatronic Engineering, Sustainable Building Research Centre, University of Wollongong, Innovation Campus, Fairy Meadow, NSW 2519, gkg@uow.edu.au

Double skin facades (DSFs) have been widely recognised as sustainable design elements for reducing energy consumption in buildings. However overheating problems in DSFs in warm seasons and locations have been reported in various studies for contributing additional increase in cooling loads in buildings. Although strategies such as utilisation of shading devices and incorporation of thermal mass into DSFs have been investigated by some researchers, there are still some technical and scientific barriers to be overcome to ensure effective heat transfer processes in the systems. This paper focuses on the experimental evaluation of an integrated phase change material (PCM) blind system based on previous theoretical study. Detailed procedures for developing the integrated blind system based on laminated composite PCM have been established which cover series of screening tests on alternative materials. Temperature and airflow velocity data were monitored and collected from a typical DSF test facility equipped with a PCM blind prototype in the summer of 2014. The data analysis showed that the integrated PCM blind system was able to stabilise the cavity temperature to about 36oC during the hottest period which showed no significant increase as compared with the ambient temperature. Even though the developed system has demonstrated some level of capacity to mitigate the overheating phenomenon in DSF, there is the need for longer term investigations into the energy storage efficiency of the PCM due to repeated charging and discharging cycling.

Keywords: Double skin facade, PCM blind system, Experimental evaluation

75: Experimental Research on Cooling Effect of Battery Pack with Liquid Flow Heat Exchange Structure

TIANSHI ZHANG [1, 2], QING GAO [1, 2,*], YANLONG GU [1, 2], GUOHUA WANG [1, 2], KAIPENG ZHANG [1,2] CONG XIAO [3], Y.Y. YAN [4]

*[1]State Key Laboratory of Automotive Simulation and Control, Jilin University, 130025, Changchun, China *Corresponding Email: gaoqing@jlu.edu.cn*
[2] College of Automotive Engineering, Jilin University, 130025, Changchun, China, zhangtianshi@jlu.edu.cn
[3] R&D Centre, China First Automobile Works Group Corp, 130011, Changchun, China, xiaocong@rdc.faw.com.cn
[4]Faculty of Engineering, University of Nottingham, Nottingham, NG72RD, UK, Yuying.Yan@nottingham.ac.uk

In order to realize high efficiency and lightweight of battery thermal management (BTM), we designed a new liquid flow heat exchange structure which used flat tube bundle and graphite layer with high thermal conductivity. In different battery pack cooling processes, series of experiment were conducted to investigate basic heat transfer characteristics include temperature variation, temperature uniformity, thermal response and temperature fluctuation. The experimental results showed that the designed structure not only ensured cooling effect and temperature uniformity of battery pack, but also reduced volume and weight of liquid flow. At the same time, through adopting variable temperature cascade cooling method, cold shock were alleviative and temperature uniformity was promotion during battery pack cooling process. In addition, battery cooling effect was not sensitive to variation of liquid flow within experimental conditions, and this characteristic will facilitated to achieve low flow resistance and low pump power consumption.

Keywords: BTM; liquid flow heat exchange; flat tube bundle; graphite layer; cooling effect

76: Study on Case Analysis and Support System Development for Green Remodeling of Building

JI-YEON PARK[1], CHANG-U CHAE[2]

[1] Korea Institute of Civil Engineering and Building Technology, 283 GoyangdaeRo IlsanseoGu GoyangSi GyeonggiDo Republic of Korea, Jypark@kict.re.kr
[2] Korea Institute of Civil Engineering and Building Technology, 283 GoyangdaeRo IlsanseoGu GoyangSi GyeonggiDo Republic of Korea, Cuchae@kict.re.kr

In the architectural field, energy reduction of new architectures for reducing emitting CO2 and energy consumption has been recommended since 2000s. By reflecting this, the supporting system and institution weighting on new buildings have been formed.

However, based on 2014, with the era of existing buildings amounting to 6.8 million, the target for energy reduction has been changed from new buildings into existing buildings.

Since the renovation plan or remodeling for energy reduction is executed in the existing buildings, which have been supplied more than new buildings. And also, the rate of CO2 emission came to be higher than the rate of CO2 for new buildings. Therefore, it is necessary to change the support system focusing on new buildings into the support system of existing buildings for activating green remodeling.

In order to activate green remodeling, institutional support of government, technology development related to green remodeling, green remodeling manual development for building owner and residents are required to be established systematically.

In this study, case analysis of technology and institution for activating green remodeling market in domestic and foreign country, plan to secure support system, applying the current situation, will be prepared. For the establishment of green remodeling support system, the activation of green remodeling market is predicted and the energy efficiency improvement and the emission of environmental load are expected.

Keywords: Green Building, Green Remodeling, Energy Efficiency Improvement, Supporting System

78: Thermodynamic analysis of solar hybrid coal-fired power system

HUI HONG[1,*], SHUO PENG[1,2], WEI HAN[1], HONGGUANG JIN[1]

1 Institute of Engineering Thermophysics, Chinese Academy of Sciences, Beijing 100190, China
2 University of Chinese Academy of Sciences, Beijing 100049, China

Integrating solar energy with fossil fuel is a cost-efficient way to use solar energy to generate electricity in the near and mid-terms. In a solar hybrid coal-fired power system, concentrated solar heat is used to replace the extracted steam from the coal-fired power plant to generate electricity. Previous researches proposed several system configurations where solar heat is used to substitute extracted steam with different temperature and pressure in the coal-fired power system. The contribution of solar heat to the work output for such hybrid power system has been pointed out. However, the inherent reason of solar-to-electricity increased by solar hybridization with fossil fuel has rarely been examined. In this paper, on the basis of the concept of energy level, the correlation of the solar-to-electricity efficiency with the reduced exergy destruction of solar hybridization process is fundamentally derived and their interaction is revealed. In addition, the thermodynamic performance of a typical 330 MW solar hybrid coal-fired power system is evaluated by using the derived equations. The result obtained in this study is expected to provide a basic principle for designing the solar hybrid coal-fired power system.

Keywords: Solar hybrid coal-fired power system; Net solar power output; Exergy destruction; Energy level;

81: Numerical Investigation of the Thermal Performance of Water Based Closed Loop Oscillating Heat Pipe (CLOHP)

SIEGFRIED YEBOAH[1], JO DARKWA[2]

1 The University of Nottingham Ningbo China, 199Taikang East Road, Ningbo China, Siegfried.yeboah@nottinghamedu.cn
2 The University of Nottingham, University Park, Nottingham, NG7 2RD, UK, J.Darkwa@nottingham.ac.uk

The enhanced capabilities of Oscillating/Pulsating Heat Pipes (OHPs/PHPs) are often curtailed by a gamut of factors that affects their optimum thermal performance. These factors ranging from their design parameters to operating conditions may not make it feasible to develop experimental prototypes through trial and error as optimum thermal performance cannot be ascertained a priori.

In this study, an Eulerian Volume of Fluid (VOF) model coupled with a Level Set Method has been used to numerically investigate the thermal performance of a five-turn water based CLOHP with volume fractions 0.3, 0.5 and 0.7 in vertical and horizontal modes. The capabilities of this computational fluid dynamics (CFD) approach to help predict the optimum thermal performance of OHP/PHPs is well established in literature.

A summary of the results from this investigations show that more convective heat transfer rate occurs from the liquid phase than from the vapour phase. Also orientation was found to significantly influence pressure distribution within the CLOHPs. Finally it was observed that thermal resistance was significantly influenced by volume fraction/fill ratio rather than by orientation of the device.

Keywords: Closed Loop Oscillating Heat Pipe, Volume of Fluid (VOF), Computational Fluid Dynamics (CFD), Thermal Performance

82: Thermodynamic Optimization for Central Heating System by Using Industrial Waste Heat through Absorption Heat Transformer

YIN ZHANG, FEI XIONG, WENXING SHI, YINPING ZHANG*, XIN WANG

Department of Building Science, Tsinghua University, Beijing, China
** Corresponding author: zhangyp@tsinghua.edu.cn*

Urban heating energy consumption in northern China accounts for 40% of total building energy consumption. Meanwhile there are large quantities of low grade waste heat discharged into the environment during industrial processes in northern China. Utilizing these industrial waste heat for central heating in winter is of great importance in energy saving and has raised more concerns during recent years. However, in traditional systems, the low grade waste heat is often used to produce relatively low temperature supply water through heat exchangers, often leading to large mass flow rate in the primary network, which results in huge pump energy consumption after long distance delivery, since the heating users are often far away from the industrial heat sources. To break through such application bottleneck, the key is to increase the temperature difference between the supply and the return water, and decreasing the mass flow rate in the primary network. In this paper, based on the concept of heat adaptor, two kinds of heat adaptors, absorption heat transformer and absorption heat pump, are used at heat source and substations respectively to take place of heat exchangers in central heating system, to decrease the mass flow rate in the primary network. Aiming to minimize the pump energy consumption, the thermodynamic model of the new system is built and the optimal supply and return water temperatures can be obtained through extreme principle. The illustrative example indicates that the optimal supply water temperature in primary network is much higher than the waste heat temperature when the absorption heat transformer is utilized. The results also show that the delivery pump energy consumption can be decreased by almost 96% for the ideal heat adaptor system after optimization, compared to absorption heat exchange system. The theoretically ideal system deduced out in this paper is significant for guiding the optimization design of practical central heating systems using industrial waste heat.

Keywords: Waste heat, Heat engine, Heat pump, Absorption cycle, Extremum principle

83: Thermal simulation of a laminated microencapsulated multiphase change material drywall

WEIGUANG SU [1], JO DARKWA [2], GEORGIOS KOKOGIANNAKIS [3]

1 University of Nottingham Ningbo China, Centre for Sustainable Energy Technologies (CSET), 199 Taikang East Road, Ningbo, 315100, China, Weiguang.Su@nottingham.edu.cn
2 University of Nottingham, Faculty of Engineering, University Park, Nottingham, NG7 2RD, UK, J.Darkwa@nottingham.ac.uk
3 University of Wollongong, School of Mechanical, Materials and Mechatronic Engineering, Sustainable Buildings Research Centre, 1 Pitt Street, Loftus, New South Wales 2232, Australia, gkg@uow.edu.au

Phase change materials (PCMs) possess the potential of reducing energy consumption in buildings because of their relatively large energy storage capability at constant temperatures. However, currently available PCMs have single phase change temperatures and therefore unable to be tuned to multiphase change temperature applications. In this regard the thermal performance of a proposed laminated microencapsulated multiphase change material (MEMPCM) drywall has been theoretically evaluated. The simulation results showed that the MEMPCM was able to reduce the maximum peak room temperatures by 2.86℃ to 6.67℃ from May to October while the overall thermal comfort period was enhanced by 25.4% in a selected location. Future experimental evaluation is however recommended to establish its practical potential.

Keywords: Simulation, ESP-r, Fluent, microencapsulated multiphase change material

84: Research on PCM Thermal Storage Structure of the Size and Mixing Melting Points Sphere Packing

GUOHUA WANG[1, 2], QING GAO[1, 2], CHUN GAO[1, 2],
WENLONG XU[3], TIANSHI ZHANG[1,2], Y.Y. YAN[4]

1 State Key Laboratory of Automotive Simulation and Control, Jilin University, Changchun, China, gqing@jlu.edu.cn
2 State Key Laboratory of Automotive Simulation and Control, Jilin University, Changchun, China, wanggh@jlu.edu.cn
3 China FAW Group Corporation R&D Center, Changchun, China
4Faculty of Engineering, University of Nottingham, Nottingham, NG72RD, UK, Yuying.Yan@nottingham.ac.uk

Electric vehicles as a main development direction of future car development, the technology of parking heat storage and heat recovery storage is very important to solve the winter heating and battery cold start. Through using the phase change thermal storage at sphere packing structure, the temperature equalizing and controlling stability of battery power system can be ensured. The research works focus on heat flux characteristics of phase change thermal storage at sphere packing structure, by combining the model of numerical simulation analysis and experimental verification. And, the further analysis focuses on the sphere diameter, multi melting points mixture by uniformity and layered structure. The research shows that the good temperature adaptability and heat flux characteristics in this thermal storage device, by using the way of small diameter and mixing melting points.

Keywords: Thermal Storage; PCM; Sphere Packing; Sphere diameter; Mixing Melting Points

85: Experimental Investigation of Open Sorption Pipe Heat Storage Under North Cyprus Climate Conditions

DEVRIM AYDIN[1], SEAN CASEY[1], SAFFA RIFFAT[1]

1 Division of Infrastructure, Geomatics and Architecture, Faculty of Engineering, University of Nottingham, University Park, Nottingham, NG7 2RD, UK, ezxda4@nottingham.ac.uk

Thermal energy storage systems have gained much attention in recent years as they are now seen as one of the most promising solutions to increase utilisation of solar energy and reduce greenhouse gas emissions. In the last decade, thermochemical versions of these systems have been widely researched for 'seasonal' storage of solar energy as they have the potential to store heat at ambient temperatures for extended periods of time without any degradation or heat loss. In this study an experimental analysis is carried out to investigate the applicability of thermochemical heat storage for space heating facilities under Northern Cyprus climate conditions. For this purpose a prototype sorption pipe was developed and the composite SIM-3a (Vermiculite – CaCl2) was used as the absorption media. The discharging part of testing was conducted in a 12.4 m2 test room whilst the charging process was conducted in an open environment with an integrated concentrating solar panel attached to the sorption pipe to dehydrate the material. According to the test result, a heat storage density (Ed) of 219 kWh/m3 was achieved with a moisture sorption rate of 0.22 kg/h. The average thermal power output (Qout) was found as 0.303W for a 9.38 h discharging period. During that period, the total thermal energy (Et) provided by the heat storage was determined as 87% of the total heat load (EI) of the test room. The charging period lasted 6 h with a desorption rate of 0.22 kg/h achieved using the solar energy. This corresponds to a drying ratio of 60%. In the discharging process encouraging results were achieved however for the charging process further improvement will be required to utilize the solar energy more effectively to fully dehydrate the absorbent.

Keywords: North Cyprus, solar energy, heat load, thermochemical heat storage, theoretical and experimental analysis

88: The environmental impact of thermal discharge of warm water from a heat pump in commercial building to a canal

PORNPUT JARUMONGKONSAK[1], SHENYI WU[2], YUYING YAN[3]

[1] *HVACR & Heat Transfer Research Group, University of Nottingham, UK NG7 2RD, ezxpj@nottingham.ac.uk*
[2] *HVACR & Heat Transfer Research Group, University of Nottingham, UK NG7 2RD, lazsw@nottingham.ac.uk*
[3] *HVACR & Heat Transfer Research Group, University of Nottingham, UK NG7 2RD, lazyy@nottingham.ac.uk*

Using natural water sources like rivers, lakes, canals etc. to remove heat from heat pump or air-conditioner systems is a good practice in terms of improving the system efficiency and running costs. However, the rise of water temperature due to the discharge of heat could potentially impact on the near-by environment and animals. In order to minimise the impact, measures have to be taken to make sure the discharge complying with the regulations. Currently, this is done case by case, which is accurate but time consuming. A general and reliable model of thermal discharge is a useful tool for this purpose; however, this has not yet been sufficiently developed. This study is a step towards this direction and develops an exact solution through applying the advection-diffusion equation for temperature with the known boundary conditions. By assuming that the thermal diffusion in the canal is similar to plume diffusion in the river, the general equations of both vertical and transverse turbulent diffusivities were found from the combination of Manning's equation and Fischer's common formula. A Matlab model based on this has been developed and the solution from this model was verified by the referred experiment data with 3-5% difference. The results from the exact solution show that the major influence factors to the thermal diffusion in the canal are the ground friction, the hydraulic radius and the depth of the canal. They influence the turbulent vortices and eddy in vertical and transverse directions through shear forces. Meanwhile, the variation of velocity of discharged warm water in the turbulent range is unaffected to the temperature decay when is higher enough to reach the maximum limit of turbulent diffusion on its specific canal condition.

Keywords: Heat pump, Thermal discharge, Environmental impact

90: Photovoltaic Ventilated Façade as an Energy Efficient Measure for Building Retrofitting

ISABEL SANCHEZ[1], ELENA RICO[2],
DAVID MARTIN[3], TEODOSIO DEL CAÑO[4]

[1] Onyx Solar Energy S.L., Río Cea 1 05004 Ávila (Spain), isanchez@onyxsolar.com
[2] Onyx Solar Energy S.L., Río Cea 1 05004 Ávila (Spain), erico@onyxsolar.com
[3] Onyx Solar Energy S.L., Río Cea 1 05004 Ávila (Spain), dmartin@onyxsolar.com
[4] Onyx Solar Energy S.L., Río Cea 1 05004 Ávila (Spain), tdc@onyxsolar.com

The expected relevant role, within the new energy paradigm of photovoltaic (PV) solar energy, is mainly based on the rapid research and development advances in the PV field. In this sense, the current state of the art of these innovative technologies has allowed reaching the integration of PV glass products in buildings in an attractive and efficient manner. This approach is known as Building Integrated Photovoltaic (BIPV) Solutions which insertion ensures an enormous future for the distributed energy approaches as an energy-efficient measure for retrofitting applications.

In this respect, Onyx Solar participates as a partner of HERB Project (Holistic Energy-Efficient Retrofitting of Residential Buildings) within the funding of the European Commission through its 7th Frame Programme. The HERB Project aim is to implement active and passive energy efficient properties in residential buildings already existing and located in several countries around Europe. Therefore, BIPV solutions are one of the technologies developed.

As a first step, the PV ventilated façade was evaluated by means of computational modeling and façade prototype testing through a prototype in a Paslink test cell. This analysis is very useful for obtaining critical information concerning temperatures in the different layers of the wall, characterization of the air behaviour, heat generated within the façade air chamber and electrical production.

Then, Onyx Solar has coordinated a family house retrofit in Gotarrendura, a village of Ávila (Spain). Among the wide range of retrofitting solutions used, it has been included the integration of a PV ventilated façade using opaque and semi-transparent glass based on a-Si active layer.

This paper summarizes relevant results and conclusions of the research studies, testings carried out and the real case study mentioned whose combination demonstrates the potential of these measures in the field of energy-efficient retrofittings.

Keywords: Building Integrated Photovoltaics, Retrofitting, Energy

91: Simulation and experimental research on the solar absorption cooling system driven by linear Fresnel reflector solar collectors with thermal storage

L.Y. ZHOU [1], Y.J. DAI [2], R.Z. WANG [3]

[1] *Institute of Refrigeration and Cryogenics, Shanghai Jiao Tong University, Shanghai 200240 PR China, zhoulingyu@sjtu.edu.cn*
[2] *Research Centre of Solar Power and Refrigeration, Shanghai Jiao Tong University, Shanghai 200240 PR China, yjdai@sjtu.edu.cn*
[3] *Research Centre of Solar Power and Refrigeration, Shanghai Jiao Tong University, Shanghai 200240 PR China, rzwang@sjtu.edu.cn*

A novel solar hybrid system, composed of linear Fresnel reflector (LFR) solar collectors, a single/double effect absorption chiller, a thermal storage tank with intermediate-temperature molten salt and assistant components, is investigated both theoretically and experimentally in this paper. Compared with conventional solar cooling system, this system is designed for operating with different modes under various solar irradiances and requirements of load. Under a typical meteorological day in summer condition, theoretical analysis on the performances of solar collectors, absorption chiller and the entire system employing MATLAB software, has been implemented. Meanwhile, an experimental system is built to validate the theoretical model. It is found that the simulation and test results have a good agreement with each other. For the solar collector with rectangle cavity receiver, under the highest temperature of 180oC, the average thermal efficiency of 38% can be obtained. For the absorption chiller, the operating mode automatically changes as the variation of hot water inlet temperature. The COP of the single/double effect can reach up to 0.7 and 1.2 under the single and double effect modes. Thermal storage tank designed for storing and releasing thermal energy can support the absorption chiller operate under the single effect for 2 hours. Besides, the experiment results show that this hybrid system can be available for a whole day in typical summer condition.

Keywords: Solar energy; Linear Fresnel reflector solar collector; Single/double effect absorption chiller; Molten salt energy storage.

93: Experimental study and modelling of air distribution systems and temperature control for chilled food factories in a scaled test facility

DEMETRIS PARPAS[1], CARLOS AMARIS[2], SAVVAS TASSOU[3]

[1] RCUK National Centre for Sustainable Energy Use in Food Chains (CSEF), Institute of Energy Futures, Brunel University London, Uxbridge, Middlesex, UB8 3PH, UK, Demetris.parpas@brunel.ac.uk
[2] RCUK National Centre for Sustainable Energy Use in Food Chains (CSEF), Institute of Energy Futures, Brunel University London, Uxbridge, Middlesex, UB8 3PH, UK, Carlos.amaris@brunel.ac.uk
[3] RCUK National Centre for Sustainable Energy Use in Food Chains (CSEF), Institute of Energy Futures, Brunel University London, Uxbridge, Middlesex, UB8 3PH, UK, Savvas.Tassou@brunel.ac.uk

Abstract: In this paper, an investigation on different air distribution systems at the required conditions of an actual chilled food processing factory is presented. A scaled test facility has been set-up for the analysis of air distribution systems and their energy consumption at different conditions. A three-dimensional CFD model of the scaled test room was also developed, validated and used to investigate the most appropriate air distribution approaches to create temperature stratification in the space.

Initial experiments focused on the study of an air distribution via fabric duct which is the current configuration used in an actual chilled food processing facility. Measured temperatures were found to vary between 6.7 ºC and 11.3 ºC. CFD Modelling of the air distribution system employing the SST-k-ω turbulence equation was also conducted. Results showed that the predicted temperatures and velocities were in good agreement with respect to the data measured from the scaled experimental test facility. The CFD model was then used to evaluate the performance of (a) air distribution via displacement ventilation with one horizontal diffuser, (b) air distribution with displacement ventilation system with two 1-way supply diffusers, (c) air distribution system with a half fabric duct at a medium level, and (d) air distribution system via slot diffusers at medium level.

Results from the different approaches investigated showed that the half fabric duct located at medium level provided a wider temperature gradient (from 7 ºC to 14 ºC). The most significant stratification was observed between head level and the ceiling level. It was also identified that the air distribution system via half fabric duct at a medium level provided a more homogeneous air flow over the entire production zone. The level of temperature stratification provided, air flow homogeneity and ease of implementation in a real factory situation provides a good solution for achieving thermal stratification and energy savings in a chilled food factory without compromising the thermal environment.

Keywords: Air distribution systems, Chilled food factory, Refrigeration, Efficient energy use, Computational Fluid Dynamics

95: Analysis and Design Optimization of a Photovoltaic Airflow Window for Winter Heating Seasons

ABDULLAH HAREDY[1], GUOHUI GAN[2]

1 Department of Architecture and Built Environment, University of Nottingham, University Park, Nottingham NG7 2RD, UK, evxah3@nottingham.ac.uk
2 Department of Architecture and Built Environment, University of Nottingham, University Park, Nottingham NG7 2RD, UK, guohui.gan@nottingham.ac.uk.

Computational Fluid Dynamics (CFD) and ECOTECT have been employed to model the mechanical and natural ventilation of a semi-transparent photovoltaics integrated airflow window and the daylighting impact of various PV transparent degrees (0.15, 0.2, 0.25, 0.3 and 0.35) on the interior space, respectively, for winter conditions noon time in London. This paper presents results of modelling of the airflow window system integrated with an office room for energy efficiency and adequate level of thermal and optical comfort. Results have revealed that buoyancy induced flow spreads the heat internally warming the space to be thermally acceptable during the heating seasons. The thermal and visual comfort was compared for different PV airflow window transparent levels to determine the optimum PV transparency for the office space. It has been found that a PV transparency of about 0.2 and 0.25 are optimal for the indoor comfort.

Keywords: CFD, mechanical ventilation, daylighting, natural ventilation, STBIPV/T.

97: Deterministic and Bayesian approach to U-value measurements

LIA DE SIMON[1], MARCO IGLESIAS[2], EDWARD COOPER[1],
DAVID TETLOW[1], CHRISTOPHER WOOD[1]

[1] Department of Architecture and built Environment, University of Nottingham, University Park, NG7 2RD, ezxld@nottingham.ac.uk
[2] School of Mathematical sciences, University of Nottingham, University Park, NG7 2RD

In the framework of reducing building carbon emissions, more efficient building systems are designed to reduce heating and cooling loads in domestic premises. Extensive measurements are essential to evaluate the thermal qualities of the single building systems as well as monitoring the performance "as built" pre and post retrofit.

A series of experimental measurements have been carried out in a controlled environment with the aim of optimizing the analysis process in terms of time and reliability of the results.

The data have been examined with standard and innovative techniques, based on Bayesian statistical analysis. Initial investigation shows that the combination of accurate data collection and the employment of mathematical statistical tools in the analysis can produce reliable results also under non-steady conditions. Further advantages are the simultaneous estimation of a statistical error on the values obtained.

Keywords: Thermal mass, RC model, Bayesian Analysis, Insulation

98: A study on use of three-dimensional miniature dielectric compound parabolic concentrator (3D dCPC) for daylighting control application

MENG TIAN[1], YUEHONG SU[1]

[1] Institute of Sustainable Energy Technology, Department of Architecture and Built Environment, University of Nottingham, University Park, Nottingham NG7 2RD, UK, yuehong.su@nottingham.ac.uk

Low-concentration solid dielectric parabolic concentrator (dCPC) is regarded as a high-potential design in daylighting control and energy saving in lighting system. The incident light could penetrate the lateral surfaces of dCPC as its incident angle is beyond the acceptance angle of dCPC, by which dCPC will control the amount of daylighting coming into the room according to the sun position. The light within the incident angle will be concentrate to the bottom of dCPC. This study is a further research based on the evaluation of two-dimensional (2D) dCPC, which aims to investigate the advantages of three-dimensional (3D) miniature solid dCPC comparing with 2D dCPC based on their daylight transmittance values under sunny sky. An optical analysis software Photopia is used to simulate the daylighting control performance of different types of concentrators. The performances of concentrators in Nottingham, UK (53° N, 1.2° W) are put forward as a case study. It is demonstrated that 3D dCPC has great advantages than 2D dCPC in control daylight, which performs higher transmittance in the morning and afternoon and lower transmittance at noon. Then, two types of 3D dCPC are compared for its tolerance on horizontal rotation angle. One has polygonal apertures with 4 sides (3D s-dCPC), and the other is revolved 3D dCPC (3D r-dCPC). Each dCPC has two different structures, which are with non-reflective material affixing on base and without base coating. Results show that the 3D non-coated r-dCPC may be the best choice in application with the advantages of installation, more stable illuminance level it provides and lower cost in manufacture.

Keywords: daylighting control, dielectric compound parabolic concentrator, transmittance, illuminance, Photopia

99: Embodied Energy of Fired Bricks:

The Case of Uganda and Tanzania

ARMAN HASHEMI[1], HEATHER CRUICKSHANK[2]

1 Centre for Sustainable Development, Department of Engineering, University of Cambridge, UK. a.hashemi@eng.cam.ac.uk
2 Centre for Sustainable Development, Department of Engineering, University of Cambridge, UK. hjc34@cam.ac.uk

This paper evaluates the embodied energy of fired/burned bricks as one of the major construction materials in East African countries. Production processes of bricks by artisans, and small- and medium-scale manufacturers are explained. Embodied energy of brick walls is also calculated and the key factors in the energy efficiency of brick kilns are discussed in detail. Low quality, high material waste and excessive energy waste during production and handling are highlighted as the major issues associate with traditional manufacturing processes of burned bricks in Uganda and Tanzania. The results reveal that small clamp kilns lose up to 3.5 times more energy through their cooling surfaces compared to large kilns. The results also indicate that clamp fired bricks are up to 60% more energy intensive than generic bricks and the embodied energy of artisan brick walls is 35% more than standard brick walls with comparable thicknesses. Improving kiln construction and production methods, educating artisan producers, replanting tress, providing alternative renewable energy sources, and design improvements to control fire intensity and air circulation in brick kilns are some of the recommendations to improve the energy efficiency and mitigate the environmental impacts of fired bricks in East African countries.

Keywords: Embodied Energy, Life Cycle Assessment, Fired Brick, Burned Brick, East Africa, Uganda, Tanzania.

100: Heat Transfer Analysis of Ferrofluids Based Solar Parabolic Trough Collectors

MUSTAFA, ALSAADY, YUYING, YAN, RABAH, BOUKHANOUF

HVACR & Heat Transfer Group, Faculty of Engineering, University of Nottingham, University Park, Nottingham NG7 2RD, UK

The paper is concerned the use of ferrofluids in solar parabolic trough collectors enhances thermal efficiency of solar collectors. Ferromagnetic nanoparticles dispersed in common heat transfer fluids (ferrofluids) exhibit better thermos-physical properties compared to the base fluids. By applying the right magnetic intensity and magnetic field direction, the thermal conductivity of the fluid enhanced more than conventional nanofluids. Therefore, ferrofluids based concentrating solar collector design is slightly different from conventional solar collectors. External magnetic source is installed to alter the thermos-physical properties of the fluid. In this paper, a heat transfer model based on energy balance of the solar collector is presented. The balance includes the direct thermal solar irradiation on the collector, optical losses, thermal losses, and heat gain of solar absorber. Various nanoparticle concentrations (<0.05 %) at the operational temperatures between 300 K and 500 K were used in the current study. The model was compared to experimental data that used conventional heat transfer fluid. The results of the model were in a good agreement with the experimental data. Using ferrofluids as a heat transfer fluid increases the efficiency of solar collectors. Increasing the concentration of particles increase the efficiency of the collector. In the presence of external magnetic field, the solar collector efficiency increase to the maximum. At higher temperatures, the ferrofluids shows much better efficiency than convectional heat transfer fluid. The ferrofluids shows better heat transfer coefficient and decrease the surface temperature of the absorber. Ferromagnetic particles build a chain like structure in the presence of external magnetic field allowing faster heat transfer throw conduction.

Keywords: Solar Energy, Nanofluids, Ferrofluids, Parabolic Trough Collector, Thermal Efficiency

104: Application of Biochar Arising from Gasification to Rehabilitate Soil of Tropical Secondary Forest on Degraded Land

ZHANYU YANG[1, 2], SHUN KAI KOH[2], WEI CHENG NG[1], REUBEN C. J. LIM[3], HUGH T. W. TAN[3], YEN WAH TONG [1, 2,] YANJUN DAI [4], CLIVE CHONG [5], CHI-HWA WANG [1, 2]

[1] NUS Environmental Research Institute, National University of Singapore, 1 Create Way, Create Tower #15-02, Singapore 138602
[2] Department of Chemical and Biomolecular Engineering, National University of Singapore, 4 Engineering Drive 4, Singapore 117576
[3] Department of Biological Sciences, National University of Singapore, 14 Science Drive 4, Singapore 117543
[4] School of Mechanical Engineering, Shanghai Jiaotong University, #800 Dongchuan Rood, Shanghai, China 200240
[5] Bioplas Energy (Asia Pacific) Pte Ltd 9 Tuas South Street 15, Singapore 637077

Biochar arising from gasification is porous (surface area 77.2m2/g), alkaline (pH 9.0), rich in nitrogen (12100ppm), phosphorus (873.4ppm), potassium (4833.3ppm) and low in its carbon to nitrogen ratio (8:1), indicating its potential use as an amendment to the soil of adinandra belukar, a form of secondary forest on degraded land. Such soil is highly compacted (surface area 4.0m2/g), acidic (pH 4.0), poor in nitrogen (1120ppm), phosphorus (3.2ppm), potassium (29.9ppm) and high in its carbon to nitrogen ratio (14:1). In this study, the forest soil was mixed with biochar at 33.3, 50.0 and 66.7% by weight, and subsequently used to cultivate water spinach (Ipomoea aquatica). After 8 weeks of cultivation, water spinach grown in the forest soil mixed with 33.3% biochar grew the tallest (193.8mm, 4 times that of pure soil), had the heaviest stem dry weight (0.483g, 10 times that of pure soil) and the largest leaf surface area (100.6cm2, 30 times that of pure soil). Compared to commercially available water spinach, it had almost the same height, heavier stem dry weight and more leaf surface area, indicating the possibility of biochar to be used as an amendment to adinandra belukar soil.

Keywords: Biochar, Gasification, Secondary Forest, Degraded Land, Acidic Soil, Water Spinach.

105: Co-gasification of Woody Biomass and Solid Waste for Clean Energy Production

PENGWEI DONG[1], THAWATCHAI MANEERUNG[1], ZHANYU YANG[1], YE SHEN[1,2,] XIANG KAN[1,2], KOON GEE NEOH[2], CHI-HWA WANG[2], YEN WAH TONG[2], YANJUN DAI[3], CLIVE CHONG[4]

1 NUS Environmental Research Institute, National University of Singapore,1 Create Way, Create Tower #15-02, Singapore 138602
2 Department of Chemical and Biomolecular Engineering, National University of Singapore, 4 Engineering Drive 4, Singapore 117585
3 School of Mechanical Engineering, Shanghai Jiaotong University, #800 Dongchuan Road., Shanghai, China 200240
4 BioPlas Energy Singapore PTE LTD, 1 Tuas Avenue 11, Singapore, 639067

Gasification is a promising alternative technology in solid waste management for megacities. It can reduce the volume of solid waste and recover heat and value-added products from this process. The feasibility test on co-gasification of different solid wastes with woody biomass has been conducted in this work using a 10 kW down-draft gasifier.

Food waste, horse manure, chicken manure and sewage sludge mixed with wood chips in different ratios were fed to the reactor continuously at the rate of 10 kg/h. The temperature in combustion and reduction zone was 900 oC and 850 oC respectively. In-situ analyses of the produced syngas were conducted using a gas analyser before the gases were burned in the chimney. The syngas composition varied with the type and ratio of solid waste due to difference in ash content, elemental composition and solid structure.

Keywords: co-gasification, downdraft gasifier, solid waste management, syngas.

107: Plutonium Utilization in HTGR with ThO2 Fuel

ABDUL WARIS[1], SYEILENDRA PRAMUDITYA[2],
SIDIK PERMANA[3], ZAKI SU'UD[4]

1 Nuclear Physics & Biophysics Research Group, Department of Physics, Faculty of Mathematics and Natural Sciences, Institut Teknologi Bandung, Jl. Ganesa 10 Bandung 40132 INDONESIA, Email: awaris@fi.itb.ac.id
2 Nuclear Physics & Biophysics Research Group, Department of Physics, Faculty of Mathematics and Natural Sciences, Institut Teknologi Bandung, Jl. Ganesa 10 Bandung 40132 INDONESIA, Email: syeilendra@fi.itb.ac.id
3 Nuclear Physics & Biophysics Research Group, Department of Physics, Faculty of Mathematics and Natural Sciences, Institut Teknologi Bandung, Jl. Ganesa 10 Bandung 40132 INDONESIA, Email: psidik@fi.itb.ac.id
4 Nuclear Physics & Biophysics Research Group, Department of Physics, Faculty of Mathematics and Natural Sciences, Institut Teknologi Bandung, Jl. Ganesa 10 Bandung 40132 INDONESIA, Email: szaki@fi.itb.ac.id

VHTR (very high temperature reactor) is one of Generation IV nuclear reactors. HTGR (high temperature gas cooled reactor) is a VHTR type of reactors with a graphite moderator, helium gas coolant with UO2 fuel and outlet coolant temperature of 900oC or higher than that. In this study, instead of using UO2 fuel, we will evaluate the utilization of PuO2 and ThO2 as a mixed fuel in HTGR. The burnup period is 1100 days, which corresponds to 3 years of fuel cycle length. The reactor 3D calculation was performed by using CITATION-SRAC 2006 code, with the nuclear data library was derived from JENDL3.3. The neutron spectra become harder with the boosting of the plutonium fraction in loaded fuel. Moreover, the neutron spectra at EOC become softer compared to that of BOC. Fascinatingly, U-235 is generated more with the increasing of plutonium fraction.

.Keywords: Plutonium, HTGR, ThO2, SRAC, JENDL

111: A Design Study of an Amphitheatre in Delphi:

Nuances of Form, Fabric and Soundscape

SAT GHOSH[1,2], RAHUL HARIMOHAN PILLAI[3], ANAND MURALI[4], AMITESH ROY[5], SAIF UL HAQUE[6]

1 VIT University, Vellore, Tamil Nadu, India
2 School of Earth and Environment, University of Leeds, United Kingdom, satyajitg@vit.ac.in
3 VIT University, Vellore, Tamil Nadu, India, rahul.pillai93@gmail.com
4 VIT University, Vellore, Tamil Nadu, India, anandVITA411@gmail.com
5 VIT University, Vellore, Tamil Nadu, India, amiteshroy94@yahoo.in
6 VIT University, Vellore, Tamil Nadu, India, saif.haque9@gmail.com

The open air amphitheatre at Delphi in Greece is a structure of sublime architectural sanctity that has been the subject of study for ancient theatrical performances. This study explores through architectural and fluid mechanical modelling, the connection between layout, natural topography and the amphitheatre's orientation. A SolidWorks rendition of the centre stage along with the stepped gallery is embedded into sophisticated environmental fluid mechanical software ENVImet, for the very first time. A historical retelling is effected through the inclusion of Delphi's tree-scape around the amphitheatre. In addition, effects of dappled lighting of the mellow Mediterranean sunshine as the shadows lengthened for an evening spectacle is all replicated. Study of the ingress of winds and levels of coolth and warmth in the amphitheatre is also studied. Thereafter, the quality of the direct, reflected and the echoed notes are re-enacted through Autodesk Ecotect modelling. Theatrical grandeur is a subject of utmost importance in the plan of the Delphi Theatre. Exemplary transmission of sound has been achieved by creating a balance between the still surroundings of the slope overlooking the temple of Apollo, which prevents reverberations from external sources, whilst evenly distributing the sound by reflection from the orchestral area – all this is vividly recreated through the combination of architecture and fluid mechanics.

Keywords: Delphi, soundscape, day-lighting, form, orientation.

113: Performance and emissions prediction of natural gas engine using two-zone combustion model

YU DING[1], LA XIANG, JIALIN CUI, KUI WANG

College of Power and Energy Engineering, Harbin Engineering University, Harbin, China, [1] dingyu@hrbeu.edu.cn

Natural gas (NG) is considered as one of the cleanest fuels to replace the conventional fuels such as diesel, petrol because of its rather lower emissions, which has been proven by engine tests at labratories and manufactories in the world. Generally the NG engines share the similar structure profile with diesel or petrol engines, but the combustion characteristics and pollutant emissions are different due to its gaseous properties and higher hydrogen-carbon ratio.

In this paper a two-zone simulation model is built to characterize the thermodynamic state of the burnt zone and unburnt zone separately. Each of them is consisted of properties library, mass balance and composition, gas pressure, heat loss and pollutant formation sub-models, etc. The Vibe function, which is based on the first principle of chain reactions, is used to calculate the heat release rate of NG. In order to obtain the gas properties, the in-cylinder gas is considered as a mixture of three well defined basic mixtures - NG, air and stoichiometric gas, whose properties are the functions of temperature. The purpose of mass balance and composition model is to acquire the mass of each zone and proportions of the three basic mixtures. In the gas pressure model, 'First Law of Thermodynamics' is used to calculate the in-cylinder pressure. The heat transfer coefficient can be estimated using the Woschni formula while the temperatures of the cylinder wall, cylinder cover, piston crown are assumed to be constant. In pollutant formation model, the 'Zeldovich Mechanism' are applied to calculate the NO and concentration in the cylinder.

The simulation model is implemented in MATLAB/SIMULINK environment and provides the prediction of engine performance and pollutant emissions. Furthermore, a comparison is carried out between the two-zone model and a single-zone model, in which the power output and NO concentration are chosen as criterions. It is shown in the results that the two-zone model performs better in the prediction of NO emission with a slight difference in power output.

Keywords: natural gas engine, two-zone, simulation, performance, emissions

115: A Post-Occupancy Case Study on the Relationship between Domestic Energy Use and Occupancy Profiles

SOPHIE NAYLOR[1], MARK GILLOTT, EDWARD COOPER

Department of Architecture and Built Environment, Faculty of Engineering, University of Nottingham,
[1]Corresponding author - laxsjn@nottingham.ac.uk

This study covers the analysis of occupancy and energy use data collected from a live housing project in Nottingham, UK. Post occupancy evaluation/monitoring in buildings has been established to be of great importance, but implementation levels are generally low. Broader uptake of monitoring systems will increase understanding of buildings in use, allowing improved responsive building controls and future design feedback.

The analysis covered assesses: how closely domestic energy uses currently relate to inferred occupancy, whether wasteful energy behaviours can be identified between occupants in similar buildings, how these wastes might be addressed and how effectively occupancy/behaviour can be quantified using a simple and non-intrusive sensor system. Data was gathered from an existing energy platform recording space heating, water use and circuit-level electrical use in 8 high-environmental-performance houses. Occupancy was detected via two motion sensors present in each house, one per major floor. Two houses were equipped with CO2 sensors, allowing for more detailed analysis on a limited subset of the data. Data fidelity issues caused by backup at the data logger necessitated processing of the data prior to further analysis.

The results of the study show high variation in sensor response to occupancy despite the similarity between tested buildings. True occupancy levels and behaviours thus cannot be reliably inferred from simple sensor data alone, highlighting the need for a greater depth of information gathering in order to fully sense building context for the purpose of control or detailed analysis. While the relationship between domestic electrical energy use and occupancy rates is confirmed, it is difficult to prove from the data gathered whether all energy used provides utility to the occupant. Heating behaviours across unoccupied houses show approx. 14kWh per day difference, suggesting the significant impact of occupant control and behaviour in the home.

Keywords: occupancy, energy profiles, monitoring, performance, domestic

116: Software to Determine the Energy and Light Transmission of Glass Facades in Conjunction with Special Daylight Redirecting Systems

YANG LI[1], HELMUT KÖSTER[2], BERND BRUEGGE[3]

[1] Technische Universität München, Boltzmannstr. 3, Munich, Germany, yang.li@in.tum.de
[2] Köster Lichtplanung, Karl-Bieber-Höhe 15, Frankfurt/Main, info@koester-lichtplanung.de
[3] Technische Universität München, Boltzmannstr. 3, Munich, Germany, bruegge@in.tum.de

There is a lack of angle-selective evaluation of sun protection devices in rating systems. In particular, the visual transmission of the blinds, which deals with visual comfort, has not yet been addressed. In this paper we look at a specific light distribution of the transmitted sunlight, to improve daylight illumination in the depth of the room under consideration of daylight autonomy.

In order to make a qualitative assessment of shading devices and daylight systems, it is necessary to evaluate the technological structure of facades in their energetic consequence by a simultaneous evaluation of energy transmission, light transmission, room depth illumination and visual transmission with respect to latitude, orientation, climate, and sunshine hours.

We developed a software simulator based on 3D ray-tracing to meet these needs. The software allows to define a glass facade in its optimum size (light entry surface) and its technological specifications, by calculating the quantitative functional diagram and supporting an optimization of glass assemblies and glass coatings in combination with light redirecting structures.

This paper presents the development and features of the 3D ray-tracing simulation software, 3D-RayTracer. We have used the 3D-RayTracer to simulate light transmission. The results of two different daylighting systems are described (RetroLuxTherm 20 mm and RetroFlex introduced by company RetroSolar, developed and patented by Dr. Helmut Koester). The paper finishes by discussing energy savings and further development of the 3D-RayTracer.

Keywords: daylight technology, simulation, software development, daylight redirecting systems

118: Electric vehicle role in PV self-consumption optimisation

DAINIUS ALONDERIS[1], MARK GILLOTT, RABAH BOUKHANOUF

Architecture, Energy & Environment Research Group,
Faculty of Engineering, University of Nottingham, UK
[1] ezxda3@nottingham.ac.uk

One of the problems with increasing photovoltaic (PV) penetration is related to the fact that the actual generation profiles usually do not match the energy demand of a typical domestic house. There are a number of different ways which can be used to bridge this energy gap including demand side management (DSM) and energy storage techniques, allowing manipulation of energy consumption and distribution within households. This paper analyses an alternative way for increasing self-consumption of distributed energy in a zero carbon house serving as an office for research staff at the University of Nottingham. The initial focus of the work looks at electric vehicle (EV) as alternative energy storage or consumption solution for excess electricity generated from an onsite PV system.

The energy distribution within the office as well as EV charging profiles were obtained and evaluated using a state-of-the art wireless control and monitoring platform. One year data of PV exported electricity was compared to the average diurnal office energy demand. Any excess PV export then was evaluated against different EV charging approaches in order to find and relate, if any, self-consumption benefits of localised PV generation. Thus, the actual observed PV generation and EV charging profiles with controlled and uncontrolled EV charging strategies were analysed to find any possible reduction in exported electricity, increasing PV power utilisation onsite. The results show that the smart EV charging methods can increase self-consumption of electricity generated from PVs as well as may moderate the likely rise in peak energy demand associated with increasing EV penetration in the domestic built environment. In addition, results were shown that the energy demand and costs associated with charging EV batteries could be reduced when utilising PV export output.

Keywords: Building control and monitoring system; Distributed generation; Load matching ; Electric vehicles

121: Investigating the Role of Façade Design in Improving Energy Efficiency for Residential Tall Buildings in Saudi Arabia

NOURA GHABRA [1], PHILIP OLDFIELD[2], LUCELIA RODRIGUES[3]

[1] University of Nottingham, Department of Architecture and Built Environment, University Park, Nottingham, NG7 2RD, United Kingdom, laxng5@nottingham.ac.uk
[2] University of Nottingham, Department of Architecture and Built Environment, University Park, Nottingham, NG7 2RD, United Kingdom, philip.oldfield@nottingham.ac.uk
[3] University of Nottingham, Department of Architecture and Built Environment, University Park, Nottingham, NG7 2RD, United Kingdom, lucelia.rodrigues@nottingham.ac.uk

In Saudi Arabia, 53% of the primary energy is consumed in the residential sector due to the significant use of air conditioning to cool the indoor spaces. Moreover, actively conditioned tall building poses many environmental challenges as major contributors to CO2 emissions arising from the combustion of fossil based fuels. Despite the efforts reflecting the government's growing concern about domestic energy consumption, the scattered conservation efforts have been largely ineffective. As for the local building codes, the typical approach deals only with the minimum requirements of the 'engineering parameters' of building envelope (e.g. adjusting glazing and wall properties, thermal transmittance values), without addressing the façade's 'architectural design parameters' such as shading devices and intelligent use of transparency and opacity, that interact with the building design and have an impact on performance of the building.

In this paper, the authors explored the hypothesis that the current approach focussing on the façade's engineering parameters is not sufficient to achieve the necessary energy efficiency in residential tall buildings in the hot climate of Saudi Arabia, and architectural design parameters, which are less common in their application in the region, could be explored to reduce cooling loads. In order to investigate this hypothesis, the current architectural characteristics of residential tall buildings in the region were identified to establish a representative hypothetical base case in the city of Jeddah, and then 27 sets of dynamic thermal simulations were compared. The best and worst combinations of glazing ratio, wall and glazing type were identified in order to understand the most influential parameter impacting the cooling energy loads in the building. The findings suggest that the difference between the best case and worst case build up ranges between 92 and 128%, outlining the huge role even simple facade design changes can make in terms of energy performance.

The work aims to contribute to the effectiveness and potential enhancement of building codes and regulations for residential tall buildings in Saudi Arabia, especially in terms of energy efficiency measures and benchmarks, and the quality of indoor environment for this building type.

Keywords: Energy Efficiency, Tall buildings, Residential, Façade Design

123: Climate-responsive Design in Contemporary Australian Housing

The poetics and pragmatics in the Ball-Eastaway and Marika-Alderton house by Glenn Murcutt

MAURICIO LECARO[1], BENSON LAU[2]

[1, 2] The University of Nottingham, Department of Architecture and Built Environment,
[1] mauricio.lecaro@alumni.nottingham.ac.uk
[2] Benson.Lau@nottingham.ac.uk

Glenn Murcutt is nowadays recognized as one of the most influential environmental architects of the century. His design philosophy, environmental awareness and in-depth understanding of the Australian context and vernacular architecture, have led him to become one of the leaders of critical regionalism worldwide. His buildings aim not only to provide shelter, but to lower their environmental impacts through simple, yet innovative design solutions.

Murcutt's buildings are well documented and published, nevertheless, they have not received much academic attention and limited evidence based research and publications are available to assist holistic understanding of his work. Through a critical review of two of his most celebrated projects (i.e. the Ball-Eastaway and Marika-Alderton house), the authors aimed to fill this research gap.

Although the selected houses share a similar building typology, their location, orientation, materiality and environmental requirements greatly differ. While the Ball-Eastaway was conceived as a relaxing habitat, embedded in a secluded bush land in NSW and the main design concept was to exploit the local landscape and views, the Marika-Alderton house was designed as a climate responsive shelter for an aboriginal family on the seaside of Eastern Arnhem, NT.

By conducting theoretical qualitative and quantitative analysis, the close connection between the spatial quality, environmental design strategies and performance of the two houses were thoroughly studied. Through this study, the effect of these elements on Murcutt's unique way of materialising environmentally conscious buildings was revealed. The research outcomes indicate that even though both buildings experienced occasional visual and thermal discomfort, they performed well for most of the time as intended free-running buildings, proving that their constant connection with the exterior greatly affects their internal comfort conditions.

Through his environmental design principles, Murcutt's buildings are sensibly designed to be adaptable, spatially delightful and to have a low carbon footprint, while having a continuous dialogue with nature. The significance of Murcutt's work lies precisely in this delicate liaison between his romanticism and practicality.

Keywords: Critical regionalism, environmental design, responsive architecture, free-running buildings, comfort.

124: The Application of Vernacular Australian Environmental Design Principles on Contemporary Housing

Lessons Learnt from the Marie-Short House by Glenn Murcutt

MAURICIO LECARO[1], LUCELIA RODRIGUES[2], BENSON LAU[3]

[1, 2, 3] The University of Nottingham, Department of Architecture and Built Environment,
[1] mauricio.lecaro@alumni.nottingham.ac.uk
[2] Lucelia.Rodrigues@nottingham.ac.uk
[3] Benson.Lau@nottingham.ac.uk

Glenn Murcutt's deep knowledge of the Australian landscape and understanding of the climate challenges resulted in buildings designed to respond, rather than impose on the local context. The unintended greatness of his work lies on his mastery ability to adopt, reinterpret and reinvent the elements found in vernacular Australian architecture. Murcutt's buildings are narrow in plan, light, airy and in tune with seasonal climatic variations; above all, they are designed to minimise their environmental impact, guided by an unwavering belief that we have to touch this Earth lightly.

In this paper, the authors investigated and assessed the impact and implications, which the reinterpreted elements of Australia's vernacular architecture, (e.g. verandahs, overhangs, roofing shape and narrow spaces) had on the performance and spatial delight of the Marie-Short House. Through computer aided modelling, both daylight and thermal environments were assessed and analysed in correlation with Murcutt's environmental design strategies, (i.e. enhancing shading and natural ventilation) in order to achieve comfortable spaces, which enrich and enhance the inhabitants' spatial experience and comfort conditions.

The findings revealed that when Murcutt's simple environmental design strategies, (i.e. natural ventilation, shading and buildings on stilts) were combined with the reinterpreted vernacular elements, they were not sufficient for the house to perform as expected; the results showed that while Murcutt's natural ventilation strategy, when combined with the shading provided by the verandahs, is fundamental to improve thermal comfort within the house, the blinds and overhangs as designed, are not sufficient to prevent visual discomfort.

In spite of this, Murcutt's work is intuitive yet well-informed and more significantly, it is born from the uniqueness of each place. The combination of Murcutt's environmental design principles with the reinterpreted vernacular elements, reflected the skilfulness and significance that lies in his work, he envisioned a low energy consuming building that through a permanent connection with nature like an orchestra, adapted and silently merged into the landscape.

Keywords: Spatial delight, environmental comfort, vernacular inspirations, climate responsive architecture.

135: High Capacity Energy Efficiency Solar Glass

CHIN-HUAI YOUNG[1], SAFFA RIFFAT [2], ERDEM CUCE[3]

[1] Marie Curie Fellow, University of Nottingham, chin-huai.young@nottingham.ac.uk
[2] Professor, University of Nottingham, saffa.riffat@nottingham.ac.uk
[3] Research fellow, University of Nottingham, laxec5@nottingham.ac.uk

A kind of high capacity energy efficiency solar glass developed for zero energy buildings is introduced in this paper. The glass called Heat Insulation Solar Glass (HISG) can generate solar power as well as decrease energy consumption to reach a target of highest energy efficiency capacity. According to a real testing of glass house, the HISG can generate high solar power and save energy consumption of cooling and heating system. All the solar power generation from HISG can supply all the energy consumption of cooling and heating system all year and still have remaining power to supply another energy consumption of a building. Compared with all the other energy efficiency glass, the HISG is a kind of highest energy efficiency solar glass in the world for the application on the zero energy buildings and low carbon buildings.

Keywords: solar glass, insulation, energy efficiency, zero energy buildings, low carbon buildings

137: Numerical study of novel corrugated heat and moisture exchanging sheets applied to counter-flow dew point air cooler

PENG XU[1,2], XIAOLI MA[1],XIONG YAXUAN[2],DEYING LI[2],
YONGZHENG SHI[2], XUDONG ZHAO[1]*

1 School of Engineering, University of Hull, UK, HU6 7RX
p.xu@hull.ac.uk; x.ma@hull.ac.uk; x.zhao@hull.ac.uk
2 Beijing Key Lab of Heating, Gas Supply, Ventilating and Air Conditioning Engineering, Beijing University of Civil Engineering and Architecture, Beijing University of Civil Engineering and Architecture, Beijing, China, 100044
xupeng@bucea.edu.cn; lideying@bucea.edu.cn; shiyongzheng@bucea.edu.cn

The authors present a numerical investigation on the performance of corrugated-sheets-stacked heat and moisture exchanger (HMX) applied to counter-flow dew point air cooler. The computational simulation software for this investigation was developed under Engineering Equation Solver (EES) environment. The results showed that the HMX could run with stably high effectiveness (generally, wet bulb effectiveness over 130% and dew point effectiveness over 85%) and supply product air at stably low temperature, as well as improve automatically the total cooling capacity with the temperature rise of the ambient air. The HMX also presented high adaptability to the various climate conditions in Southern Europe, Northern Europe and the UK. The renovation in heat exchanger configuration could lead to significant increase in the cooling capacity and COP for dew point coolers, and decrease in size and cost of the coolers at the same cooling output.

The major factor affecting the cooling performance was the relative humidity of inlet air, therefore the HMX was particularly suitable for heat-intensive places in winter, i.e. computer data centres. The optimized air-channel's geometric sizes of height and length were 0.005m and 1.0m respectively. The ideal range of operational conditions of working air ratio should be between 0.3 and 0.5 and the reasonable velocity of inlet air around 1m/s, while the inlet water temperature had little effect on the performance.

Keywords: Dew point cooling; Corrugated sheet; Heat and moisture exchanger; Counter-flow; Simulation

138: An Innovative External Wall Insulation System for Energy Efficient Refurbishment of Houses

JENNIFER WHITE[1], LUCELIA RODRIGUES[2],
MARK GILLOTT[3], RENATA TUBELO[4]

[1,2,3,4] Department of Architecture and Built Environment, Faculty of Engineering, University of Nottingham, Nottingham NG7 2RD, UK
[1] j.white@nottingham.ac.uk
[2] Lucelia.Rodrigues@nottingham.ac.uk
[3] Mark.Gillott @nottingham.ac.uk
[4] Renata.Tubelo@nottingham.ac.uk

Energy use from housing contributes in the region of 27% of total UK carbon dioxide and greenhouse gas emissions. Therefore, achieving the national target of an 80% reduction in emissions by 2050 is highly dependent on the reduction of energy consumption in dwellings. Whilst progress is being made towards the improvement of the building fabric of new build dwellings, the existing building stock presents a more complex problem. The UK has over 8.5 million houses that are in excess of 60 years old, which are expected to still be in use for many years and yet need to be made considerably more energy efficient.

There are limited insulation options available to those who occupy solid wall properties, making these particularly difficult to treat. Existing internal and external insulation products tend to be expensive, and installation on site can be time-consuming and weather-dependent. An innovative external insulation system has been developed, which seeks to overcome some of these barriers. The system, which consists of an uPVC shell with an insulating foam core, was designed to fit on most homes, within half the time, in variable weather conditions and using a lower level of installation skills than current systems.

In this study, the authors have analysed the thermal bridging and condensation issues associated with the new product, alongside calculation of a theoretical u-value. Dynamic whole building simulation has been undertaken using a typical Nottingham (UK) property construction, with annual energy demands derived for scenarios both before and after installation of the external insulation system. The results indicate that the innovative external wall insulation panels are able to provide similar levels of improvements in u-values and energy demands/greenhouse gas emissions as compared to more conventional products. It therefore presents a viable alternative to systems that currently exist, thus expanding the number of options available for housing retrofit projects.

Keywords: retrofit, external insulation, social housing, energy efficiency, solid wall properties

140: A novel way to calculate the light transmittance loss of glass for Photovoltaic (PV) modules according to known accumulated dust density

YU. JIANG*, LIN. LU

[1] *Renewable Energy Research Group, Department of Building Services Engineering, The Hong Kong Polytechnic University, Kowloon, Hong Kong Special Administrative Region, China, jy293251@sina.com*

Abstract: Accumulated dust will decrease the light transmittance of glasses for Photovoltaic (PV) modules and thus has a negative effect on the energy conversion efficiency of (PV) modules greatly. However, there has been no model to accurately calculate the change of light transmittance of PV modules based on known accumulated dust density. In this paper, a novel way is built to calculate light transmittance resulting from accumulated dust. This way considers two processes. One is light refraction process and the other is light extinction process. For engineers, if they measure the refraction and extinction parameter of local accumulated dust, the light reduction can be calculated by this model easily. In addition, for Arizona Dust, the refraction parameter is 1.5459 and the extinction parameter is 0.028 based on the experimental results.

Keywords: Accumulated dust, Photovaltic(PV) modules, Light transmittance, Dust density, Extinction coefficient

143: An Irreversibility Analysis of the Air to Air Heat Pump

SABAN TAMDEMIR[1], ALI KILICARSLAN [2,3]

1 "Ministry of Environment and Urban Planning", Ankara-TURKEY, s-tamdemir@hotmail.com
2 "Hitit University-Department of Mechanical Engineering", 19030 Corum-TURKEY, alikilicarslan@gmail.com 3Corresponding Author, Telephone: +90(364) 2274533/1236, Fax: +90 (364) 2274535,

Second law analysis of thermal systems is very important because it enables us to determine the irreversibilities and entropy generation occurring in the elements of those systems and it also enables us to determine the exergetic efficiencies of the components of thermal systems.

In this experimental study, the air to air heat pump in which R134a is used as refrigerant, that was installed to a room having dimensions of 6000x4000x3800 mm, was tested between the outdoor temperatures of -2.5°C and 4.5°C. The irreversibilities of the compressor, indoor unit, outdoor unit and capillary tube were investigated with respect to the experimental data. Experiments at the same outdoor temperatures were repeated three times under the controlled conditions. Analyses of the results obtained from the experiments were carried out by the computer code that was developed by means of Engineering Equation Solver (EES-V9.723-3D). The irreversibilities of the elements including compressor, indoor and outdoor units and capillary tube increased as the outdoor temperature was increased. The maximum amount of irreversibilities occurred in the compressor while the minimum occurred in the indoor unit.

Keywords: Air to air heat pump; heating; second law; irreversibility; R134

144: CFD simulation of wind environment around a high-rise building at pedestrian level in Hong Kong

DEQI WANG[1*], LIN LU[1], PING CUI[2,3], YU JIANG[1]

[1] Renewable Energy Research Group, The Hong Kong Polytechnic University, Hong Kong, China
[2] Shandong Key Laboratory of Building Energy-saving Technique, Jinan, China
[3] Key Laboratory of Renewable Energy Utilization Technologies in Buildings, Ministry of Education, Shandong Jianzhu University, Jinan, China

Recently, increasing number of high-rise buildings are built in Hong Kong, especially in the urban area. Wind environment of existing buildings is affected significantly by the high-rise buildings. Flow distribution of high-rise buildings closely interacts with existing building, which may influence pollutant distributions at the height of activity of human being. In this paper, the finite volume method was used to investigate the effect of a new high rise building on wind environment of existing buildings, and the pulsating flow was simulated by RNG k-ε model. A suitable computational grid was generated by special methods. A comparison experiment was conducted between the isolated buildings with high-rise building and without high-rise building. A ventilation threat area has been found with its wind speed reaching above 12m/s and an updraft area has also been detected in the case of high-rise building, which may lead to a contamination threat to the downstream buildings.

Keywords: CFD, Wind environment, Urban area, High-rise building

146: Study on the diagnosis index system and procedure for green retrofitting of existing buildings

SUZHEN MA[1], JINJIN SUN[2]

[1] China Academy of Building Research, Room D2, 12th Floor Haili Mansion, No. 88 Dapu Road, Shanghai,
Email: masuzhen@cabr-sh.com
[2] China Academy of Building Research, Room D2, 12th Floor Haili Mansion, No. 88 Dapu Road, Shanghaii
Email: sunjinjin@cabr-sh.com

It is well known that green retrofitting of existing buildings is key supporting research of China's "Twelfth Five-Year Plan". To undertake and promote retrofitting of existing buildings, especially green retrofitting in China, the primary problem needed to be solved is diagnosis for existing buildings. Just through diagnosis, the present situation of existing buildings can be completely mastered so that the subsequent green retrofitting can become more targeted. In this paper, study for the index system of diagnosis of green retrofitting of existing buildings is discussed. This paper also illustrates the principle of the establishment of the index system of diagnosis. In the meantime, the whole index system of diagnosis, the whole diagnosis framework, procedure and method are also given. All these give a guidance for the diagnosis of green transformation of existing buildings which is significant for technology research of green retrofitting of existing buildings in China.

Keywords: Existing building; Green retrofitting; Diagnosis; Index system

148: Fabrication and commercial demands of Self-cleaning hydrophobic surface for buildings

HONGXIA CHEN [1], YUYING YAN[2], YANGLI MAO [3]

[1] Energy Sustainability Research Division, Faculty of Engineering, University of Nottingham, UK, NG9 2RD, Energy Power and Mechanical Engineering, North China Electronic Power University, China, Beijing 102206, hongxia.chen@nottingham.ac.uk
[2] Energy Sustainability Research Division, Faculty of Engineering, University of Nottingham, UK, NG9 2RD, yuying.yan@nottingham..ac.uk
[3] Energy Sustainability Research Division, Faculty of Engineering, University of Nottingham, UK, NG9 2RD, yangli.mao@nottingham.ac.uk

The super-hydrophobic surface has been a subject of intense interest over the past several years. A considerable amount of work has been carried out to study the involved mechanisms and principles, preparation methods. With the development of economic the number of skyscraper and high-rise building is continues increasing around the world during past several years. Higher the building the cleaning working is more danger and more expensive, so many skyscrapers produce enormous demands of self-cleaning coating. While, Self-cleaning coatings play their role with two mechanisms: super-hydrophilic and super-hydrophobic. Super-hydrophobic surfaces with a contact angle bigger than 150°and a low contact angle hysteresis (less than 10°) show real self-cleaning mechanical with forming a lay of air to keep the droplet stay at the top of hierarchical structures which is different from that of hydrophilic self-cleaning surface. But in the market the super-hydrophobic self-cleaning coating has not been popular until now for multifunctional demands and technological difficulties. In this paper, advanced technologies of fabrication and the commercial demands were jointed together. With the data of the distribution of skyscrapers a huge market for self-cleaning coating is shown all over the world especially in Asia. Current advanced studies on self-cleaning super-hydrophobic coatings are summarizes especially involved in the building application for its visible rapid-increased commercial demand. According to the analysis on potential market, Super-hydrophobic self-cleaning surfaces show a numerous application potential for smart building with lowest cleaning cost. In addition, more performances such as solar control, energy conservation and thermal insulation are urgent requirements of widening commercial market; prolonged lifetime, high adhesion, transparency, wear resistance and regeneration should be got more concern to cooperate with self-cleaning character in the further research work on the super-hydrophobic coating. In the nearly future, base on the mature technology and the advanced studies, surface functional materials must be serve import role in the passive building without anything consumption.

Keywords: super-hydrophobic surface; self-cleaning; smart building; low cost; commercial demand

149: Passive and Active Solutions to Improve the Energetic Efficiency of Buildings

CLITO AFONSO[1], RICARDO PEREIRA[2]

1 Porto University, FEUP, R. Dr. Roberto Frias, 4200-465 Porto, clito@fe.up.pt
2 Porto University, FEUP, R. Dr. Roberto Frias, 4200-465 Porto,ricardo@fe.up.pt

Today the building sector has a significant weight in energy consumption and a high potential for increasing its energy efficiency. With the enforcement of the energetic certification, it has been tried to find and select different solutions that presents less energy consumption and waste, which translates into an effective reduction of CO2 emissions. It is in this perspective that this work fits, since its main aim is to evaluate the contribution of passive and active solutions of a hotel for the improvement of the energetic efficiency, as well as to evaluate the contribution of some renewable energy sources. Within them, the contribution of solar systems for hot water heating and electric energy production has been approached. Despite the importance assumed by using renewable energies in the buildings sector, cogeneration remains as the most effective technology on the conversion of primary energy into electricity and heat. The application of cogeneration technologies in the buildings sector gains notability facing the rise of fuel prices and the need to ensure adequacy and comfort of spaces. Relatively to the practical case in study, the building is a hotel located in Portugal. Multizone dynamic codes for simulations were used. To improve the building performance, there were made several changes on the model with the goal of evaluating the contribution of different solutions, either at passive and active level, in order to increase the energetic efficiency of the hotel. It was concluded that they contribute to a reduction of thermal needs of 25.2% and avoided emissions of equivalent tons of CO2 of 30.4%.The analysis of the technical/economic viability of the implementation of the CHCP becomes executable, using a system based on an internal combustion engine that runs with natural gas, with an absorption chiller to produce cooling. The payback period of this solution is less than 8 years which proves that there is an economic viability of this technology.

Keywords: Energy analysis, Avoided CO2 emissions, Economic analysis.

151: Experimental Investigation of a Thermochemical Adsorption Pumping Pipe Cooling System

AUWAL DODO [1*], NORHAYATI MAT-WAJID[1], BLAISE MEMPUOU[1], SIDDIG OMER[1], SAFFA RIFFAT[1]

1 Architecture, Energy & Environment Research Group, Department of Architecture & Built Environment, University of Nottingham, University Park, Nottingham NG7 2RD, UK
**Corresponding email: Auwal.Dodo@nottingham.ac.uk*

In this paper, a novel thermochemical energy storage/cooling system, utilizing Vermiculite and Calcium Chloride composite adsorbent material is experimentally investigated. A laboratory test unit consisting of two pipe sections namely; adsorption and evaporation/condensation sections, separated by a valve was designed and constructed. The system was experimentally tested and the temperature across the cooling side of the test rig was observed to have dropped to a low temperature of around 2.5°C from an initial temperature of 18°C. The experimental results also revealed that the system could utilise relatively low temperature, around 60°C for charging/adsorbent regeneration, which could be realized through the use of low grade thermal energy and renewable energy sources. The results also showed that the novel system has the potential for high performance thermochemical adsorption cooling and could be up-scaled and utilised for building applications.

Keywords: thermochemical energy storage; thermochemical materials; adsorption cooling

153: Esterification of oleic acid with methanol by a sulfonated carbon-based solid acid microspheres (SCMs)

HONGLEI ZHANG[1, 2], ZHENG MA[1], CHUANGSHENG JIANG[1], JIARUI GAO[1], GEORGE Z. CHEN[2, 3, 4], TAO WU [1*], FENG HE [5*]

[1] Faculty of Science and Engineering, The University of Nottingham Ningbo China, Ningbo, 315100, P.R. China
[2] Department of Chemical and Environmental Engineering, Energy and Sustainability Research Division, The University of Nottingham, Nottingham, NG7 2RD, UK
[3] International Academy of Marine Economy and Technology, The University of Nottingham Ningbo China, Ningbo, 315100, P.R. China
[4] Center for Sustainable Energy Technology, The University of Nottingham Ningbo China, Ningbo, 315100, P.R. China
[5] College of Biological and Environmental Engineering, Zhejiang University of Technology, Hangzhou, Zhejiang 310032, China.

A carbon-based solid acid microspheres rich of sulfonated groups (-SO3H) was prepared by simple hydrothermal and sulfonation method using cheap glucose as raw material. The green, non-corrosive, renewable and environmental friendly carbon material was used as heterogeneous catalysts for the esterification of oleic acid with methanol for biodiesel production. The structure and properties of the carbon microsphere were characterized by using Field-Emission Scanning Electron Microscope (FESEM), Transmission Electron Microscope (TEM), Fourier Transform Infrared Spectroscopy (FTIR), Thermo Gravimetric Analysis (TGA) and Differential Scanning Calorimeter (DSC), elemental analysis, N2 adsorption–desorption test and acid-base titration. It is found that the carbon microspheres prepared under the optimal reaction conditions showed smooth surfaces, uniform particle sizes and good dispersion. The sulfonated carbon-based solid acid microspheres showed high acidity and comparable activities to sulfuric acid for the esterification reaction of oleic acid with methanol. Reaction parameters including methanol/oleic acid mass ratio and catalyst usage amount were studied to get optimal esterification reaction conditions. The catalysts showed high reusability although there is some loss in acidity due to the leaching of active sites, the sulfonated groups.

Keywords: Biodiesel production, Carbohydrates, Esterification, Hydrothermal method, Solid acid catalyst

155: Existing metrics, codes and technologies for HVAC design of energy-efficient data centre:

A literature review

ZISHANG ZHU [1], YAN LU [2], XUDONG ZHAO [1*] , YANYI SUN [3]

1 School of Engineering, University of Hull, UK, HU6 7RX
2 China Academy of Building Research Southwest Institute, China
3 Department of Architecture and Building Environment, University of Nottingham, UK

The data centre energy demand increased rapidly because the explosion of IT industry, and the annual increasing rate will keep as high as 20% in the predictable future. Until 2013, there are over 1000 large colocation data centres from 24 countries in EU and 562 from China, taken 1.3% and 1.2% energy from the whole social energy consumption respectively. However, in a typical EU data centre, 40% energy is used for HAVC and 10% is relevant to the building itself, both of which have a huge energy saving potential by applying advanced HAVC technologies and proper building design strategies.

This paper reviewed the codes and standards for energy-efficient data centre, as well as relevant techniques in term of data centre HVAC system design. The most widely used data centre energy efficacy metrics and benchmarks are studies, the requirements of codes from main countries are compared and analysed, such as Chinese "DB31/651-2012: The norm of Data centre Unit Energy Effectiveness" and "The EU Code of Conduct on Data Centres". Meanwhile, a number of data centre adoptable energy saving system (mainly represent by cooling system) are investigated.

By investigation and comparison of metrics, code and techniques mainly including cooling and energy recovery, the energy efficiency requirements emphasis and the features of available energy saving techniques for data centre are summarised in this paper. Although the code requirement is higher and higher, and the technologies are keep improving, obvious shortcomings still exist in sustainability and economic aspects which are discussed in the end of this review.

Keywords: Energy efficiency; Data centre; Building service, HVAC, codes, metrics, techniques;

156: A simplified 3D urban unit representation for urban microclimate simulations: A case study in China's 'Hot Summer and Cold Winter' climate zone

LEONIDAS BOURIKAS[1], PATRICK A.B. JAMES[1], ABUBAKR S. BAHAJ[1], MARK F. JENTSCH[2], TIANFENG SHEN[3], DAVID H.C. CHOW[4], JO DARKWA[5],

1 Energy & Climate Change Division, Sustainable Energy Research Group (SERG), University of Southampton, Southampton SO17 1BJ, UK
2 Urban Energy Systems, Bauhaus-Universität Weimar, Weimar, Germany
3 Centre for Sustainable Energy Technologies, University of Nottingham Ningbo, CN
4 School of Architecture, University of Liverpool, UK
5 Faculty of Engineering, University of Nottingham, UK

The method of how surface morphology is considered can strongly influence the function of weather prediction models. Surface detail requirements change with the purpose of the model. For example, assessing the pollution dispersion within a specific urban setting will require a higher degree of surface detail than an urban canopy model that parameterises the urban energy fluxes in the surface layer. This study aims to develop a simplified 3D urban unit model for use with microclimate simulations. The new urban unit model is thermally equivalent to actual sites studied in Hangzhou, China.

Findings are presented from a site surface analysis at nine locations with residential / institutional (universities) use. The development of the urban unit model was based on the inclusion of the main thermal and morphological characteristics of the actual studied sites. The 3D urban unit model has a circular-disk shape with a 250m radius. The size of the urban unit was assessed for the source area footprint of the air temperature and relative humidity signals at the centre of the urban unit.

The influence of the pervious surface ratio (Pr) on the local, street level air temperature and relative humidity development was assessed in relation to the distance from the centre of the urban unit through simulations using a Computational Fluid Dynamics - Surface Energy Balance analysis tool (ENVI-met version 4). The developed idealised urban unit model was validated against air temperature and relative humidity measurements collected at street level at the studied locations in Hangzhou. The simulation results for the diurnal development of the microclimate at the local scale are then used to propose initial urban design guidelines. These guidelines give an indication of the potential of moderating the urban microclimate to benefit, both pedestrian thermal comfort as well as building performance and energy use.

Keywords: idealised urban model, micro-climate simulations, vegetation, urban air temperature, cities

159: Methodology of Energy Monitoring and Assessment of the Energy Saving due to the Building Retrofit

B. MEMPOUO*, S. B. RIFFAT,

Architecture, Climate & Environment (ACE) Research Group, Institute of Sustainable Energy Technology, Department of Architecture & Built Environment, University of Nottingham; University Park, NG7 2RD Nottingham, United Kingdom
**Corresponding Author: Blaise.mempouo@nottingham.ac.uk*

Buildings account for more than 40% of Europe's Energy consumption, where about 64% is accounted for by existing buildings. Retrofitting of these existing buildings offers significant opportunities for achieving the EU objective of reducing energy consumption and greenhouse gas emissions by 20% by 2020.The methods to identify the most cost-effective retrofit measures for particular buildings are still a major technical challenge, which is leading to a "progressive widening of the gap between theory and practice". Drawing on the lack of real life data for whole buildings and technologies energy use patterns, a baseline of existing whole buildings and technologies energy usage (pre-retrofitting) must be established from which improvement and efficiencies can be measured. Since, one can't simply compare the total amount of energy the building used in the year before and the year after, due to weather difference conditions from year to year, so an abnormally warm winter the year before followed by a really cold winter might cause the house to use even more energy than before. This paper recommends a systematic approach to proper selection of energy monitoring and explores a weather-normalisation method for estimating the energy savings due to building retrofit. The energy signature and the so-called Normalised-Annual-Consumption were developed from the utilities (gas and electrical) meter readings/bills. The paper also describes the propose methodology for an on-going longitudinal energy monitoring (post-retrofitting) to determine actual energy saving brought about by a wide range of retrofitting technologies.

Keywords: Utilities (gas and electricity) bills, Monitoring, Energy Saving, Existing Dwellings, Building Retrofit

163: Development of Timber Structure and Green Building in China

XIAOYANG LI[1],SHANGQUN XIE[2, 1], QINGQIN WANG[1], ZHIJUN CHENG[1]

1 China Academy of Building Research, China
2 Beijing Jiaotong University, China.

This paper introduces the development, current situation and insufficiency of timber structure in China and offers a proposal. After analysing technical standards of timber structure, the paper supplies the ideas and development proposals of timber structure in China.

Keywords: timber structure, green building, technical standard, Chinese standard.

166: Numerical Simulation of a Hybrid Concentrated Solar Power/Biomass Mini Power Plant

JOÃO SOARES[1], ARMANDO OLIVEIRA[1,2]

[1] Dept. Mechanical Eng. University of Porto, Rua Dr Roberto Frias 4200-465 Porto-Portugal, joaosoares@fe.up.pt [2] CIENER-INEGI, Rua Dr Roberto Frias 4200-465 Porto-Portugal, acoliv@fe.up.pt

Renewable electricity generation systems are increasingly used as a means of reducing harmful emissions and also reducing operational costs, by comparison with the use of fossil fuels. However, renewable energy sources such as solar energy are characterised by a high degree of intermittence, sometimes unpredictable. This constraint leads to inability to meet the demand of a power system. Hybridisation with more stable renewable sources, such as biomass, represents a resourceful way of meeting energy demands uninterruptedly. Besides stability, hybridisation with biomass allows a fully renewable solution, at the same time promoting security of energy supply.

In this paper, a hybrid renewable electricity generation system is presented and modelled. The system relies on a combination of concentrating solar energy (CSP) and biomass sources to drive an ORC cycle. The solar field is constituted by 12 parabolic trough collectors with a net aperture area of 984 m2. As backup energy, a biogas boiler is used, running on organic food waste. The nominal ORC electrical output is 60 kW. The system was designed and a prototype will be installed in Tunis, in the framework of the REELCOOP project, co-funded by the EU.

A computer model was developed with a combination of EBSILON and EES. EBSILON is used for the solar field (SF) and boiler simulations, and EES for the ORC. Annual simulations were carried out for solar-only and hybrid modes. Distinct operation ranges and boiler sizes were analysed.

The system annual yield is significantly improved with hybridisation, with enhancement of SF and ORC efficiencies. Electrical generation stabilisation was achieved during the whole year with the fulfilment of ORC minimum requirements. On the other hand, hybridisation promoted energy excess mostly in the summer months, demonstrating that hybridisation significantly reduces, but not eradicates, the need of storage.

Keywords: CSP, Biomass, Hybridisation, Generation

167: Development of an energy simulation software for high-tech frication plants (1):

Theoretical model and verification

TI LIN[1], SHIH-CHENG HU[1], YI-YUN CHUENG[1]

1 Department of Energy and Refrigerating Air-Conditioning Engineering, National Taipei University of Technology, 1, Sec. 3, Chung-Hsiao E. Rd., Taipei City 106, Taiwan (R.O.C.), schu.ntut@gmail.com

High-tech manufacturing consumes huge of energy. For example, a 12 in DRAM (Dynamic Random Access Memory) semiconductor wafer fabrication plant (hereafter referred "fab") consumes about 400,000 MWh annually in electricity (as much as 25,000 homes use, each consumes about 4,000 kWh/year). The potential for energy savings in fabs is commensurate with the magnitude of their energy consumption. For air-conditioning, fabs are different from those commercial buildings. Fabs need a lot of outside air to keep a positive pressure, while outside air and circulating air often treated separately. The general building energy analysis software handles the air-conditioning system for the outside air mixed with return air through the centralized system, which is different from that of a fab. Plus, the general building energy analysis software does not include electricity consumption items, such as process cooling water system (PCW), compressed dry air (CDA) system, nitrogen system, vacuum system and exhaust system. Process equipment cooling system is not included in the general building energy analysis software modules either. In this study, a Fab Energy Simulation (FES) software was developed. FES with features such as: open source code, multi-language interface, capable of handling different arrangements of components in the make-up air unit (MAU). In this paper, mathematical model is presented in detail. The results are verified by the power consumption data of an operating semiconductor wafer fab, with less than 4% in each output category.

Keywords: Energy Simulation, Cleanrooms, Annual Energy Consumption

169: Sensitivity analysis for minimization of input data for urban scale heat demand forecasting

ANETA STRZALKA[1], DIRK MONIEN[2],
ATHANASIOS KOUKOFIKIS[3], URSULA EICKER[4]

[1] Stuttgart University of Applied Sciences, Schellingstr. 24, 71174 Stuttgart, aneta.strzalka@hft-stuttgart-de
[2] Stuttgart University of Applied Sciences, Schellingstr. 24, 71174 Stuttgart, dirk.monien@hft-stuttgart-de
[3] Stuttgart University of Applied Sciences, Schellingstr. 24, 71174 Stuttgart, athanasios.koukofikis@hft-stuttgart.de
[4] Stuttgart University of Applied Sciences, Schellingstr. 24, 71174 Stuttgart, ursula.eicker@hft-stuttgart.de

In the paper a methodology based on 3D building and city models is presented to calculate urban heat demand for different refurbishment scenarios. This methodology is validated on six case study buildings of the City of Essen in Germany.

The influences of the availability and quality of data input regarding the geometrical and physical parameters on the accuracy of simulation models are analysed. Different CityGML Levels of Details (LoDs) of the building models as well as different sources of the physical parameters are tested in order to investigate the uncertainty of the methods used.

In the first step, a semi-automated method with data pre-processing (FME software) as well as simulation of the heat demand (INSEL8 software) are used. The results are compared with a fully-automated method implemented in the urban simulation platform SimStadt, whose development is ongoing in the project with the same name (www.simstadt.eu). This platform has a special module integrated, which allows an automatic data pre-processing. Both methods calculate heat demand based on monthly energy balance (standardised in Germany with the DIN V 18599, or in Europe with the ISO 13790).

The calculation of the heat demand with different accuracy of the data input enables to make a statement about which parameters have the most influence on the results. Considering the difficulties in obtaining data available at a city scale this information is very useful for future reductions of the effort of data capturing. For example, the analysis showed that the geometrical Level of Detail can give up to 12% of error depending which of the LoDs are available for the analysed building.

In the next stage, the methods tested first on the six case study buildings can be extrapolated for the whole City of Essen. This methodology could be even extended to other cities on condition that they have 3D city models available.

Keywords: heat demand simulation, 3D building model, varied Levels of Detail, SimStadt-platform

170: Numerical analysis of the humidity buffering potential of various hygrothermal coatings under extreme moisture loading scenarios

SEAN CASEY

Faculty of Engineering, University of Nottingham
seaniekc@gmail.com

Within a closed environment, (e.g. building, car, aircraft) that is hygrically isolated from the exterior climate, one approach that can help reduce the energy required for indoor climate control whilst increasing comfort levels for occupants is to use hygrothermal coatings on top of existing materials. These coatings can re-introduce hygric buffering within the isolated envelope that was lost due to application of retrofitted internal finishes (i.e. – insulation, vapour barriers, paint etc.).

The aim of this paper was to perform a parametric analysis using hygrothermal numerical software (WUFI Plus v2.1.1.73) of the humidity buffering potential of various hygrothermal coatings applied to a nominal enclosed indoor environment under extreme moisture loading scenarios and air exchange rates. Three coatings were compared: gypsum plaster, spruce timber and a 'super absorbent' desiccant under four building envelope scenarios. The location was chosen as Nottingham, UK and an external climate file was generated to sinusoidally fluctuate exterior relative humidity, RHext about a median (50%) at constant temperature (T = 23 □C) for a single peak to peak cycle period of 24h. Two sets of increased moisture profiles were applied to the model in order to represent 16 'Active Adults' present in either the morning or evening for a period of 4 h.

The analysis showed that there was a general reduction of minimum indoor RHint levels when using traditional building materials as interior finishes (i.e. spruce and gypsum), indicating the greater influence of the exterior RHoe on the interior environment as the air exchange rate increased. In contrast, when utilising the super absorbent materials, RHint levels remained within the ASHRAE limits (i.e. 40% ≤ RHint ≤ 70% and T = 23 □C) under both morning and evening overloading schedules and across the full range of air exchange rates.

Keywords: Hygrothermal, WUFI, Absorbents, Comfort

171: Experimental Study of an Adsorption Heat Storage Systems for Building Applications

NORHAYATI MAT WAJID[1], BLAISE MEMPOUO[2], AUWAL DODO[3],SIDDIG OMER[4], SAFFA RIFFAT[5]

1 Mrs, Department of Architecture and Built Environment, Faculty of Engineering, University Park, University of Nottingham, NG7 2RD United Kingdom, ezxnm@nottingham.ac.uk
2 Dr, Department of Architecture and Built Environment, Faculty of Engineering, University Park, University of Nottingham, NG7 2RD United Kingdom, ezzbm@exmail.nottingham.ac.uk
3 Dr, Department of Architecture and Built Environment, Faculty of Engineering, University Park, University of Nottingham, NG7 2RD United Kingdom, ezzam2@exmail.nottingham.ac.uk
4 Associate Professor, Department of Architecture and Built Environment, Faculty of Engineering, University Park, University of Nottingham, NG7 2RD United Kingdom, Lazsao@exmail.nottingham.ac.uk
5 Professor, Department of Architecture and Built Environment, Faculty of Engineering, University Park, University of Nottingham, NG7 2RD United Kingdom, Lazsbr@exmail.nottingham.ac.uk

In this paper an Adsorption Heat Storage System (AdHS-HFC134a)/heating system utilising Vermiculite and Calcium Chloride composite adsorbent material was experimentally investigated. The main aim of the experimental investigations is to carry out preliminary tests on a small scale Adsorption Heat Storage Systems (AdHS-HFC134a) using a heat pump circuit as the regeneration heat source. The test rig was constructed using Vertical Glass Pipes with a heat pump circuit using a miniature compressor for transporting the refrigeration gas as a heat source for desorption cycle. The system also incorporates condenser coils, evaporator coils, and an expansion valve. The integration with a heat pump circuit is to analyse the performance of an AdHS-HFC134a using off peak power in desorption/charging cycle and utilising renewable energy sources to minimise energy demands from fossil fuels. The refrigerant gas used for the regeneration cycle is HFC R134a due to its low global warming potential (GWP), and no Ozone Depletion Potential (ODP), adopted for the proposed systems. Firstly, the regeneration phase occurs during night hours, when cheap off peak electricity is available under the 'Economy 7' tariff that is more suitable for households with night storage heaters or if we use lots of electricity at night. Secondly, in the heat pumping phase/adsorption loop which will occur during the day. The useful heat of adsorption in the adsorbent pipe could be used for underfloor heating (35°C-40°C), or for domestic hot water production (55°C-°60°c) during the day. The maximum temperature lift observed from the adsorption process is 68.62°C (adsorption pipe) with corresponding COP of 0.55 to 1.39.

Keywords: Thermochemical, Adsorption, Desorption, heat storage, HFC134a

172: The influence of the primary refrigerant thermo-physical properties on the performance of a domestic air source heat pump water heater

STEPHEN TANGWE[1], MICHAEL SIMON[2], EDSON MEYER[3]

[1] Fort Hare Institute of Technology, University of Fort Hare, P.B X1314 Alice, South Africa, stangwe@ufh.ac.za [2] Fort Hare Institute of Technology, University of Fort Hare, P.B X1314 Alice, South Africa, msimon@ufh.ac.za
[3] Fort Hare Institute of Technology, University of Fort Hare, P.B X1314 Alice, South Africa, emeyer@ufh.ac.za

The domestic air source heat pump is a reliable and energy efficient system in the production of sanitary hot water. It generates sanitary hot water by harnessing the low grade aero-thermal energy during the process of vapour compression refrigerant cycles. The primary refrigerant in the domestic air source heat pump water heater is responsible for the transportation of the useful high grade thermal energy from the evaporator to the condenser where is dissipated to heat up water to the desired set point temperature (55oC) during the vapour compression refrigerant cycles. The study focused on the critical monitoring of the thermodynamic properties of the distinctive refrigerants (R407C and R417A) used by two identical split type air source heat pump water heaters and under dynamic heating modes. The experimental data that displayed the temperature profiles from the installed temperature sensors at the compressor suction and discharge lines as well as the condenser inlet and outlet ends in conjunction with the electrical energy consumption were fully analysed to evaluate the refrigerant impact on the performance of the air source heat pump water heater. The preliminary results from the two split air source heat pumps retrofitting 150 liters high pressure geyser under the first hour heating rating and controlled simulated hot water drawn off demonstrated that the system with refrigerant R417A performed better than the other with R407C although there was no significant mean difference in their coefficient of performance. The coefficient of performance of the both systems under the different heating up scenarios was above 2. The REFPROP simulation software was used to give an analytical comparison of the two refrigerants. The results obtained from the study can be applied in the selection of an excellent thermo-physical refrigerant to be utilized as a primary fluid in a domestic air source heat pump water heater.

Keywords: Split type air source heat pump water heater, Vapour compression refrigerant cycles, Refrigerant thermo-physical properties, REFPROP simulation software, coefficient of performance

173: Potential Integration of Sustainable Technology in Office Building in Ghana:

Exploratory Study

EUNICE ADJEI[1], SIDDIG OMER[2], YUPENG WU[3]

[1] University of Nottingham, NG7 2RD, Nottingham, UK
Email: laxeaa@nottingham.ac.uk
[2] University of Nottingham, NG7 2RD, Nottingham, UK
Email: Siddig.Omer@nottingham.ac.uk
[3] University of Nottingham, NG7 2RD, Nottingham, UK
Email: Yupeng.Wu@nottingham.ac.uk

Building sector energy consumption has overtaken all other sectors energy use, hence this contributing significantly to the global greenhouse emission levels. It is well known that building performance is influenced by several factors, including architectural design, occupant's behaviour, building service equipment, regulations, technologies applied among others. Integration of sustainable technologies in buildings for solving the above problem remains one of the essential areas in global research, but remains at very slow rate.

This paper seeks to explore typical sustainable technologies with potential integration into office buildings in Ghana for enhanced buildings performance. The research is accomplished through administration of online survey questionnaire using Bristol Online Survey Tool and snowball sampling technique among building professionals in Ghana. The research has concluded three major findings and these are thought to have played a role in the current building energy consumption rate in Ghana. Firstly, only 14% of building professionals in Ghana access building performance of design stage and post occupancy stage. Secondly, most building professionals have little knowledge on performance of typical office building in Ghana. Thirdly, the research did not trace any significant sustainable technology that has been integrated into office building envelope in Ghana which could have affected the building performance positively.

In conclusion, sustainable technologies integrated into office buildings in Ghana is insignificant irrespective of the existing valuable research carried out in other parts of the world. This is due to the prescriptive nature of the building regulations of Ghana; hence it is recommended that the building regulation should be modified into performance based to facilitate the enhancement of performance.

Keywords: Sustainable technology, building regulation, building professionals, building performance, air sealing.

179: A case for application of vacuum insulated panels (VIPs) in high-income area solid wall buildings

Expensive technology for expensive areas

DAVID TETLOW[1], LIA DE SIMON, SAFFA RIFFAT

[1] *University of Nottingham, NG7 2RD, Nottingham, UK*
Email: david.tetlow@nottingham.ac.uk

The UK is a large producer of carbon emissions releasing over 580 million tonnes of CO2 equivalent in 2012. One quarter of this (~145 million tonnes) was accounted for by emissions derived from the residential sector. Compared to the 1990 baseline, emission levels in this sector have reduced 14% with this being achieved mainly through a mixture of UK government incentives and imposed energy legislation. However in order for the UK to meet its energy reduction obligations by 2050, significantly higher reductions are required.

According to reviewed UK studies progress in reducing domestic building energy consumption in the past 20 years has been achieved via interventions including: loft and cavity wall insulation, boiler replacements, and installation of double glazing. The majority of these having been targeted in low-income areas, where installation companies can gain access to government sponsored funding schemes such as CERT, CESP, and the ECO. However, these have not extending to enable access to the solutions in middle- and high-income areas, and minor improvements have been made to certain parts of the country, most notably in its city centres that have high-densities of solid wall housing. Recent schemes have been launched to resolve this issue (i.e. the Green Deal); however these have fallen short because of a number of reasons.

This paper addresses two of the main problems: Unsuitability of existing technology, and non-financial feasibility of current innovative solutions. A case study in a Nottingham based end-terrace house is presented for upgrade in which current solid wall insulation solutions are not feasible. A hybrid external-internal solid wall vacuum insulated panel solution was installed in this property and an economic analysis was undertaken based on house prices, rental income, and internal floor area. This was used to analyse the feasibility of this solution for this given case, which was then compared against other similar houses in medium and high income areas of the country. With the installation cost being relatively fixed, the feasibility of this solution became favourable as the value of housing and associated rental increased.

Keywords: Domestic Retrofit, Vacuum Insulated Panels (VIPS), Energy Efficiency, Cost efficiency

180: The state of the art: Superinsulation construction materials under the UK's domestic energy building:

Aerogel and vacuum insulation technology applications

MAHMOUD SHATAT [1*], THEO ELMER[2],
DAVID TETLOW[3] , SAFFA RIFFAT[4]

1,2,3,4 Faculty of Engineering, University of Nottingham, Nottingham, NG7 2RD, UK
**Email: mahmoodshatat@hotmail.com*

The concept of building retrofit has become a top priority for many countries and especially in the European Union in order to meet the world Kyoto protocol to reduce carbon dioxide emissions. Consequently, the EU is committed to reduce the energy of heating in buildings and the greenhouse gases by 50% and 80% respectively compared to 1990 levels by 2050. This translates to one house being retrofitted every minute. A viable solution in achieving this target is to increase the amount of insulation in the building stock. Numerous materials have therefore been introduced to the market during recent decades. Until recently aerogel has been used in the space and chemical industry, while VIPs have been used in the refrigeration and cold shipping industry. Their use in the building environment has been limited, and the challenging factor causing this is high cost. However, this can be offset by the high thermal insulation properties that provide a thinner final construction profile. This advantage could create new opportunities for architects and construction engineers to design energy efficient buildings. This paper presents innovative superinsulation materials of very low thermal conductivity, and their application under the UK's building energy codes. The thermal performance and energy saving capacity of aerogel and vacuum insulation panels (VIPs) are covered in addition to the economic, health and safety aspects. Additionally, their application in domestic homes to achieve the UK's Code for Sustainable Homes level four and six ratings is discussed.

Keywords: Climate change, Insulation material, Aerogel, Vacuum insulated panels, thermal conductivity

181: Calibration of the Simulation model of the HERB building in Bologna in its Present State

ENZO ZANCHINI[1], CLAUDIA NALDI[2], STEFANO LAZZARI[3], STEFANIA FALCIONI[4], GIAN LUCA MORINI[5]

[1] University of Bologna, Department of Industrial Engineering, Viale Risorgimento 2, 40136 Bologna, Italy, enzo.zanchini@unibo.it
[2] University of Bologna, Department of Industrial Engineering, Viale Risorgimento 2, 40136 Bologna, Italy, claudia.naldi2@unibo.it
[3]University of Genova, Department of Sciences for Architecture, Stradone S. Agostino, 37, 16123 Genova, Italy, stefano.lazzari@unige.it
[4]University of Bologna, Department of Industrial Engineering, Viale Risorgimento 2, 40136 Bologna, Italy, stefania.falcioni@unibo.it
[5]University of Bologna, Department of Industrial Engineering, Viale Risorgimento 2, 40136 Bologna, Italy, gianluca.morini3@unibo.it

In the framework of the EU-funded Project HERB (Holistic Energy-efficient Retrofitting of residential Buildings), the University of Bologna and the Municipality of Bologna are performing the energy retrofitting of a detached house with 6 apartments in Bologna. The annual saving of primary energy obtained by the retrofitting will be assessed through dynamic simulations of the building before and after retrofitting, performed through a model implemented in TRNSYS 17 and calibrated by comparison with monitoring results. In this paper, the calibration of the building model in its present state is described.

The 3-D hourly simulation model of the building was obtained starting from 3-D drawings performed through Google SketchUp. Four thermal zones were considered for each small apartment (bedroom, bathroom, kitchen-living room, entrance) and five thermal zones for a larger apartment. The characteristics of the building enclosure were determined by accurate inspections and tests, which included infrared thermography, blower door tests and direct measurements of the transmittance of the external vertical wall.

The building was monitored during the heating season 2013-2014. The use of natural gas for heating was determined by periodic readings of the gas meter placed in the distribution duct to the central boiler, hourly values of the internal air temperature and relative humidity in each room were recorded, while hourly weather data were taken from the Bologna Urbana Weather Station, close to the building. The internal heat gains were evaluated through measurements of the use of electricity and of natural gas in single apartments.

A comparison between the measured values of the primary energy use for heating during 16 time intervals and those determined by dynamic simulation revealed that the simulation model widely fulfils the accuracy requirements stated by ASHRAE Guide 14 and yields the measured total energy use for heating during the season considered with an accuracy better than 0.4%.

Keywords: building dynamic simulation – building monitoring – model calibration

182: Investigation on the overall energy performance of an a-Si based photovoltaic double-skin facade in Hong Kong

JINQING PENG[1,2], LIN LU[1], HONGXING YANG[1], AOTIAN SONG[1], TAO MA[1]

[1] The Hong Kong Polytechnic University, Hong Kong China, bellu@polyu.edu.hk (L. LU)
[2] Hunan University, Changsha China, jallenpeng@gmail.com (J. PENG)

This paper simulates the annual overall energy performance of an amorphous silicon (a-Si) based photovoltaic double-skin facade (PV-DSF) in Hong Kong. Based on EnergyPlus, a numerical simulation model was developed to simulate the thermal, power and daylighting performances of the ventilated PV-DSF simultaneously. The overall energy performance of the optimized PV-DSF was calculated. Per unit area of such PV-DSF was able to generate about 38 kWh electricity yearly in Hong Kong. The studied PV-DSF is also featured with pretty good thermal and daylighting performances. A great amount of solar heat gain was blocked by the PV module, which resulted in a lower solar heat gain coefficient (SHGC) for the PV-DSF. At noon of sunny day, the maximum daylighting illuminance reached 470 lux, which was very close to the design illuminance level. Thus, if combined with a dimmable lighting control system, the semi-transparent PV-DSF could reduce considerable lighting energy use. Moreover, with the efficiency improving of semi-transparent PV modules, the overall energy performance of PV-DSFs would be further improved, and thus it would be more and more promising.

Keywords: building integrated photovoltaic (BIPV), double-skin facade, semi-transparent a-Si, overall energy performance

183: Appraisal of a Zero Energy Solar House model via reduction of the GHG emission and improvement of energy efficiency

CLAUDIA OLIVEIRA[1], FERNANDA ANTONIO[2], MIGUEL UDAETA[3]

[1] University of São Paulo - FAU, Rua do Lago No. 876
São Paulo - SP - Brasil, ctao@ups.br
[2] University of São Paulo - FAU, Rua do Lago No. 876
São Paulo - SP – Brasil, f.antonio@ups.br
[3] University of São Paulo – GEPEA, Av. Prof. Luciano Gualberto Trav. 3 No. 158 –
São Paulo - SP – Brasil, udaeta@pea.usp.br

This study aims to demonstrate the modeling and architecture of a Zero Energy Solar House towards sustainable development, based in first instance on global greenhouse gases emissions mitigation. The methodology is based on multiple criteria accounting for aspects such as electricity conservation, power generation and greenhouse gases emissions reduction. The potential and limitations of photovoltaic systems, as well as the residential sector electricity consumption are studied. The guidelines and strategies of a Zero Energy Solar House are defined, focusing on the use of the sun in architecture, solar heating and photovoltaic system. These studies are carried out through a zero energy house model (considering the annual consumption of a residence connected to the grid) that incorporates the guidelines and strategies of a Solar House. The bioclimatic strategies and solar systems are analyzed considering its application in the city of São Paulo. The evaluation of passive strategies for thermal conditioning demonstrates a potential to increase by 70% the hours of comfort in the year. On the other hand, the adoption of more efficient technologies for lighting shows energy conservation potential around 12.5%, within the defined parameters and considering the average residential consumption. The use of solar system for water heating indicates a potential to save up to 16.3% of energy compared to a business-as-usual scenario (traditional house). The electricity generation by photovoltaic systems combined with the adoption of energy efficiency measures demonstrates a potential to achieve, at least, zero net annual energy balance relatively to the business-as-usual residential consumption of the grid. Thus, it is estimated a potential to avoid up to 1.66 t CO2 per year for each housing unit.

Keywords: Zero energy home; Solar energy; Architecture; Energy conservation; Sustainable development.

184: The Studies of Nanotechnology Applications on the Development of Energy and Technology Teaching Material

CHIENKUO KU[1], CHIALING WEI[2]

1 University of Taipei, No.1, Ai Kuo West Road, Chung Zheng District, Taipei,2007ckku@gmail.com
2 University of Taipei, No.1, Ai Kuo West Road, Chung Zheng District, Taipei, chialing@mail.mhups.tp.edu.tw

Energy storage devices have the characteristics of high activity, large surface area, ultrafine crystal grain characteristic and particular electro-optic properties, and hence energy storage devices are actively developed worldwide, attempting to provide high capacity of energy storage system which is better than the current capacity of batteries. Taiwan has developed high capacity power storage elements and electro-optic batteries, aiming at enhancing the usage efficiency and reducing the waste consumption. Besides, the nanotechnology in power saving has designed new form of solar panels, which are able to absorb sunlight more efficiently. At present, schools in Taiwan have not provided any courses related to nanotechnology. In order to promote energy and nanotechnology education, related supplementary teaching material is developed. This research aims at using ADDIE teaching mode to develop the nanotechnology applied on energy teaching material. To analyze learners and teaching requests and opinions, students and teacher are interviewed. Then the integration and analysis of related literature, K-12 curriculum, and learners' characteristics are completed, in order to design the teaching material structure. Stories as teaching material are outlined based on the structure. Education, nanotechnology and energy experts are invited to review the accuracy and appropriateness of the content. The teaching material is designed for three-hour classes, and the participants are grade-six 25 students. This teaching material is presented as stories and hands-on experiments. The teaching time is arranged after school, and the length is 90 minute. It will take two classes to complete the teaching. The review and improvement of the teaching material are made through qualitative interview. The teaching material is shared through the website.

Keywords: nanotechnology , energy, K-12 curriculum , Elementary Schools , picture Books

193: Towards an integrated computational method to optimise design strategies for the built environment

POLYTIMI SOFOTASIOU[1], JOHN K. CALAUTIT[2],
BEN R. HUGHES[3], DOMINIC O'CONNOR[4]

[1] *University of Sheffield, Western Bank Arts Tower, psofotasiou1@sheffield.ac.uk*
[2] *University of Sheffield, Western Bank Arts Tower, j.calautit@sheffield.ac.uk*
[3] *University of Sheffield, Western Bank Arts Tower, b.hughes@sheffield.ac.uk*
[4] *University of Sheffield, Western Bank Arts Tower, dboconnor1@sheffield.ac.uk*

The distinctly need for developing energy efficient and functional structural designs, demands the adoption of multidisciplinary techniques that will guarantee constructions' integrity. Towards this objective, engineers and scientists employ Computational Fluid Dynamic (CFD) tools and optimisation techniques, in order to first predict the physical phenomena occurring in the built environment and in sequence to find optimum solutions that will assist the conceptual design phase. In the current study, a methodology to conduct design optimisation studies is demonstrated, using coupled CFD and Response Surface Methodology (RSM) meta-model based optimisation techniques. Regarding the assessment of the natural ventilation performance of a cross ventilated building, the design optimisation of the window openings was performed. The results revealed the ability to obtain locally optimal solutions, along with a further insight on the influential role of the design parameters in design's response. The methodology was validated with wind tunnel experiments and the optimisation results were verified, confirming the competence for conducting similar design optimisation studies.

Keywords: Computational Fluid Dynamics, Response Surface Methodology, optimisation, natural ventilation

196: High Efficiency Absorber with Perforated Plate for Solar Air Collector

[1]*VINSON ADIDHARMA AUDWINTO, [1]HOY-YEN CHAN,
[2]SINA ENTESHARI, [2]VINESH THIRUCHELVAM

1Solar Energy Research Institute, The National University of Malaysia (UKM), 43600 Bangi, Selangor, MALAYSIA. Email: vinsonaudwinto@gmail.com
2Department of Engineering, Asia Pacific University (APU), 57000 Bukit Jalil, Kuala Lumpur, MALAYSIA

Jet impingement is one of the convective heat transfer methods to transfer heat from a surface to the flowing fluid. This method can be used for many applications as enhancement method to increase the overall performance. The main objective of this research is to study the thermal performance of solar collector under different solar radiation by using jet impingement method.

A solar air collector with jet impingement design was fabricated and tested. A perforated plate of 6mm holes diameter with triangular geometry was designed and installed into the solar air collector. The effect of different irradiance on the rise of temperature was applied to evaluate the thermal performance. The fixed mass flow rate of 0.0076 kg/s was used in the test. It was found that temperature difference between inlet and outlet increases with irradiance. The highest and lowest efficiencies were measured to be 80.40% and 69.60% respectively. From the study, it showed that there are a slight increase of thermal efficiency as the solar irradiance increases.

Keywords: Perforated Plate, Jet Impingement, Solar Air Heater, Solar Collector

198: A Study on the Development of Measuring Equipment of the Solar Heat Gain Performance by Using a Natural Sunlight

SEOK-HYUN KIM[1], SANG-HOON LIM[2], SOO CHO[3]

[1] Korea Institute of Energy Research(KIER), 152, Gajeong-ro, Yuseong-gu, Daejeon, Korea, ksh7000@kier.re.kr
[2] Korea Institute of Energy Research(KIER), 152, Gajeong-ro, Yuseong-gu, Daejeon, Korea, shlim@kier.kr
[3] Korea Institute of Energy Research(KIER), 152, Gajeong-ro, Yuseong-gu, Daejeon, Korea, scho@kier.re.kr

In the middle of the effort of the energy consumption reduction in buildings, the area of window at building was increasing according to the view of exterior and the method of construction. The insulation performance of window is low than the building envelope and the solar heat gain performance affects the building energy consumption of heating and cooling. Many efforts to improve the window performance have been made. The method how to verify the window performance was also proposed. This method helped designer to choose of type of window and performance of window. The solar heat gain performance test method by the use of solar simulator was developed. But the measuring equipment about solar heat gain performance of window by use of natural sunlight was not utilized. This study proposed the measuring equipment about solar heat gain performance of window by use of natural sunlight.

Keywords: Window, Solar Heat Gain Coefficient, Measuring Equipment, Natural Sunlight

200: Thermal Performance Assessment of New Type Structure Applied in Tent

JUN WANG[1], FENG XIONG[2], SIQIANG LV[3], MING QU[4]

1 College of Architecture and Environment, Sichuan University, No. 24, First loop south first section, Chengdu City, Sichuan Province, China, wangjunhvac@163.com
2 College of Architecture and Environment, Sichuan University, No. 24, First loop south first section, Chengdu City, Sichuan Province, China, fxiong@scu.edu.cn
3 College of Architecture and Environment, Sichuan University, No. 24, First loop south first section, Chengdu City, Sichuan Province, China, Lusiqiang@scu.edu.cn
4 Sichuan Provincial Architectural Design and Research Institute, No. 688, Tianfu road middle section, Chengdu City, Sichuan Province, China, 306322159@qq.com

Tent can be regarded as one kind of special building or man-made space, which is widely used for the wild living, nomadic living and disaster relief. The envelop enclosure of tent is formed by fabric layer, which has very thin thickness of 0.5-2 mm and high air permeability and thermal radiation adsorption. Accordingly, its indoor thermal environment is very poor in most cases, as a result of low thermal inertia and resistance of tent envelope. For improving thermal environment of tent, new type structure was proposed and applied in tent, including outer fabric layer, phase material (PCM) layer and inner fabric layer. Meanwhile, theoretical model depicting heat transfer of this new type structure used in tent was established and verified. Moreover, for the climatic conditions of Chengdu city in China, the thermal performance of composite three layers structure of tent were evaluated with the aid of numerical simulation under the influence of different PCM thermo-physical properties, containing PCM thermal conductivity coefficient, latent heat, specific heat capacity and phase-transition temperature. Low PCM thermal conductivity coefficient and phase-transition temperature, high phase change latent heat and specific heat capacity are needed to achieve the excellent thermal performance of new type structure.

Keywords: tent; new type structure; phase change material; numerical simulation

202: Empirical study of the energy saving potentials in Shanghai residential buildings through human behaviour change

XINGXING ZHANG[1],*, JINGCHUN SHEN[1], JINLU SI[1], TONG YANG[1], WU DENG[1], LLEWELLYN TANG[1], YUPENG WU[2]

1 Department of Architecture and Built Environment, University of Nottingham, China, 199 Taikang East Road, Ningbo, 315100, China. Xingxing.zhang@nottingham.edu.cn; Jingchun.Shen@nottingham.edu.cn; zy09747@nottingham.edu.cn; Tong.Yang@nottingham.edu.cn; Wu.Deng@nottingham.edu.cn; Llewellyn.Tang@nottingham.edu.cn
2 Department of Architecture and Built Environment, University of Nottingham, UK, NG7 2RD Yupeng.Wu@nottingham.ac.uk

Smart meters and in-home displays (IHD) have been recently adopted to help give residential consumers more control over energy consumption, and to help meet environmental and security of supply objectives. The paper aims to identify the effectiveness of smart meters and real-time IHDs in reducing Shanghai household energy consumption. A first pilot in Shanghai city with an effective sample of 131 respondents was arranged to two groups as IHD households and non-IHD households. A statistical analysis model was developed to investigate the characteristics and the regulations of electricity consumption in these two groups, such as check frequency, electricity consumption reduction and shifting, energy bill saving, and standby power. The research results demonstrate IHD could lead to around 9.1% (11.0%) in reduction of monthly electricity consumption (bill). A general comparison of the electricity consumption reduction between this research and the average UK case was further made. The overall research is expected to contribute some empirical evidence on how IHD feedback could influence household electricity consumption in the Chinese context. It will further provide a social-technical basis for the electricity-economic leverage of government and the bidding competitiveness of power-related industries.

Keywords: In-home display; Residential building; Behaviour change; Electricity consumption.

204: Simulated building energy savings with ventilated PCM ceiling tiles

THOMAS WHIFFEN[1]

[1] *University of Nottingham, Dept. of Architecture and Built Environment, University Park, Nottingham, NG7 2RD, thomas.whiffen@nottingham.ac.uk*

The reduction of building energy consumption is a direct target for the many governments worldwide. To date active thermal energy storage (TES) technologies have demonstrated the capability of reducing 30-40% of end-use energy demand. However traditional active TES solutions are integral to the building fabric, making retrofit due to building demand changes difficult to incorporate. Phase change material (PCM) has demonstrated comparable TES ability with five to fifty times less mass, depending on material properties and conditions. PCM solutions therefore offer lightweight TES solutions suitable for retrofit in the built environment. Traditionally PCM solutions have been fitted passively in construction layers, such as ceiling tiles or wall sections. These have suffered from poor heat transfer, leading to poor thermal cycling and performance. Novel Active-PCM solutions have been developed for AC systems saving 34%.

Through building simulation this paper investigates a novel method for improving PCM integrated ceiling tile performance. The method proposes using ventilation strategies to improve heat transfer and optimise the benefits of PCM ceiling tile retrofit. The modelled building was constructed and simulated in Design Builder using NCM templates. Ventilation strategies employed were zero ventilation, day ventilation, evening ventilation, night ventilation and twenty-four hour ventilation. The annual energy consumption for heating and cooling was analysed, as well as the total building energy savings. The results demonstrate that coupled night ventilation provided the greatest energy savings in low air-leakage buildings. Further investigation was given to enhancing heating energy savings for mechanically ventilated buildings. Simulation of combined heat recovery and PCM ceiling tile retrofit offered a 72% reduction in annual heating and cooling energy consumption in the reference building.

Keywords: Active thermal mass, thermal energy storage, sustainable built environment, phase change materials, building retrofit technology

205: An office study of lighting energy-demand savings

Conducted using a purpose built, intuitive building energy management system interface

THOMAS WHIFFEN[1], SOPHIE NAYLOR[2], DAINIUS ALONDERIS[3]
MARK GILLOTT[4], CHRISTOPHER WOOD[5], SAFFA RIFFAT[6]

University of Nottingham, Dept. of Architecture and Built Environment, University Park, Nottingham, NG7 2RD, [1]thomas.whiffen@nottingham.ac.uk, [2] laxsjn@nottingham.ac.uk, [3] ezxda3@nottingham.ac.uk, [4]mark.gillott@nottingham.ac.uk, [5] christopher.wood@nottingham.ac.uk, [6] saffa.riffat@nottingham.ac.uk

To date, building energy management systems (BEMS) have been well established in the large scale non-domestic field as an energy saving technology, contributing towards sustainable future cities. They utilise complex control interfaces, with control signals passed through purpose built communication wiring. Estimated end-use energy savings, due to BEMS addition, can reach up to 50%, with associated financial savings for building users. The intelligent control, featured in BEMS, enables buildings to adapt; optimising operation based on weather forecast data. Traditionally they have been complex to install and operate, requiring trained personnel to maintain. Alternatively domestic BEMS are growing in popularity, monitoring and controlling the simple heating functions of a house.

This work outlines the development of a novel BEMS for the small to medium sized non-domestic market. The market features a variety of building types, sizes and uses therefore an adaptable and intuitive system is required to facilitate energy savings within the sector. From initial concept, through a brief review of the market, this work finally presents a viable BEMS to reduce end-use energy in non-domestic buildings. Having showcased the development of an intuitive monitoring GUI, the energy saving results from a single-occupancy office trial found PIR control more beneficial than daylight illuminance threshold control, for the office trial context. Combining the two control methods achieved 67% savings during the test period.

Keywords: Building energy management systems, intelligent building control, low energy buildings, intuitive GUI, office energy savings

206: Transportation Energy Consumption and Emissions:

A View from City of Indonesia

IWAN SUKARNO[1], HIROSHI MATSUMOTO[2]

[1]Architecture and Civil Engineering, Toyohashi University of Technology, Japan, iwan_sukarno81@yahoo.com
[2] Architecture and Civil Engineering, Toyohashi University of Technology, Japan, matsu@tut.ace.jp

The transportation sector in a city is one of the fundamental aspects of social – economic system which includes moving people and trade in an increasingly globalized world, as well as for improving standards of living. No doubt that transportation sector cannot be separated from the fuel consumption. Every country applied different policies and scenarios to introduce alternative fuel and technology to reduce the road transportation that is dependent on fossil fuel and the environmental impacts. However, in the last decade, global energy consumption in the transport sector was increased continuously. In the city context, transportation sector should be put on the long term urban planning toward sustainable development.

The purpose of this study is to investigate the energy consumption and road emissions of the transportation sector to predict the future energy consumption and emissions interactions. A system dynamics model for transportation sector was developed in this study to model the transportation energy consumption and road emission trends. The basic data on energy consumption, transportation data and emissions factor were used as the basic input parameters. Results show that total fuel consumption and GHG emission in Padang road transport is predicted 65 times in 2050 compared to 2013 levels. Increase of private vehicles plays a very essential role in road emissions reduction activities of Padang. The modelling results also show that reducing of private vehicles and integrated public transportation has reduced the fuel consumption and GHG emission to about 34% in 2050. All these results will provide essential information and can be used for policy maker to meet challenges of decision making to support the urban development process

Keywords: Transportation, Energy Consumption, Road Emission, System Dynamic

209: Experimental Optimization of CI Engine Operated Micro-Trigeneration System for Power, Heating and Space Cooling

RAHUL GOYAL*[1], DILIP SHARMA2, S.L.SONI[2],
PRADEEP KUMAR GUPTA[2], DHEERAJ JOHAR[2]

1 Mechanical Engineering Department, VGU, Jaipur, Rajasthan (India)
2Mechanical Engineering Department, MNIT Jaipur, Rajasthan (India)
**Corresponding author. Tel.: +91-9460763566. E-mail: rahulgg2702166@yahoo.com*

Trigeneration systems use waste heat from prime movers to generate heating and cooling along with power. They are more efficient, less polluting & more economical than conventional systems. In this paper, in addition to the electricity generated from the engine genset waste heat from engine exhaust was used for heating and space cooling purpose. In this work, for space cooling, four units of Electrolux vapor absorption system, each with a capacity of 51 liters and heat input of 95 Watts, were used. Exhaust gas from the engine was the source of thermal energy to provide heat to the four generators of the VA system. A cabin (3'X5'X6') made of ply wood was fabricated as a space for cooling. The test results show that a temperature drop of 6.50C was obtained in cabin at full engine load about 6 hours after system start up. In this trigeneration or combined cooling heating and power (CCHP) mode, cooling water after extracting heat from engine block was designed to pass through the heat exchanger, where the other fluid was exhaust gas coming out from VA system generators. For the optimization of trigeneration system in CCHP mode, different VA units were operated one by one to obtain the best energy output in terms of space cooling and water heating. The test results show that in this size of set-up, using 3 units of VA system (i.e. approx. 150litres) generates an optimized trigeneration system. However, if more cooling effect is desired, then all four units of VA system should be put into operation, though sacrificing some output in terms of water heating.

Keywords: Trigeneration, Micro trigeneration, Waste heat, Vapor absorption system, Space cooling.

210: Optimising Housing Design to Improve Energy Efficiency in Jordan

HEBA NAZER[1], LUCELIA RODRIGUES[2]

1 Middle East University, Jordan, Nazerheba@gmail.com
2 University of Nottingham, UK, Lucelia.Rodrigues@nottingham.ac.uk

Jordan faces an energy crisis aggravated by the limitation of energy resources and coupled with the high dependency on neighbouring countries. In addition, the raise in the country's population has resulted in excessive pressure on the residential sector to hasten housing construction projects resulting in a reduction of quality in favour of speed. A viscous cycle was created in which new buildings with poor thermal performance further exacerbate the energy crisis. Adding to the problem, a significant rise in summer temperatures is anticipated in the near future as a result of climate change, which would result in even more demand for active means of space conditioning.

The objective of this research was to assess the thermal performance of a typical residential apartment in Amman, and propose interventions that would help reduce its reliance on mechanical methods of space conditioning during cooling periods. Through dynamic simulation modelling, a parametric analysis was developed involving a number of iterations exploring different fenestration designs and thermal transmittance values for walls. In order to improve the models' accuracy, the results of a longitudinal survey of residents in 145 similar apartments were utilized to inform the simulation assumptions. The survey gathered data on the occupants' thermal perception and behaviour, their socio-economical attributes and the building physical characteristic and use.

The authors concluded that small amendments in the design, such as the incorporation of natural ventilation for parts of the year, could enhance the thermal performance up to 45%. The optimum glazing to wall ratio for more energy efficient residential buildings within the context of Jordan was defined as 15% to 20% in all orientations, whereas the thermal transmittance for walls and roofs as 0.13W/m2K. The conclusions were proposed as a set of recommendations to help designers to choose optimal building element characteristics and orientation for each function in early design stages.

Keywords: Thermal comfort, Energy efficiency, Design codes

211: Investigation on the Performance of Air Source Heat Pump System with new Environment Friendly Refrigerants for a Low Carbon Building

YATE DING*, ERDEM CUCE, SAFFA RIFFAT, CHUNGUI LU

Department of Architecture and Built Environment,
University of Nottingham, Nottingham NG7 2RD, UK
**Corresponding Author E-mail Address: yate.ding@nottingham.ac.uk*

Energy is an important development factor. It is consumed in different format from different sources in daily human activities. Solar energy, as the most fundamental renewable energy resource, serves in a clean, domestic and environmentally friendly way with minimum impact on surroundings. Due to the ability of transferring heat from low temperature to high temperature, heat pump systems can make great use of natural resources and waste heat resources for the purpose of space heating. Based upon this theoretical principle, this paper presents an investigation on the performance of air source heat pump (ASHP) system with new environment friendly refrigerants, such as R1233zd(E), R1234YF, R1234ze(Z) and R1234ze(E). At the same time, some conventional refrigerants (R134a, R245fa and R123) have been investigated as well for results comparison. A MATLAB program has been developed with the assistance of the database of CoolProp. The results show that the use of some selected environment friendly refrigerants in air source heat pump system for building application alongside other refrigeration applications in strongly recommended.

Keywords: heat pump, refrigerants, air source

212: Improvements in Glazing Technologies to Reduce Building Heat Losses

ABDULELAH ALOTAIBI[1], SAFFA B. RIFFAT [2]

1 University of Nottingham, University of Nottingham, Department of Architecture & Built Environment, ezxata@exmail.nottingham.ac.uk
2 University of Nottingham, University of Nottingham, Department of Architecture & Built Environment, saffa.riffat@nottingham.ac.uk

This paper offers a review of the existing and emerging glazing technologies for windows. Windows account for up to 60% of the heat losses in buildings. The commercially available window systems on the market are double glazing, triple glazing, suspended films, vacuum glazing and smart glazing systems. Double glazing window systems can rarely meet the new energy standards while the other systems are expensive and not always reliable. Often, they require use of low-e coatings and inert gases which substantially increase cost of production. Recently, new glazing systems have been explored with the focus on window cavity filling and the novel combinations of materials in multiple cavities. Aerogel and PCM glazing systems represent the first segment of this research. While offering better U-values, such systems still have disadvantages such as material fragility (in case of aerogel), visibility (in case of PCM) and some other relevant parameters. Novel glazing designs such as solar pond and air sandwich also allow to increase thermal performance of the systems, but their applications are still in their infancy. PV systems represent a very promising direction in this regard. They are based on combining the existing proven technologies, and while showing higher U-values than other advanced glazing systems, they generate electricity to at least partially offset energy spending on heating and cooling. Optimisation of PV glazing system parameters is considered one of the major factors that could make them a product of choice in the nearby future.

Keywords: windows, glazing, energy, heat transfer, photovoltaics

213: Architectural Design Principles for Passive Cooling in Cyprus Climate

PERVIN ABOHORLU[1], SAFFA RIFFAT [2]

1 Department of Architecture & Built Environment, University of Nottingham, University Park, Nottingham NG7 2RD, UK, pervinabohorlu@hotmail.com
2 Department of Architecture & Built Environment, University of Nottingham, University Park, Nottingham NG7 2RD, UK, saffa.riffat@nottingham.ac.uk

Energy consumption in houses in Cyprus is mostly for cooling, with buildings responsible for 30,84% of total energy consumption. The electricity is mainly produced and consumed during the summer as demand for cooling is increased.

The aim of this study is to analyse and emphasise passive cooling strategies in traditional building of Cyprus, in order to maximize comfort level, while reducing energy consumption and the level of CO2 emissions to the environment. Architectural design principles are analysed in terms of passive cooling to focus on the importance of climate. These passive cooling methods are reviewed in order to prevent energy consumption through the use of mechanical air conditioners.

Cyprus is hot and dry in summer, mild and rainy in winter. It is formed by two dominant mountains: the slopes facing to the north of the mountains are humid, whereas the south facing slope is drier. Different design parameters for the two different climatic regions are evaluated to show the relationship between space and passive cooling energy use.

The climatic analysis techniques such as sun path diagram and wind rose diagrams are used to evaluate the design principles of buildings. Then, Autocad is used as a drawing software to show the buildings and the cooling methods for each climatic regions, hot-dry and hot-humid. These are evaluated according to the following design principles: building shape and orientation, shading, vegetation, building layout, wall openings, topography and thermal mass material. These design principles and passive cooling methods are clearly illustrated as tables and figures to make comparision of different climatic conditions.

Keywords: Passive Cooling, Cyprus, Architectural Design Principles, Orientation

216: AirAid - An alternative for harnessing Wind Energy using Venturi effect for low-wind regimes

VISHAL RAMESH[1], SRINIVAS MORAPAKALA[2], NIKHIL AGARWAL[3]

[1] Mechanical Engineering Department, BITS-Pilani Hyderabad Campus, Hyderabad, RR District, Telangana State, India, 500078, vishalramesh94@gmail.com
2 Associate Professor, Mechanical Engineering Department, BITS-Pilani Hyderabad Campus, Hyderabad, RR District, Telangana State, India, 500078, morasrini@hyderabad.bits-pilani.ac.in
3 Mechanical Engineering Department, BITS-Pilani Hyderabad Campus, Hyderabad, RR District, Telangana State, India, 500078, agarwal_nikhil@outlook.com

A new concept in wind energy harnessing is conceived which delivers a significantly higher output and outperforms traditional wind turbines of the same rotor size and design characteristics. The most innovative feature of this concept is that it captures wind at certain speeds but delivers it to the rotor at much higher speeds, increasing the power available at the rotor. Additionally, the requirement of classic, tower mounted turbines is eschewed, mitigating the need for a cumbersome installation of the turbine-generator system at great heights and reducing installation, operation and maintenance costs. Other factors that have undermined the wind industry such as radar impact, aesthetics etc., are addressed. The concept funnels wind through a venturi section that naturally accelerates its flow, increasing a given input velocity of 2 m/s to an average velocity of 10.3 m/s at the rotor, giving a speed ratio of over 5. The CFD analysis is performed on COMSOL using a standard laminar flow model closures with steady flow conditions. The CFD results revealed a non-turbulent velocity distribution near the rotor (no vortex formation), with a minimal variation in the velocity at the rotor's cross section. This shows that because of increased wind velocities, it is possible to have a significant improvement in the power output.

Keywords: Wind energy, wind turbines, ducted turbines, venture

217: Technology Research and Development Boost the Development of Green Building in China

QINGQIN WANG [1, 2], SHANGQUN XIE [1, 2]

1. China Academy of Building Research, Beijing 100013, China
2. Beijing International Collaboration Base on Green Building, Beijing 100013, China

By improving the technology innovation vitality and the development of green buildings, Chinese government is promoting the transformation and upgrading of the building industry. This paper, the overall situation of the government support for research and development in the field of green building in China is introduced, the development status of standards, key technologies, products and equipment, and projects of green building summarized, the effect of green building for energy saving and emission reduction analysed, and the development trend and priorities of green buildings in China discussed.

Key words: Green Building; Technology Research and Development; Development Priorities

220: Numerical simulation of a new biomass/solar micro-cogeneration ORC system

ANA I. PALMERO-MARRERO[1], JOÃO SOARES[2] AND ARMANDO OLIVEIRA[3]

[1] *University of Porto, Dept Mech.Eng., Rua Dr. Roberto Frias, 4200-465, Porto, Portugal, apalmero@fe.up.pt*
[2] *University of Porto, Dept Mech.Eng., Rua Dr. Roberto Frias, 4200-465, Porto, Portugal, joaosoares@fe.up.pt*
[3] *University of Porto, Dept Mech.Eng., Rua Dr. Roberto Frias, 4200-465, Porto, Portugal, acoliv@fe.up.pt*

This paper presents numerical simulation results for a new prototype of a 6 kWe solar/biomass system. The system uses a micro-cogeneration Organic Rankine Cycle (ORC), driven by a combination of solar thermal and biomass sources. Both sources may be used separately or combined. The solar thermal energy is obtained through medium-temperature concentrating compound parabolic solar collectors (CPC) with evacuated tubes. This system is able to generate electrical energy and useful heat at two different temperature levels. The computer model of the overall system was developed by combining EES (Engineering Equation Solver) with TRNSYS software. EES was used for the power cycle calculation, and TRNSYS for simulating the solar circuit and overall system. The ORC/power cycle model consists of a set of algebraic equations representing the thermodynamic behaviour of each ORC component. The ORC simulated by EES includes the following components: evaporator, expander, generator, regenerator, condenser and pump. For an electrical output equal to 6 kW, a fluid inlet temperature in the ORC evaporator of 180ºC was assumed, achieved with the solar collectors and biomass boiler. The ORC is expected to operate at nearly steady-state conditions, as the cycle driving temperature is kept approximately constant. However, TRNSYS is needed to take into account the transient behaviour of solar energy. The TRNSYS model includes the following components: solar collector, boiler, thermal storage, economizer, pumps and control systems. The system is under development and a prototype will be installed and tested in Benguerir (Morocco), in the framework of the REELCOOP project, funded by the EU. For solar resource assessment purposes, Meteonorm software was used to generate climatic data of Benguerir. Results of system simulation under different operating conditions are presented. Annual solar fraction and annual global electrical efficiency for different collector areas and storage capacities were calculated.

Keywords: organic Rankine cycle, micro-cogeneration, solar energy, biomass

221: An Experimental Study of the Thermoelectric Properties of Oriental Hornet Silks and their Application in Buildings

MARK WORALL[1], BIANCA LAURA LATINI[2], THEO ELMER[3], RABAH BOUKHANOUF[4]

1 University of Nottingham, University Park, Nottingham, NG7 2RD, Email. mark.worall@nottingham.ac.uk
2 University of Nottingham, University Park, Nottingham, NG7 2RD, Email: bllatini@libero.it.
3 University of Nottingham, University Park, Nottingham, NG7 2RD, Email theo.elmer@nottingham.ac.uk
4 University of Nottingham, University Park, Nottingham, NG7 2RD, Email rabah.boukhanouf@nottingham.ac.uk

This paper investigates the thermoelectric and thermoregulatory properties of Oriental hornet silk. The larvae of the Oriental hornet produce silks, which it uses to create a silken cap at the end of a vertically orientated comb. It has been found that the silk caps also play a part in hornet nest thermoregulation. The nest of the Oriental hornet is maintained at a constant temperature of 28°C whilst the ambient temperature outside ranges from 20 to 40°C. Silk caps possess thermoelectric and thermophotovoltaic properties that help to regulate the temperatures in the nest by storing excess heat as an electric charge in the caps as temperatures rise and releases the energy as heat as temperatures fall.

Controlled experiments have been carried out on silk cap samples in which we measured resistance, voltage and current during variations in temperature and relative humidity (RH). We have showed that in dry conditions, silk caps act as high resistance materials. The material therefore acted as a dielectric. We measured the charge and discharge characteristics and found that it behaved as a high performance capacitor. In humid conditions, silk caps acted as low resistance materials. The material therefore acted as a thermoelectric energy generator. Doping of the silk caps with LiCl reduced the resistance and increased thermoelectric generation in comparison to results found during high RH conditions. It was shown that resistance was temperature dependent and reached a peak between 25 and 32°C, which is thought to correspond with the glass transition temperature.

We discuss how the principles could be applied to buildings and other applications. Energy harvesting is a growing field of study and by using variations in ambient conditions, such as temperature, RH, and solar irradiation, we could develop multifunctional structures for buildings integrated with high efficiency buildings, and so reduce reliance on distributed energy and conventional supply infrastructure.

Keywords: thermoregulation, homeostasis, biomimetics, silk, thermoelectric

225: Recent development in polymer heat exchangers

XIANGJIE CHEN , YUEHONG SU , SAFFA RIFFAT

Faculty of Engineering, University of Nottingham
xiangjie.chen@nottingham.ac.uk
yuehong.su@nottingham.ac.uk
saffa.riffat@nottingham.ac.uk

Due to its low cost and corrosive resistant features, polymer heat exchangers have been intensively studied to replace metallic heat exchangers in a wide range of applications. This paper reviews recent development of polymer heat exchanger, including cutting edge materials, heat transfer enhancement methods of polymers and a wide range of polymer heat exchanger applications. Theoretical modelling and experimental testing results have been reviewed and compared with literatures. It is shown that polymer materials do hold promise for use in the construction of heat exchangers in many applications, but that a considerable amount of research is still required into material properties and life-time behaviour.

Keywords: Polymer heat exchanger

234: Theoretical investigation of soil-based thermal energy storage system for greenhouses

ERDEM CUCE, YATE DING, SAFFA RIFFAT AND CHUNGUI LU

University of Nottingham, Department of Architecture and Built Environment, Faculty of Engineering, NG7 2RD Nottingham, UK, Erdem.Cuce@nottingham.ac.uk

In this short communication, a novel thermal energy storage system for greenhouses is presented. The novel system is based on directly heating a particular mass of soil through the solar power and utilizing the energy stored in critical months such as November, December, January and February. The target mass of soil is placed beneath the greenhouse with a height of 2m and the boundaries are well-insulated via vacuum insulation panels to provide adiabatic conditions yielding to no heat loss from the edges. Through electric heaters placed inside the target mass of soil, thermal energy is stored inside the soil via the power coming from photovoltaic (PV) panels fixed on the roof of the greenhouse. A specific thin film PV glazing technology called heat insulation solar glass (HISG) is preferred for the power input to the greenhouse. As the first aim of the research, heating demand of the greenhouse is determined for each month. Temperature difference and overall heat transfer coefficient between indoor and outdoor environment are considered to be independent variables in the analyses. Secondly, soil-based thermal energy storage system is introduced and its potential contribution to the heating demand is discussed. The preliminary results indicate that the soil mass is a dominant parameter in soil temperature and hence the thermal energy storage capacity. For a soil mass of 250 tonne, around 600K soil temperature is achieved by the end of year, which is very remarkable.

Keywords: Greenhouses, Energy consumption, Heating demand, Thermal energy storage, Solar power

235: Preliminary performance investigation of a novel direct contact evaporative cooling system

PINAR MERT CUCE[1,*], KEMAL GANI BAYRAKTAR[2], SAFFA RIFFAT[1], SIDDIG OMER[1]

[1] Department of Architecture and Built Environment, Faculty of Engineering, University of Nottingham, University Park, NG7 2RD Nottingham, UK
[2] Izocam Tic. ve San. A.S., Altaycesme Mah., Oz Sokak, No:19, Kat:3-5-6, P.K. 34843, Maltepe, Istanbul, Turkey
**Corresponding email: ezxapm@nottingham.ac.uk, Tel: +44(0)747 327 8285*

Buildings are responsible for about 47% of total energy consumption in the world. The energy consumed is mainly for cooling, heating and ventilation. It is noted that energy requirement for cooling reached 14.6% per annum between 1990 and 2000. Energy demand of buildings will continue to rise in near future owing to long-term use of buildings, increasing comfort demand of occupants and growth in population. In this regard, the aim of evaporative cooling systems is to mitigate the energy consumption and cost of operating a building by transferring heat between two fluids. An evaporative cooling system simply works as increasing the moisture contents of the air with use of water. When hot and dry air welcomes water, the water starts to evaporate with help of energy taken from the air. Thus the air becomes cooler whereas its relative humidity ratio goes up. The evaporative cooling system can be categorised as direct contact or indirect contact with respect to interaction between the streams. In this paper, domestic application of a novel direct contact evaporative cooling system is experimentally investigated. Within the concept of this research, performance evaluation of the system is introduced. For different temperatures of inlet fresh air, outlet temperatures are measured time-dependently and the level of cooling achieved is determined. Proper temperature and relative humidity measurements are performed for a reliable performance assessment. The results indicate that the efficiency of evaporative cooling is very promising. Even if extreme weather conditions are considered for air at the inlet, more than 20 oC temperature difference can be obtained with a remarkably high range of COP. In this respect, it can be easily concluded that the system provides very promising results for hot and arid climates.

Keywords: Evaporative cooling, HVAC, building applications

238: Solar-panels-assisted heat pump

A sustainable system for domestic low-temperature space heating applications

ELAMIN A R.MOHAMED[1], SAFFA RIFFAT[2], SIDDIG. OMER[3]

1 University of Nottingham, University of Nottingham, Dept. of Architecture and Built Environment, amin_eissawi@alumni.nottingham.ac.uk
2 University of Nottingham, University of Nottingham, Dept. of Architecture and Built Environment, saffa.riffat@nottingham.ac.uk]
3 University of Nottingham, University of Nottingham, Dept. of Architecture and Built Environment, siddig.omer@nottingham.ac.uk

Direct expansion solar panels assisted heat pump systems (DX SAHP) have been extensively used in many applications. In the DX-SAHP systems the solar collector and the heat pump are combined into one unit so as to convey the solar energy to the refrigerant. The current work is aimed at examining the use of the DX-SAHP for low temperature space heating applications. The solar collector is used as the evaporator, where refrigerant is directly vaporized due to solar energy input. The thermal performance is examined at the laboratory and also modelled in parallel using computer program. Results point out that the DX-SAHP using solar panels for space heating systems when compared to the conventional solar-assisted heat pump systems, where two components used for one single purpose (DX-SAHPs combine two processes; absorbing solar energy and vaporize refrigerant) is promising as substitute in terms of both energy conserving as well as economic viability. This innovative design results in higher heat transfer coefficient in solar collector-evaporator, lower system losses due to low evaporating temperature and reduces overall system cost.

Keywords: Solar-panels-assisted; Heat pump; Space heating; Economic viability; Low temperature applications.

240: Risk assessment in a central receiver system (CRS)

SAMANIEGO DANYELA.[1], FERREIRA ALMERINDO D[2],
GAMEIRO DA SILVA MANUEL[3]

1 Department of Mechanical Engineering, University of Coimbra, Portugal, danyela.samaniego@gmail.com.
2 ADAI-LAETA, Department of Mechanical Engineering, University of Coimbra, Portugal, almerindo.ferreira@dem.uc.pt
3 Department of Mechanical Engineering, University of Coimbra, Portugal, manuel.gameiro@dem.uc.pt

Sun is used as a renewable source for electricity production by the concentrated power systems (CPS). Among the CPS technologies available, the central receiver system (CRS) is becoming more popular within the options in the promising future of solar thermal industry. Basically the CRS technology consists in the concentration of sunrays on the receiver by reflecting them in heliostats' surfaces (mirrors). The reflections can be differently classified based on the concept of human-interacting situations, e.g. the reflection aimed the sky, reflections from one single heliostat, the reflected irradiance from the receiver or concentrated solar radiation from the field of heliostats. Since solar radiation has the potential to interact positively and/or negatively with biological human systems, and adding that CPS facilities are usually located in sunny environments, those situations might exhibit scenarios of potential risks for human health. The workers sometimes developed their duties under lower protection. Those stages could happen, for instance, to people located up in the central tower, workers who stand in front of a heliostat surface, and also people in the near surroundings. Based on simulations of the irradiance flux in a CRS, through the usage of software SolTRACE®, this paper aims to provide information about the assessment of eye exposures.

Keywords: Solar energy, environmental conditions, risk assessment, concentrated power systems, central receiver systems.

244: Experimental study on a direct-expansion solar-assisted heat pump

WENZHU HUANG，JIE JI *，NING XU,
FANGLIANG ZHAO, HAOFANG ZHENG

Department of Thermal Science and Energy Engineering, University of Science and Technology of China
#96 Jinzhai Road, Hefei City, Anhui Province, People's Republic of China
**Corresponding authors email: jijie@ustc.edu.cn*

In this study, a direct expansion solar-assisted heat pump system (DX-SAHP) with bare flat plate collectors is investigated experimentally in the enthalpy difference lab with a solar simulator and tested for space heating under different stable conditions. The influence of solar irradiation and outside temperature on the heating performance of DX-SAHP is analyzed. When outside temperature changes from 5℃ to 15 ℃ with solar irradiation of 300 W/m2, COP increases from 1.83 to 1.99, while the evaporator temperature and the condensing heat exchange rate increases by 8.9℃and 25%. Moreover, When solar irradiation changes from 100 W/m2 to 300 W/m2 with outside temperature of 15℃, COP of the system increases from 1.85 to 1.99, and the evaporator temperature and the condensing heat exchange rate increases by 2.0℃ and 21.0%, respectively. It is observed that when outside temperature is 7℃, without irradiation, after 30 min the evaporator is seriously frosted and the evaporating temperature is -0.77℃,while under irradiation of 80 W/m2 the evaporator is not frosted and the evaporating temperature and COP is respectively 3.12℃ and 15.5% higher than the former situation.

Keywords: Solar-assisted; Heat pump; COP; Exergy

249: Investigation on the applicability of screw expander in distributed solar thermal electricity generating systems

PENGCHENG LI[1], JING LI*[2], GANG PEI*[3], JAHAN ZEB ALVI[4], JIE JI[5]

1,2,3,4,5Department of Thermal Science and Energy Engineering, University of Science and Technology of China, Jinzhai Road 96, Hefei City, Anhui Province, People's Republic of China
1lpc1988@mail.ustc.edu.cn 2lijing83@ustc.edu.cn 3peigang@ustc.edu.cn 4alvi@mail.ustc.edu.cn 5jijie@ustc.edu.cn

Screw expander (SE), with high applicability in power conversion with steam-liquid mixture, would be successfully applied in solar electric generating systems (SEGS). A cascade steam-organic Rankine cycle (SORC) integrated with parabolic trough collectors (PTC) was proposed. The top cycle was SE-based steam Rankine cycle (SRC) and the bottom cycle was organic Rankine cycle (ORC). The SRC condensation heat was used to drive the ORC. By comparison with conventional PTC-SEGS, the proposed system averted superheated steam and was suitable for distributed power generation applications. The actual achieved thermal efficiency was lower than the theoretical value when the influence of operating PR on SE efficiency was considered. Maximum thermal efficiencies of 14.26% and 16.00% could be obtained for SORC system with benzene as bottom fluid at the design hot / cold temperatures of 200/40℃ and 200/10℃. The efficiencies exceeded those of cascade organic Rankine cycle (CORC) system by 4.0% and 1.5% respectively, even if the working fluids in CORC were carefully selected and working conditions were optimized.

Keywords: screw expander; thermal efficiency; cascade system; pressure ratio

251: Harnessing Post Occupancy Evaluation to understand student use of indoor environmental controls in a modern halls of residence

RUCHA AMIN, DESPOINA TELI, PATRICK JAMES, LEONIDAS BOURIKAS

Sustainable Energy Research Group, Energy & Climate Change Division, University of Southampton, University Road, Southampton, S017 1BJ, R.Amin@soton.ac.uk

User behaviour is increasingly being seen as the major determinant of 'performance gap' in buildings. This study is using a modern University halls of residence building occupied by a highly heterogeneous student population; here, we would expect to see user behaviour driven performance gap to appear.

The case study building is a newly built, £70 million student halls of residence building complex in Southampton, UK; the complex consists of three individual buildings of varying size that together provide 1104 rooms. A post occupancy evaluation (POE) was undertaken in the building which included an online questionnaire survey and environmental monitoring. The questionnaire, carried out at month 5 of their 9 month stay, asked occupants about the environmental conditions in their room and the use of controls to change their indoor environment. A total of 223 responses were gathered of which approximately 26% were non-UK students. The environmental monitoring was undertaken in 80 student rooms and involved measurements of air temperature and relative humidity for this period.

This paper analyses students' reported use of indoor environmental controls regarding window opening and indoor space heating, and compares their responses to the environmental measurements. The results highlight the diversity in the reported use of the available environmental controls within rooms with similar typological characteristics. The potential reasons for the different levels of user control (as reported) such as climate history and gender are explored. The paper provides insights into the impact of occupant behaviour on the energy performance of the newly built halls of residence.

Keywords: post occupancy evaluation, occupant behaviour, thermal comfort, performance gap

252: A novel approach on measuring solar transmittance of glazing

GEORGE GORGOLIS[1], NIKOLAOS SKANDALOS[1], DIMITRIS KARAMANIS[1]

[1] University of Patras, 2,G.Seferi str. Agrinio, ggorgolis@upatras.gr nskandalos@upatras.gr dkaraman@upatras.gr

Due to the increased interest of reducing building energy demand, innovative glazings are being developed and tested worldwide. Among other properties, solar transmittance should be carefully measured in order to be used in the building thermal simulation studies. Currently, the standard measuring procedure relies on the application of the ASTM E424-71 method by the use of a spectrophotometer and artificial light sources or a pyranometer and the sun. In this work, an alternative method was developed based on an in-house designed and built wind tunnel of controllable conditions of air RH, temperature and wind flow, simulated solar radiation by a 1000 W Xe source and a pyranometer of class A. The system was calibrated by an electrochromic glazing of 10x10 cm2 that was biased at different time intervals in order to scan all the transmittance range. Prior to the solar simulator measurements, electrochromic transmittance values were determined by an UV/VIS/NIR spectrophotometer with an 150mm integrated sphere. The method was applied in the solar transmittance measurement of innovative glazings like semi-transparent PV and insulating aerogels. The results of solar transmittance that were produced from this proposed method were very close to the corresponding produced results after the reduction of the observed transmittance spectrum with the ASTM G173 spectrum. Also, the results were in good agreement with the values of solar transmittance that were observed using the method of measuring the ratio of solar radiation with and without a glazing material. So, the method can be used as a fast and accurate procedure for solar transmittance measurement, while in the same measurements, the reflected radiation can be monitored.

Keywords: glazings, solar spectrum, materials, thermal behaviour

257: Renewable Energy Potential Maps for Building Thermal Design in China

SIQIANG LU[1], KAZUO EMURA[2],JUN WANG[3],
FENG XIONG[4], , MING QU[5]

1College of Architecture and Environment, Sichuan University, No. 24, First loop south first section, Chengdu City, Sichuan Province, China, Lusiqiang@scu.edu.cn
2 Graduate School of Human Life Science, Osaka City University, 3-3-138 Sugimoto Sumiyoshi-ku, Osaka-shi, 558-8585,JAPAN, emura@life.osaka-cu.ac.jp
3 College of Architecture and Environment, Sichuan University, No. 24, First loop south first section, Chengdu City, Sichuan Province, China, wangjunhvac@163.com
4College of Architecture and Environment, Sichuan University, No. 24, First loop south first section, Chengdu City, Sichuan Province, China, fxiong@scu.edu.cn
5Sichuan Provincial Architectural Design and Research Institute, No. 688, Tianfu road middle section, Chengdu City, Sichuan Province, China, 306322159@qq.com

This paper examines the potential for use of several types of renewable energy through the creation and analysis of maps of potential usage in China. Passive solar potential (PSP) to heat houses, and the nocturnal cold air potential (NCP), the evaporative cooling potential (ECP) and the nocturnal radiative cooling potential (RCP) to cool houses in China are examined. The Standard Year Weather Data for calculating the heat load of buildings is selected to analyzing the regional climate. From it, these potential indictors are evaluated by formulations with showing these attributions. By calculating these indicators at 270 locations throughout China, contour maps are drawn and their indication of potential effect on utilizable renewable energy is analyzed. Through use of these maps, the suitability of these renewable energy technologies in a location can be determined. It is expected that such information on energy conservation can be useful to architects and designers at the first stage of building planning.

Keywords: renewable energy; efficiency; potential map; passive solar; nocturnal cool air; evaporative cooling; nocturnal radiative cooling

259: Theoretical analysis of a membrane-based liquid desiccant system

ZIWEI CHEN[1], YUQI PAN[2], JIE ZHU[3]

[1] Ziwei Chen, Department of Architecture and Built Environment, The University of Nottingham, University Park, Nottingham NG7 2RD, UK, ezxzc@nottingham.ac.uk
[2] Yuqi Pan, Department of Architecture and Built Environment, The University of Nottingham, University Park, Nottingham NG7 2RD, UK, layyp3 @nottingham.ac.uk
[3] Jie Zhu, Department of Architecture and Built Environment, The University of Nottingham, University Park, Nottingham NG7 2RD, UK, jie.zhu@nottingham.ac.uk

Ventilation and air humidity are two important factors determining the thermal comfort of indoor environment. Liquid desiccant dehumidification has become one of the widely used dehumidification technologies with high efficiency and energy storage capability. Different from the conventional packed beds dehumidification, membrane-based dehumidification systems overcome the problem of liquid droplets from crossing over. Heat and mass transfer phenomena of the membrane-based dehumidification are much more complicated than the commonly well-investigated packed columns. Based on the literature studies, a simplified steady-state counter-flow mathematical model has been developed in this paper for a single layer membrane unit. The theoretical model can be used to carry out performance analysis and system design. The governing equations were solved iteratively by finite difference method. The performance analysis has been completed for a small-scale membrane-based dehumidification module consisting of 8 air channels and 8 solution channels. The influences of main design parameters on dehumidification effectiveness have been evaluated, including air and solution inlet conditions, air flow rate (NTU) and solution to air mass flow rate ratio (m). The numerical results indicated the capabilities of the membrane-based unit to provide the dehumidified air under various climate conditions. The system NTU and solution to air mass flow rate ratio (m*) are two key parameters impacting the dehumidification performance, and they affect each other positively. Higher sensible and latent effectiveness can be achieved with larger NTU and m*. Suggestions for the system design and operation have been provided with performance evaluations.*

Keywords: Dehumidification, Liquid Desiccant, Membrane-based, Heat and Mass Transfer, Numerical Model

260: A Review on Desiccant Cooling System

KHALID ALSALEH [1], SAFFA RIFFAT[1]

1 Faculty of engineering, University of Nottingham, Nottingham ng7 2rd, UK, ezxka1@nottingham.ac.uk

World are planning for signification deployments of Renewable and Nuclear energy to produce energy from clean and sustainable source. Renewable energy will save hydrocarbons and oil that are currently used to generate energy which will reflect in the environmental pollution.

The roadmap for Solar PV will envision up to 16% of global electricity. According to IEA, "6 300 TWh generated in 2050, up from the 4 500 TWh foreseen in the 2010 roadmap. Total global capacity overtook 150 gigawatts (GW) in early 2014".(IEA, 2014)

About half the large PV deployment would take place on buildings or nearby such as over parking. The prospects for self-consumption are higher in hot countries, where air-cooling loads partly drive consumption, and for buildings other than residential.(IEA, 2014)

According to the U.S. Energy Information Administration (EIA), heating and cooling accounted for 72% of the energy used in household in the United States. Air conditioning is claimed to account for over 65% of the energy consumption in Gulf Cooperation Council (GCC) country.(SEEC, 2013)

Desiccant cooling system has been growing rapidly since 2004 from 60 systems to more than 1000 system installed in less than ten years. However, compared to the potential of using solar energy to generate cooling, deployment levels are very low. In the Sunbelt region, where cooling demands are quickly rising, there are still only a few demonstration plants and studies available. (IRENA, 2015)

The demand for cooling in hot and humid regions is more than heating which showed excellent opportunity to develop renewable cooling system in that region.(IEA, 2007) The need of a solar assisted desiccant system is more important today especially in regions of high humidity.(Elsarrag, 2008)

This paper aims to presents a review of the available cooling technologies; followed by a pros and cons analysis of the different solar cooling processes as well a market study will be carried.

Keywords: desiccant, cooling, solar, market, policy

261: Design and Optimisation of a Novel Passive Cooling Wind Tower

JOHN KAISER CALAUTIT[1], BEN RICHARD HUGHES[2], POLYTIMI SOFOTASIOU[3]

[1] *University of Sheffield, Sheffield, UK, j.calautit@sheffield.ac.uk*
[2] *University of Sheffield, Sheffield, UK, ben.hughes@sheffield.ac.uk*
[3] *University of Sheffield, Sheffield, UK, psofotasiou1@sheffield.ac.uk*

Buildings are responsible for almost 40% of the world energy usage. Heating Ventilation and Air-Conditioning (HVAC) systems consume more than 60% of the total energy use of buildings. In hot climates, the percentage of energy consumption by air conditioning is significantly larger due to the more extreme conditions of the local climate. Clearly any technology which reduces the HVAC consumption will have a dramatic effect on the energy performance of the building. Natural ventilation offers the opportunity to eliminate the mechanical requirements of HVAC systems by using the natural driving forces of external wind and buoyancy effect. A technology which incorporates both wind and buoyancy driven forces is the wind tower. Wind towers are natural ventilation systems based on the design of traditional architecture. Though the movement of air caused by the wind tower will lead to a cooling sensation for occupants, the high air temperature in hot climates will result in little cooling. In order to maximise the properties of cooling by wind towers, heat transfer devices were incorporated into the design to reduce the supply air temperature.

The aim of this work was to design and optimise a wind tower integrated with heat transfer devices using CFD modelling, validated with wind tunnel and field experiments. Care was taken to generate a high-quality CFD grid and specify boundary conditions. An experimental model was created using 3D printing. Qualitative and quantitative wind tunnel measurements were compared with the CFD data and good correlation was observed. Field testing of the wind tower was carried out to evaluate its performance under real operating conditions. A prototype of the device was produced and installed on top of a test facility in Ras Al Khaimah, UAE. The study highlighted the potential of the wind tower in reducing the temperature by up to 12˚C and supplying the required fresh air rates. The technology presented here is subject to a patent application (PCT/GB2014/052263).

Keywords: buildings; computational fluid dynamics (CFD); heat pipes; natural ventilation; wind tunne

262: Operation performance of separated heat pipe in data centre

Testing and analysis

TAO DING, ZHI GUANG HE, ZHEN LI, ZHEN YING WANG

Department of Engineering Mechanics, Tsinghua University, Meng Min Wei Technology building, Tsinghua University, Beijing 100084 China, dingtaohang01@163.com

Data center grows rapidly all over the world, at the same time energy consumption is also increasing. According to research, nearly 45% of the total energy in data center is used for IT equipment while about 45% for computer room air conditioning (CRAC) system. Apparently, cooling system consumes too much energy. Badly air organization and compressor of air conditioning working all year round are the mainly two shortcomings for CRAC system. In order to save energy, a new kind of cooling system called separated heat pipe cooling system is used in data center. This system has better airflow organization and it can use free cold ambient air as heat sink in winter. In this paper, working condition of separated heat pipe system is tested. For example, temperature at some typical points will be measured, like chilled water's inlet/outlet temperature, IT equipment's working temperature and room temperature. On dealing with temperature distribution, T-Q diagrams of CRAC and separated heat pipe system showing the temperature distribution are drawn. In T-Q diagram, temperature difference of heat transfer in every process can be easily calculated, which can be used to direct heat transfer enhancement. As for an evaluation index of data center energy efficiency, PUE (power usage efficiency) will also be measured. In theory, the system's PUE will get the minimum value in winter, while get the maximum value in summer. Briefly, using free ambient cold air and installing evaporator inside the rack are the mainly two advantages of separated heat pipe system, which will lead to better working environment for IT equipment and more energy saving compared with traditional CRAC system.

Keywords: Separated heat pipe, CRAC, free ambient cooling, data center cooling

263: Intelligent Building Management System for Energy Demand and Supply Optimisation

ASSIST. PROF. DR. H. UFUK GÖKÇE[1*],
ASSIST. PROF. DR.-ING K. UMUT GÖKÇE[2]

[1] R&D Director, EOS Sustainable Energy Solutions GmbH, Vahrenwalder Str. 7, 30165, Hannover, Germany. Tel: +49 511 260 304 93, Fax: +49 511 260 304 94, e-mail: ufuk.gokce@eos-ses.de
[2] Managing Director, EOS Sustainable Energy Solutions GmbH, Vahrenwalder Str. 7, 30165, Hannover, Germany. Tel: +49 511 260 304 93, Fax: +49 511 260 304 94, e-mail: umut.gokce@eos-ses.de

The quality of life in Europe's cities states that although quality of life has improved in many areas, in other areas such as environmental issues and energy efficiency have deteriorated. Energy consumption for building-related services accounts for approximately 40% of European Union's total energy consumption. Total carbon emissions generated by the buildings account for 35%. In such places, people, companies and public authorities experience specific needs and demands regarding domains such as energy efficiency, environment and transportation services. These domains are increasingly enabled and facilitated by web-based applications, service oriented architectures, ubiquitous sensing infrastructure, advanced information management applications such as data warehousing and data mining technologies which generate actionable information for intelligent and predictive control for further optimised smart buildings and cities.

The research presented in this paper focuses on an innovative model-driven development approach that integrates systems in building supply-side and building demand-side to balance efficient energy production from off-the-grid systems and optimized consumption.

The research findings will be demonstrated in a residential building in Hannover, Germany integrating different energy efficient production/consumption systems addressing the renewable energy technologies coupled with energy storage systems and building energy management systems comprising scalable and robust sensing network platforms, energy performance monitoring and data warehouse technologies.
The research will be carried out within the scope of State of Lower Saxony Innovation Support Program (Niedersächsischen Innovationsförderprogramms) which is funded by Ministry for Economic Affairs, Labour and Transport of State of Lower Saxony-Germany (Niedersächsisches Ministerium für Wirtschaft, Arbeit und Verkehr), Ministry for Environment, Energy and Climate Protection of State of Lower Saxony-Germany (Niedersächsisches Ministerium für Umwelt, Energie und Klimaschutz), Investment and Support Bank of State of Lower Saxony Nbank (Investitions- und Förderbank Niedersachsen – NBank) and the European Union.

Keywords: Building management system, renewable energy, holistic monitoring and analysis methodologies, scenario based control strategies, data warehouse technologies.

271: Economic Evaluation of a CAES system for increased wind penetration to Egyptian grid

OMAR RAMADAN, SIDDIG OMER, SAFFA RIFFAT

1 University of Nottingham, University Park, Nottingham, NG7 2RD, laxor1@nottingham.ac.uk

Renewable Energy systems have gained growing interest especially in the last decade. However, there are serious issues that come with these systems, related to the intermittency of the renewable energy sources. Energy storage could play a big role to solve or at least minimize the issues related to the intermittency of the renewable energy systems. Compressed air energy storage (CAES), among many has the ability to have a considerable impact when it comes to large scale renewable energy systems as it can absorb and release large amount of energy (100's MW) for a long period of time (hours). An economic evaluation of CAES is important to establish its feasibility for large-scale renewable energy systems. An economic study is carried out in this paper taking Egypt as a case study for implementing CAES system as part of the proposed plans of increasing wind farms installation in Egypt by 2020.

Keywords: Energy Storage, CAES storage, Wind energy, Economic evaluation

274: The review of solid and liquid desiccant cooling technologies in sustainable energy development

MOHD ANAS MOHD SABRI[1], SIDDIG OMER[2], SAFFA RIFFAT[3]

1Mohd Anas Mohd Sabri, Institute of Sustainable Energy Technology, University of Nottingham, United Kingdom, ezxmam@nottingham.ac.uk
Department of Mechanical & Manufacturing Engineering, Faculty of Engineering & Built Environment, Universiti Kebangsaan Malaysia, Malaysia anas@eng.ukm.my
2Siddig Omer, Institute of Sustainable Energy Technology, University of Nottingham, United Kingdom, Lazsao@exmail.nottingham.ac.uk
3Saffa Riffat, Institute of Sustainable Energy Technology, University of Nottingham, United Kingdom, Lazsbr@exmail.nottingham.ac.uk

In a fast moving and very competitive world, high energy requirement could be very demanding for engineers and researcher. Nevertheless, it sometimes misled to unwanted pollution and destruction to the environment. Energy cooling in buildings in a hot and humid country is one of the biggest contributors to this problem. Main reason is because of vapour compression cycle system requires high energy to dehumidify the air. This conventional air-conditioning system can be replaced by using desiccant cooling technologies. The objective of this paper is to review the development and application of solid and liquid desiccant cooling technologies. We will be looking on the basics and further enhancement of both solid and liquid desiccant technologies. For solid desiccant, we studied the classic desiccant-based rotor wheel and also other type of dehumidifier such as fixed bed solid desiccant. For liquid desiccant, we studied the single stage and multiple stage liquid dehumidification system and hybrid liquid desiccant cooling system. We also focus on the dehumidification mechanism for heat and mass transfer and also liquid desiccant solution. From the review, we can use as guidelines to develop a new desiccant cooling technology.

Keywords: solar energy, solid desiccant, liquid desiccant, vapour compression cycle, dehumidification

278: Nano composite "Vermiculite-CaCl2" matrix for open thermochemical heat storage:

Experimental investigation of cyclic behaviour and numerical determination of "operating line"

DEVRIM AYDIN[1], SEAN CASEY[1], SAFFA RIFFAT[1]

[1] Faculty of Engineering, University of Nottingham, University Park, Nottingham, NG7 2RD, UK, ezxda4@nottingham.ac.uk

In the last decade, low carbon technologies for reducing the dependency on fossil fuels have been attracting attention. Domestic heating is one of the prior areas needing advanced sustainable technologies to reduce global energy demand. Population growth and the increasing comfort demand in dwellings have caused a sharp rise of fossil fuel consumption in the last 50 years. On the other hand solar energy is counted as one of the promising renewable sources and has a great potential for thermal energy generation. However the mismatch of solar energy availability and building heat loads in winter conditions constitutes a drawback needed to be overcome for increasing solar share in space heating applications. Thermochemical heat storage system is a promising alternative for long term – seasonal storage of solar energy without any heat loss which seems difficult with sensible or latent heat storage systems.

In this study the cyclic behaviour and thermal performance of nano-composite matrix "Vermiculite-CaCl2" is experimentally investigated. A novel open thermochemical reactor consisting of meshed tube diffusers was developed for conducting the experiments. Results showed that "Vermiculite-CaCl2" has a good cyclic behaviour. Additionally it is found that 0, 01 m3 of Vermiculite-CaCl2 can provide an average temperature lifting of air, ΔT~20 °C over 180 minutes corresponding to ~1 kWh heat output. The results suggested a linear correlation between thermal performance and moisture uptake. Concordantly an "operating line" showing the instantaneous ΔT – Δw relation for certain inlet air conditions is numerically generated. Experimental results were used to validate the model and it was found that a numerically achieved operating line is in close approximation with the test results. Determining operating lines will be useful for effective design and control of thermochemical heat storage systems.

Keywords: thermochemical heat storage, Vermiculite, CaCl2, cyclic behaviour, thermal analysis, operating line

280: A Carbon Neutral Small Scale District Heating

MICHELE TUNZI[1], EDWARD COOPER, BOUKHANOUF RABAH

[1] *Department of Architecture and Built Environment, University of Nottingham, University Park, Nottingham NG7 2RD, United Kingdom, ezxmt@nottingham.ac.uk.*

The energy requirement of an existing small scale district heating (DH) network, connected to seven properties of mixed use (office and living spaces), located in Nottinghamshire and fuelled by a 300 kW biomass boiler, was studied in view of upgrading it. This paper presents results of heat energy simulation, monitoring and an energy audit of the existing heat network. The individual properties' heat load profiles were modelled in order to get an aggregated site profile network. In addition, on selected points of the network, the operating conditions of the network were monitored and collected: supply/return temperatures and mass flow rate are presented. The paper also summarises a recommendation for an upgraded heat network, focusing on improving the DH and to propose this as a solid technology for the future challenges of the heat energy market.

Keywords: community energy scheme, district heating, heat load profile, thermal simulation

281: Occupant Behaviour and Thermal Comfort in Naturally Ventilated Office Buildings in China

Field Studies in Zhejiang

JINDONG WU[1], LUCELIA RODRIGUES[2], BRIAN FORD[3]

[1] The University of Nottingham, University Park, Nottingham, UK, NG7 2RD, Laxjdw1@nottingham.ac.uk
[2] The University of Nottingham, University Park, Nottingham, UK, NG7 2RD, Lucelia.rodrigues@nottingham.ac.uk
[3] Natural Cooling, UK, DE4 5AR, brian@naturalcooling.co.uk

In China, heating, ventilation and air conditioning systems account for 40% to 60% of the energy consumed in office buildings. Despite the widely known benefits of using natural ventilation as a passive cooling method and the potential reduction in energy demand the implementation of this strategy may bring, most office buildings in China are not designed to be naturally ventilated and little work has been developed in this area. In particular, there is a significant gap in knowledge with regard to how occupants adjust their indoor environmental conditions to achieve thermal comfort by controlling the opening and closing of windows. Understanding the patterns of this behaviour, and the relationship between this and other indoor environmental factors, is of great significance to the study of thermal comfort and energy efficiency.

In this study, the authors attempted to demonstrate the relationship between the occupant behaviour with regard to window control and various indoor environmental factors, mainly through empirical data collected during field studies in Zhejiang province (a typical area with the climate of hot summer and cold winter in China). Field measurements and the results of questionnaires were correlated to establish the patterns of window openings in a naturally ventilated office building. It was found that window state changes mainly happen at the moment of occupant arrival and leaving, and a clear relationship between occupant window control behaviour, indoor temperature and indoor air speed was identified.

Keywords: Window Control Behaviour, Thermal Comfort, Natural Ventilation

283: Thermal Performance of an Experimental Solar Pond Provided with Heat Exchanger in Egypt

WESSAM E. ABD ALLAH[1], M.A. TAWFIK[2], M.K. ABD EL-WAHAB[3]

[1] University of Zagazig, PO Box 44511, Zagazig City, Egypt. Email: dr.wesam15@yahoo.com
2 University of Zagazig, PO Box 44511, Zagazig City, Egypt. Email: mohamed.ezeldien@yahoo.com
3 University of Zagazig, PO Box 44511, Zagazig City, Egypt. Email: kadryprof@yahoo.com

This work aims to study the availability of absorbing, trapping and exploiting the high radiation- as heat energy- in Egypt. Therefore, a set of practical experiments were conducted to evaluate both the thermal performance of an experimental salinity gradient solar pond (SGSP) and the heat extraction by using an internal heat exchanger (IHE). All experiments were carried out at Faculty of Agriculture, Zagazig University, Egypt (Latitude 30o 35/ N, Longitude 31o 31/ E) during 2013.

The results revealed that, the average temperature stored in the lower convective zone (LCZ) of the pond was about 32.4, 49.3 and 53.2 oC at average penetrated solar radiation flux of 151.8, 239.5 and 298.6 W/m2 for months of January, April and July, respectively .It was found that, about 28.8% of the incident solar radiation on the pond's surface reached the LCZ. Ultimately, the average values of IHE's effectiveness and the thermal efficiency of the pond were 0.505 and 24.5 %, respectively at month of July. Hence, it is clear that, the SGSP has a good thermal performance and suitable for different thermal applications under the Egyptian climate conditions.

Keywords: solar pond, thermal performance, heat extraction, effectiveness, thermal efficiency.

284: Space Cooling in Buildings in Hot and Humid Climates – a Review of the Effect of Humidity on the Applicability of Existing Cooling Techniques

ADRIAN R KATILI, RABAH BOUKHANOUF, ROBIN WILSON

The University of Nottingham, University Park Nottingham NG7 2RD, ezxark@nottingham.ac.uk

The building sector is one of the biggest consumers of energy in many countries and in South East Asian region it accounts for around 30% of primary energy demand. This is mainly dominated by the use of air conditioning systems to provide space cooling for the building's occupants. Energy intensive vapour compression systems consume over 50% of total energy used in buildings, increasing to 80% at peak times. In addition, air dehumidification is achieved by reducing the ambient air temperature below its dew point, which is far lower than the required comfort conditions in buildings, causing more energy waste for air reheating.

In this paper various cooling techniques will be reviewed and their suitability to provide comfort cooling in the context of hot and humid climates discussed. Compared to vapour-compression system which offer good reliability and comfort control level, passive cooling techniques have also been developed as viable low carbon alternatives. Commonly, passive cooling technologies such as radiant cooling, ground cooling, evaporative cooling, etc. have been mainly used in dry and hot climate, however their adoption in humid climate poses a problem as ambient air moisture content is high. Techniques for water vapour removal from air using desiccant materials will be discussed as well the use of solar energy to reduce energy consumption.

Keywords: energy in buildings, humidity, space cooling

285: Impact of weather dependent variables on minimizing dehumidifying load on air conditioned office

EUNICE AKYEREKO ADJEI[1], SAFFA RIFFAT[2], SIDDIG OMER[3]

1 Department of Architecture and Built Environment, University of Nottingham, laxeaa@nottingham.ac.uk
2 Department of Architecture and Built Environment, University of Nottingham, Lazsbr@exmail.nottingham.ac.uk
3 Department of Architecture and Built Environment, University of Nottingham, Siddig.Omer@nottingham.ac.uk

Dehumidifying load remains the largest contributing load to total cooling load in hot humid tropical climate. Minimizing dehumidifying load at a low cost in a new building design and existing building in developing country comes with design challenges. This paper uses ESDL TAS building simulation software to perform dynamic simulation of whole office building envelope using weather sensitive variables for parametric study. Significant findings are: a. The total dehumidifying load of the base case was reduced by 55% with a corresponding reduction of 45 % of the total cooling load by the following significant strategies: i. Changing the thermostat temperature and relative humidity setting to 26oC and 60% respectively. ii. Reducing infiltration arising from all leakages to a practically feasible minimum of 0.20 ACH as well as ventilation gain of 1 ACH. b Vapour diffusion property of building materials had insignificant effect on minimizing the dehumidifying load. The following were concluded: 1. There is no single approach in minimizing dehumidifying load and maintaining indoor environmental building performance. 2. ESDL Tas, is inadequate software package for predicting vapour diffusion. Finally, dehumidifying load of air-conditioned buildings in hot humid climate in developing country can be minimized at cost effective approach by changing the weather dependent variables (ventilation gain, thermostat setting and infiltration gain).

Keywords: dehumidification load, air-conditioning, electricity consumption, hot-humid climate and Ghana

287: Field performance of air-source heat pump in low-temperature region of north China

SONGHUI AI[1], BAOLONG WANG, XIANTING LI, WENXING SHI*

1 Department of Building Science, Tsinghua University, Beijing, China, hu_tu_tu@126.com
**Department of Building Science, Tsinghua University, Beijing, China, wxshi@mail.tsinghua.edu.cn*

As the rapid development of economics and the deterioration of environment, development of sustainable energy is of vital importance. In north China, the traditional heating form in winter is boiler which has resulted in severe air pollution. The air-source heat pump, as a clean and efficient form of heating source, could be used as a new form of heating source. However, the running performance drops sharply as the outdoor temperature decreases, especially in winter of north China. As the development of compressor technology, several technologies have been utilized to solve this problem. The quasi two-stage compression with refrigerant injection is an effective method, which can decrease the discharge temperature and increase the coefficient of performance. Several site tests have been conducted during a long period in this paper.

To investigate the operating performance of air-source heat pump applied in low-temperature region, several parameters were measured, including the energy consumption, the heating capacity and the outdoor temperature. Thus, the running performance is analyzed.

The testing result shows that the coefficient of performance maintains above 2.8kW/kW when the outdoor temperature is -8℃ in Beijing. In Taiyuan of Shanxi province, the average heating capacity of an air-source heat pump water heater during the coldest month is 24.5kW, which is close to 75% of the rated heating capacity under much mild 7/6℃ working condition. The average hourly heating performance is 2.71kWh/kWh. The average hot water temperature is about 45.5℃.The testing data above proves that the air-source heat pump with scroll compressor of quasi two-stage compression shows great running performance in the cold region of north China, which could be a reasonable choice of heating device applied in north China.

Keywords: air-source heat pump, low-temperature, site test, running performance

293: SOC Management of BESS for Frequency Regulation with Hysteresis loop control

JIN-SUN YANG[1], JIN-YOUNG CHOI[2], DONG-JUN WON[3], IN-SUN CHOI[4], GEON-HO AHN[4], YEONG-JUN CHOI[4]

[1] Dept. Electrical Engineering, INHA University, Inchoen, Republic of korea,sealvoeyjs@gmail.com
[2] Dept. Electrical Engineering, INHA University, Inchoen, Republic of korea,djwon@inha.ac.kr
[3] Dept. Electrical Engineering, INHA University, Inchoen, Republic of korea,jy128308@gmail.com
[4] Dept. Power Grid Integration of R&D Center, Hyosung Corporation, Republic of Korea

For stably operation of BESS for frequency regulation, BESS needs a SOC manage¬ment algorithm. This paper proposes that BESS changes a base point for the SOC management for stable operation to keep high performance score. To manage SOC of BESS providing frequency regulation, the base point is changed in accordance with a proposed hysteresis loop control when the SOC exceeds a limit, BESS provides the additional output as much as changed base point more than a regulation set point. Through this process, BESS recovers SOC and keeps stable operation range and high performance score. Three cases are observed: 1) without hysteresis loop control; 2) using hysteresis loop control; 3) using hysteresis loop control at high SOC. Cases simulated by using PSCAD/EMTDC. For the accuracy of simulation, this paper performs simulation based on real frequency regulation signal data of the PJM in USA. First case simulation shows that the SOC exceeds stable range and this situation finally causes shutdown the BESS because SOC reaches full. Second case simulation shows that SOC is managed in stable operating range. And final case shows that BESS is recovered from high SOC. This means BESS operators should set proper operation range and SOC limit for the SOC management. A simulation results show that if the proposed algorithm is applied to BESS for frequency regulation, the BESS is able to keep high performance score. Also proposed algorithm can be applied to BESS to perform other roles in power system.

Keywords: Battery energy storage system, state of charge management, regulation set point, base point, frequency regulation

296: Thermal environment of an atrium enclosed with an ETFE foil cushion envelope

SABRINA AFRIN[1], JOHN CHILTON[2], BENSON LAU[3]

1, 2, 3 University of Nottingham, University Park, NG7 2RD
1 Sabrina.Afrin@nottingham.ac.uk, 2John.Chiton@nottingham.ac.uk, 3Benson.Lau@nottingham.ac.uk

Ethylene-tetrafluoroethylene (ETFE) foil is most commonly employed in buildings as a replacement for glazing to enclose transitional spaces, for example atria and circulation areas, although, increasingly, it is used as a secondary or primary façade for more intensively occupied architectural spaces where thermal comfort needs to be more precisely controlled. Despite the different thermal/optical properties, thickness and form in use of this material when compared to glass, there has been only limited investigation of the influence of these characteristics on the dynamic thermal responsiveness of the envelope and its impact on the thermal environment of the enclosure.

This paper presents results of an ongoing investigation into the thermal environment of an approximately 625m2 atrium enclosed by a two-layer ETFE-foil cushion roof recorded by onsite monitoring conducted from April 2014 to April 2015. In order to examine the thermal environment of the atrium during different seasonal conditions, continuous field measurements of indoor thermal environmental parameters were recorded under varying external climatic conditions at different vertical levels and horizontal positions in the atrium with and without operation of the HVAC system and with variable occupancy. The effects of solar transmission, outdoor air temperatures, surface temperatures of the ETFE cushion on internal air temperatures and mean radiant temperatures at different levels of the atrium are compared and discussed.

Keywords: ETFE foil cushion, thermal environment, thermal performance, temperature stratification, cushion envelope.

297: Soil Temperature Profile for some New Cities in Egypt:

Experimental Results and Mathematical Model

AHMED A.SERAGELDIN[1], ALI K.ABDELRAHMAN[1], AHMED HAMZA.H.ALI[2], MOHAMED R.O.ALI[3],SHINICHI OOKAWARA[4]

[1] Egypt-Japan University of Science and Technology (E-JUST), Alexandria- Egypt, Ahmed.serageldin@ejust.edu.eg, ali.kamel@ejust.edu.eg
[2] Assiut University , Assuit- Egypt, drahmedhamza@yahoo.com
[3] Al-Minia University, Al-Minia-Egypt, mohamedroalin@mu.edu.eg
[4]Tokyo institute of Technology,Tokyo-Japan, Assuit- Egypt, sokawara@chemeng.titech.ac.jp

Egypt nowadays passes through an energy crisis in spite of the development of the building sector, represented by the plans of the Egyptian government to establish new cities over wide and different areas of the country, Earth-air heat exchanger (EAHE) systems are of the promising systems by which building electricity consumption can be reduced; through the reduction of energy needed for carrying air conditioning loads. Many parameters affecting the performance of such systems one of which is the soil temperature distribution profile. The aim of this research is to investigate experimentally the soil temperature variation with depth, in the avenue of the Egypt Japan university of Science and Technology (EJUST), New Borg Al-Arab city, Alexandria, Egypt during March 2015. In addition, an analytical model was developed to predict soil temperature distribution profile. The validation of the analytical model with the experimental results gave an error and correlation coefficient values of 5.59 % and 98 % respectively. The validated model was used with six different new cities in different areas in Egypt with four different ground surface cover conditions. The results of the model show that the type and nature of the surface cover affects directly the soil temperature profile especially when increasing the clay percentage.

Keywords: Earth Air Heat Exchanger, Soil Temperature, Analytical Model

303: Performance Assessment of Residential Scale Solar Driven Adsorption Cooling System in Hot Arid Areas and Gained Operational Experiences

AHMED HAMZA H. ALI

Mechanical Engineering Department, Faculty of Engineering, Assiut University, Assiut 71516, Egypt, ah-hamza@aun.edu.eg

This study present performance assessment of residential scales solar thermal driven adsorption cooling system as well as the gained operational experiences installed at Assiut, Egypt (hot arid and dusty climate) and in operation since summer 2012. The system consists of the following main components: evacuated tube solar collector field with apparent area of 36 m2 modified with back high reflective parabolic surface under the vacuum tubes, adsorption chiller of 8 kW nominal cooling capacity (silica gel-water), hot water storage buffer of 1.8 m3 effective volume and cold water storage tank of and 1.2 m3 effective volume, 34 kW or 50 kW capacity wet cooling tower, two 4.5 kW capacity fan-coils, energy saving pumps, expansion tanks, backup gas water heater, controllers, measuring sensors and data acquisition system with impeded controller. The results show that: The daily solar collector efficiency during the reported period of system operation ranged from about 50 % to 78 %. The chiller average COP was ranged from 0.4 to 0.64 with average chilling power ranged from 3. 6 to 6.42 kW, the average cooling water temperature outlet from the cooling tower ranged from 31.4 ˚C to 23.4 ˚C and the average chilled outlet water temperature from the chiller ranged from 19 ˚C to 12.12 ˚C. For the cooling session of 2012 cooling water outlet temperature from the cooling tower of 31 oC, which is higher, the city water at temperature of 27.5 ˚C was used to cool the chiller directly and this experiment leads to enhancement the chiller COP by 40 % and the chilling capacity of the chiller by 17 %. In the cooling session of 2014 a 50 kW cooling capacity wet cooling tower is integrated in the system and the measurements show that the outlet cooling tower water temperature is about 23.4 oC at ambient air dry bulb of 35.7 oC and Wet Bulb temperature of about of 19 oC. Consequently, the chiller cooling capacity reach around 6.42 kW and COP was about 0.64 and chilled water temperature was 15 oC. As the heat rejection from the system has a major impact on the system performance in hot arid area, therefore, the re-cooling system should be based on alternative heat sink recourses techniques.

Keywords: Solar cooling system; Small scale adsorption chillers; Operational experiences

304: Income Growth and Sustainable Behaviour Motivation in Developing Countries

Understanding the Relationship According to the Environmental Kuznets Curve (EKC): The Case of Cairo, Egypt

AMIRA ELBORTOKALY[1], NIHAL ABDELGAWWAD[2], AHMED SHALABY[3]

[1] Teaching Assistant, Architecture Department – Faculty of Engineering – Cairo University, Giza, amera_elbortokaly@yahoo.com
[2] Lecturer Assistant, Architecture Department – Faculty of Engineering – Cairo University, Giza, nihal.abdelgawwad@hotmail.com
[3] Professor of Architecture and Urban Development, Architecture Department – Faculty of Engineering – Cairo University, Giza, amshalaby@gmail.com

Enhancement of the urban environment quality has been the point of interest of numerous researches that studied and analysed the factors affecting sustainable practices and behaviours. The most prominent of which is the environmental Kuznets curve (EKC), that hypothesizes that environmental quality and sustainability are enhanced as income grows. However, the EKC seems to miss variables that may affect the environmental quality as public awareness and support for environmental protection. Additionally, it does not represent the majority of slower growing economies where consumerism is at its highest as in the case of developing countries. The paper focuses on Greater Cairo Region (GCR), Egypt as an example, where citizens live a consumer's lifestyle since the 1980s Sadat's liberalizing policies. The issue – among other triggering reasons as the over population of the CBD – that caused the swoop of suburbanization, represented in upscale gated communities providing only 10% of the housing stock scattered in the desert's outskirts, claiming to offer a more sustainable lifestyle for the high-income and luxury segments that present 8% of the country's population and receive almost 65% of the GDP. The research, accordingly, aims at examining the applicability of the EKC in a developing country's city and questions: do urban communities of high level income groups necessarily represent a more sustainable behaviour and environment than communities of lower level income groups?. To achieve the said aim, the paper compares the sustainability indices of two urban areas of high and low- income groups in GCR, through a multi-criterion framework (environmental, social, economic and institutional) for assessing these areas' sustainability. The framework includes quantitative indicators that can be measured simultaneously for the two chosen areas as the noise levels, quantity of solid waste generated, residential density, mean travel time and distance to work, etc. The paper concludes that income level clearly influences the sustainability of urban areas, however, in cities of developing countries, sustainability may be proven to be higher in urban areas with a lower income level where hidden potentials and motivation for sustainable behaviour can be found.

Keywords: Sustainability Index, Income Growth, Environmental Kuznets Curve (EKC), Developing Countries, Sustainable Behaviour, Consumption and Production Patterns

305: Experimental research and theoretical analysis of a novel testing platform for the thermal performance of solar domestic water heating systems

YIHONG YANG, WEI HE, JIE JI, YANQIU WANG AND MAO JUN

This research focus on finding a new approach for the thermal performance testing of solar domestic water heating systems (SDWHS). All the existing national standards for testing the thermal performance of SDWHS require the daily solar irradiation gain of more than 16 MJ/m2. However, only a small part of days in a year meets this requirement, which makes quality inspection departments have no enough ability to regulate the SDWHS market. In order to lower the limit of solar irradiation on the thermal performance testing of SDWHS, we designed a condenser tracking platform. The testing platform consists a sun-tracking flat-mirror reflector which direct the sunlight to the collector to increase the daily solar irradiation gain, and produces a light spot of 2×2 m2. Experiments have been conducted to measure the performance of the testing platform. And the results show that the platform can increase the daily gain of solar irradiation to 16 MJ/m2 from 12 MJ/m2, and the light spot has a no uniformity of less than 3%. We randomly selected two solar domestic water heating systems samples with same specifications. They are measured simultaneously, one on the platform and the other on the ground. It is found that the relative difference between the daily thermal efficiency measured by the two methods is less than 2%. The further study show that the relative difference between the daily thermal efficiency measured by the two methods is mainly caused by the change of incident angle and a bigger deviation appears in higher proportion of direct light situations. The effect of the incident angle on the relative difference is deduced in detail.

Keywords: Solar domestic water heating systems(SDWHS), condenser tracking platform, thermal performance testing, the incident angle, direct light proportion

306: A review on resource potential in Africa and energy consumption in some buildings of Cameroon

MODESTE KAMENI NEMATCHOUA[1]*, BLAISEMEMPOUO[2]*,TCHINDA RENE[3], CHRYSOSTÔME R.R. RAMINOSOA[4] ,ANDRIANAHARINJAKA ARO-ZO[4].

1Environmental Energy Technologies Laboratory, University of Yaounde I, Cameroon,
2Institute of Sustainable Energy Technology, University of Nottingham, Nottingham NG7 2RD, UK,
3LISIE, University Institute of Technology Fotso Victor University of Dschang, Cameroon,
4Fluid and Energy Laboratory, University of Antsiranana , Madagascar
**Correspondingauthors:Email:kameni.modeste@yahoo.fr(K.Modeste),blaise.mempouo@arpedac.org(M.Blaise)*

Presently, the human energy requirements are enormous and still growing. All the countries of the world need energy, which is the main source of development. The shift to renewable source is not only environmental friendly but it is almost available in every country. The development of African continent is still very slow; it is mainly due to the limited policy interest and investment levels. The aim of this paper is to review the status and current trends of potential of the resources in some Africa countries and energy consumption in the residential sector of Cameroon. It was found that the Africa's energy needs are constantly growing and should exceed 50% of current levels in next century .Moreover Africa has substantial new renewable energy resources, most of which are under-exploited. We found that 83% of the rural population in Africa has no access to electricity. This rate reached 92% in some countries in sub-Saharan Africa. Nigeria is known as an oil producing state, Cameroon has the second largest forestry potential in the Congo Basin, while South Africa is among the 20 highest contributors to CO2 emissions in the world.

Keywords: Energy consumption, Resource potential , buildings, Africa.

308: Energy performance assessment of market available photovoltaic module technologies under Kuwait climate condition

AHMED HAMZA H ALI[1] AND HASSAN M.G. ALFADHLI[2]

1 Mechanical Engineering Department, Faculty of Engineering, Assiut University, Assiut 71516, Egypt (ah-hamza@aun.edu.eg)
2 Engineering Projects Department, Ministry of Interior, Mirqab, Kuwait City, Kuwait

Energy performance assessment of the two main photovoltaic technologies available in 2015 market operates under hot arid climatic conditions for the state of Kuwait is carried out. For the case of one MWp PV plant, the study investigated the influence of climatic parameters on energy production and performance ratio based on the daily, monthly and yearly energy produced from crystalline silicon based and thin film technology photovoltaic technologies. The assessed technologies are monocrystalline, polycrystalline and thin-film of cell types of cadmium telluride (CdTe) and CdS/CdTe semiconductor. The assessment is based on the manufacture provided PV modules characteristics and 30 years average hourly values of the ambient air dry temperatures, horizontal solar radiation and average wind speed for the state of Kuwait. The main results of this study are: For same maximum power for all investigated technologies compared with Polycrystalline one the Monocrystalline technology plant requires extra area by 3.696%, thin-film cadmium telluride (CdTe) requires extra area by 4.34% and thin-film cadmium sulphide (CdS)/cadmium telluride (CdTe) (CdS/CdTe) requires extra area by 16.1% respectively. While, referenced to the net energy produced from Polycrystalline PV technology: the Monocrystalline technology plant produces extra annual net energy by 0.552%, thin-film cadmium telluride (CdTe) technology produces extra annual energy by 0.43% and thin-film CdS/CdTe technology produces extra annual energy by 0.62%, respectively. The CdS/CdTe PV technology has the higher performance ratio values of the all-over the hot months of the year for the state of Kuwait. Modules with tilting angle of 30 degree with the horizontal have the higher yearly average incident solar energy of 2157.49 kWh/m2 for the state of Kuwait.

Keywords: PV technologies energy performance, PV systems in hot arid areas, PV module efficiency

311: Performance Evaluation of Photovoltaic panel Integrated with Compound Parabolic Concentrator (CPC) Installed in Hot Arid Area

MOHAMED S.YOUSEF[1], ALI K. ABDELRAHMAN[1],
S A. NADA[2] AND S. OOKAWARA[3]

1 Energy Resources Engineering Department, Egypt- Japan University of Science and Technology (E-JUST), Alexandria, Egypt, mohamed.mohamed@ejust.edu.eg
2Department of Mechanical Engineering, Benha Faculty of Engineering, Benha University, Benha, Egypt, samehnadar@yahoo.com
3Department of Chemical Engineering, Graduate School of Science and Engineering, Tokyo Institute of Technology, Tokyo, Japan, sokawara@chemeng.titech.ac.jp

Egypt is facing energy crisis despite of the development in every consumption sector. Hence, a search for the efficient utilization of renewable energy, specially the solar energy is a must. The aim of the present work is experimentally and numerically investigating the performance of the photovoltaic (PV) panel integrated with truncated symmetric compound parabolic concentrator (CPC) in hot arid area. For the sake of the experimental work, symmetric CPC with geometrical concentration ratio of (2.4X) has been designed, fabricated and tested. Experiments have been conducted outdoors on the roof top of the Energy Resources Engineering (ERE) building at Egypt-Japan University of Science and Technology (E-JUST) in new Borg El-Arab city, Alexandria, Egypt (Longitude/Latitude: E 029º 42´ / N 30º 55´). A detailed thermal/electrical analytical model was developed and numerically solved using MATLAB software environment to calculate the thermal and electrical performance parameters of the (PV-CPC) system. The Numerical results were in a good agreement with the experimental results. Results showed that PV maximum power was enhanced by 18 % with CPC compared to the non-concentrating one. Although, the results indicate that concentration increases short circuit current (Isc) by 32%, it decreases open circuit voltage (Voc) by 5%. Finally, the proposed (PV-CPC) system yielded promising results in both increasing electrical power production with low cost and provide an advantage for building-integrated PV systems. The study recommends to use proper cooling system for further performance enhancement and effective operation of the (PV-CPC).

Keywords: Photovoltaic panel, Compound parabolic concentrator (CPC), Thermal-electrical model, Experimental, Numerical.

312: Kinetics of direct CO_2 capture from ambient air using K_2CO_3/Al_2O_3 composite sorbent

JANNA VESELOVSKAYA[1], VLADIMIR DEREVSCHIKOV[2], ALEKSEY OKUNEV[3]

[1] Boreskov Institute of Catalysis, Pr. Ak. Lavrentieva, 5, Novosibirsk, 630090, Russia; Novosibirsk State University, Pirogova str., 2, Novosibirsk, 630090, Russia; Research and Educational Center for Energy Efficient Catalysis in Novosibirsk State University, Pirogova str., 2, Novosibirsk, 630090, Russia, jvv@catalysis.ru

[2] Boreskov Institute of Catalysis, Pr. Ak. Lavrentieva, 5, Novosibirsk, 630090, Russia; Novosibirsk State University, Pirogova str., 2, Novosibirsk, 630090, Russia; Research and Educational Center for Energy Efficient Catalysis in Novosibirsk State University, Pirogova str., 2, Novosibirsk, 630090, Russia

[3] Novosibirsk State University, Pirogova str., 2, Novosibirsk, 630090, Russia, Boreskov Institute of Catalysis, Pr. Ak. Lavrentieva, 5, Novosibirsk, 630090, Russia

The composite material K2CO3/Al2O3 is a promising solid absorbent for direct CO2 capture from ambient air. In the current work the kinetics of CO2 absorption by this composite material was studied in the perfectly mixed reactor. The dependence of CO2 absorption rate on temperature and characteristic grain size of the composite sorbent was investigated. It was revealed that the total CO2 uptake decreases in the temperature range from 50 to 80oC. Comparison of CO2 absorption kinetics of by fractions of the composite with characteristic grain sizes of 0.8-1.0 mm and 1.6-2.0 mm showed that the initial rate of CO2 absorption inversely depends on characteristic grain size of the composite material, which indicates that the absorption process is limited by mass transfer. The results obtained are of interest for the capture of air-borne CO2 with subsequent renewable methane production using H2 from alternative sources of energy.

Keywords: renewable energy storage, direct air capture, carbon dioxide, potassium carbonate, alumina

313: Investigation of the PV self –cleaning

SAMI ALSALEH[1] , SIDDIG A OMER[2] AND RABAH BOUKHANOUF [3]

1 Institute of Sustainable Energy Technology, University of Nottingham, University Park, Nottingham, UK, NG7 2RD, ezxsa1@exmail.nottingham.ac.uk
2 Institute of Sustainable Energy Technology, University of Nottingham, University Park, Nottingham, UK, NG7 2RD, siddig.omer@nottingham.ac.uk
3 Institute of Sustainable Energy Technology, University of Nottingham, University Park, Nottingham, UK, NG7 2RD, lazrb@exmail.nottingham.ac.uk

This study focuses on the investigation and development of PV self –cleaning and its impact on dust removal, that would enable a wider deployment of solar photovoltaic systems in the Middle East and Gulf region which enjoys abundant solar radiation throughout the year, and where sand storm dust and elevated ambient temperature persist. The dust reduces the power generated by the solar devices or hinders the visibility through windshields. The research intends to combine a number of technologies to assist and improve the operational performance of photovoltaic (PV) systems. This investigation covered some of systems which employed PV self-cleaning techniques including application of Titanium Oxide (TiO2) coatings to remove the particles of dust from the PV panel surface.

Regular cleaning of the panels is often necessary to prevent serious degradation of their performance, especially in regions with dusty climates. However, manual cleaning of solar panels, especially in the context of large installation, can be a labour-intensive process and thus often prohibitively costly. Even in small buildings, cleaning a PV system can involve complicated issues of access that might require the intervention of specialist staff. Some of the technologies involve the use of electrodynamic screens for electrostatic dust removal, robotic cleaning tools, vibrating mechanisms featuring piezo-ceramic actuations, as well as TiO2-treated chemical or nano-films. Nevertheless, none of these technologies has to date been able to establish itself as an industry standard and achieve the necessary commercial breakthrough. In light of the above, self-cleaning technologies could present the perfect solution to these issues and help address many of the obstacles preventing solar panel technology from becoming more widely adopted. This would help reduce dependence on the fossil-fuel based energy resources which can be devoted to generation of national revenues and also leads to a reduction of CO2 emissions to the environment.

Keywords: PV, Self –Cleaning, Dust

315: Performance and Emission Profile of Micro-algal biodiesel in Compression Ignition Engine

ANDREW C. ELOKA-EBOKA[1], BABATUNDE F. BAKARE [2], CHIEMELA . ONUNKA [3]

[1, 2] Faculty of Engineering, Centre for Renewable Energy Research and Waste Management Research Niche Areas, Mangosuthu University of Technology, Umlazi, Durban, South Africa, fatherfounder@yahoo.com
[3] Department of Mechanical Engineering, Mangosuthu University of Technology, Umlazi, Durban, South Africa

Micro-algae are a large and diverse group of simple typically autotrophic organisms which have the potential to produce greater amounts of non-polar lipids and biomass than most terrestrial biodiesel feedstocks. Having emerged as one of the most promising sources for biodiesel production. They are gaining research interests in the current energy scenario due to their phenomenal growth potential (< 21 days log phase) in addition to relatively high lipids production which are also excellent source of biodiesel. In this study, engine performance and emission profile was performed using biodiesel fuels and blends from micro-algal technology in a compression ignition engine. The technology of micro-algae involved open pond cultivation and the use of photo-bioreactor model BF-115 Bioflo/celli Gen made in the US of 14 litre capacity (200 Lux light intensity) and flowrate of 2.5L/min. The micro-algal species used were Chlorella vulgaris and Scenedesmus spp. The biodiesel produced were blended with conventional diesel (AGO) at different proportions. The performance parameters evaluated include: engine power, torque, brake specific fuel consumption (BSFC), smoke opacity, thermal gravimetry, thermal efficiency, exhaust gas temperatures and lubricity while the varying effects of emission pollutants during combustion were also studied. Results showed that viscosity, density and lubricity have significant effects on engine output power and torque than when throttled with AGO which was used as control. Combustion efficiency and emission profile were better than the AGO due to the oxygenated nature of the micro-algal biodiesel which brought about complete combustion. A striking deduction arrived is that oxygen content of the algal biodiesel had direct influence on smoke opacity and emissions in the engine and also thermo-gravimetrically stable for other thermal applications. The engine tests (BSFC, BTE, ThE, MechE, EGT) and overall emissions (CO2, CO, VOCs, HC, SOx, NOx) were within acceptable limits and comparable with AGO. The implication of the study is that Micro-algal technology is feasible and can revolutionise development in biodiesel industry.

Keywords: emission profile, microalgal technology, biodiesel, compression ignition engine, open pond cultivation, photobioreactor, performance. hybridization, in situ, ex situ

316: Experimental study of Heat Transfer during mPCM Slurry Flow in Microchannels

RABIA SHAUKAT[1,2], MUHAMMAD SAJID KAMRAN[2], SAQIB RAZA JAVANI[1], LEI CHAI[1], JIE SUN[3], TONG YANG[4], HUA SHENG WANG[1,*]

[1]School of Engineering and Materials Sciences, Queen Mary University of London, E1 4NS, r.shaukat@qmul.ac.uk [2]Department of Mechanical Engineering University of Engineering and Technology, Lahore, Pakistan.
[3]Institute of Engineering Thermophysics, Chinese Academy of Sciences, Beijing 100190, China.
[4]Centre For Sustainable Energy Technologies, Faculty of Science and Engineering, The Nottingham University Ningbo, Ningbo, China

Microencapsulated phase change materials (mPCM) slurries have been used as the working fluids to enhance heat transfer compared with pure water due to their high latent heat and almost constant temperature during the phase change. A test rig has been built to measure heat transfer and pressure drop during the mPCM slurry flow in microchannels. Local surface temperature and heat flux along the channels are determined from temperatures measured at 98 precisely-known locations in the aluminum test block by inverse solution of the conduction equation (Yu et al. (2014)). The mass concentration of the mPCM slurry varies from 0 to 5%. The mass flow rate varies from 3.3 to 6.6 g/s. The results of the mPCM slurry are also compared with those of pure water. The results showed that 5% mass concentration of mPCM slurry showed local wall temperature reduction and increase in local heat flux as compared to pure water. This enhancement in heat transfer performance of mPCM slurry depends on the mass flow rate of mPCM slurry flow inside the microchannels.

Keywords: Heat transfer, microencapsulated phase change material, microchannel, inverse conduction

320: Numerical Investigation of Thermocline Packed Bed Thermal Energy Storage System for CSP Plants

AJAS ABDULLA[1], K. S. REDDY[2]

[1,2] Heat Transfer and Thermal Power Laboratory,
Department of Mechanical Engineering,
Indian Institute of Technology Madras, Chennai – 600036, INDIA; Email:
[2]ksreddy@iitm.ac.in,
Tel: +91-44-2257 4702; Fax: +91-44-2257 4652

Thermal energy storage system is becoming indispensable part of any Solar Energy Generation Systems (SEGS) because of its intermittent nature and for enhancing dispatchability of Concentrating Solar Power (CSP) plants. In this study, a two dimensional transient analysis of thermocline sensible heat storage system was carried out numerically to study the discharging characteristics of the packed bed storage system. The governing equation was discretized by finite volume method and coded in MATLAB R2014a. The model takes into account local thermal non-equilibrium between the Heat Transfer Fluid (HTF) and the solid filler bed, thermal diffusion inside HTF, various temperature dependent correlations to obtain the thermo-physical properties for the HTF and considers heat loss through the insulated tank wall henceforth making the model more reliable to design a Thermocline Thermal Energy Storage (TTES) tank. The behaviour of thermocline during discharging and various parameters affecting the performance of the system, namely – tank dimensions, inlet velocity of HTF, storage temperature difference, and cut-off temperature difference criterion were considered. The model was carefully verified based on grid refinement and time step independence studies, and validation of the reference case was done with experimental results in the literature to ascertain the consistency of the proposed model. After validation, all the further analyses were done by taking a modified reference case. It was observed that during discharging, hot region shrinks continuously and the thermocline region is moving upward accompanied by slight expansion and it reached a maximum value of 4.76m inside the tank, almost 1/3rd of the tank height; discharging time increases with height of the tank and decreases with inlet velocity of the HTF; increasing the diameter of tank improves the storage capacity of the system whereas it has no significant influence on the discharging time. It was also obtained that discharging time not only depends on the storage temperature difference, but also with the cut off temperature difference criterion. Discharge time increased from 4.52 hours to 5.32 hours when the cut-off temperature difference was changed from 20 K to 30 K.

Key words: Concentrating solar power, thermocline, packed bed, dispatchability

321: Heat Transfer and Fluid Flow Studies in Helical – Spiral Coils of Modified Cavity Receiver for Solar Dish Process Heat System

K. S. REDDY[1], T. SRIHARI VIKRAM[2],

[1,2] Heat Transfer and Thermal Power Laboratory, Department of Mechanical Engineering,
Indian Institute of Technology Madras, Chennai – 600036, INDIA; Email: [1]ksreddy@iitm.ac.in
Tel: +91 44 2257 4702; Fax: +91 44 2257 4652

The present study deals with the heat transfer and fluid flow characteristics of heat transfer fluid in helical coil of modified cavity receiver of solar dish collector. A 3-D numerical model is developed to study the effect of fluid flow rate, DNI and opening ratios on the heat transfer and fluid flow from the receiver. The variation of average fluid temperature along the coil, Nusselt number and friction factor has been estimated for the fluid flow along the helical coil under different conditions. At DNI of 500 W/m2 and diameter ratio of 0.48, the rise in average fluid temperature for 100 lph is about 160K and about 17 K for 1000 lph. A steep increase in the average fluid temperature is observed in the spiral section whereas in the bottom helical section, it varies linearly and in the top helical section, the variation is very less. Nusselt number varies between 25 to 75 in the spiral section and 50 to 200 in the helical section for different flow rates. Nusselt number along the coil decreases in the spiral part and oscillates along the helical section. The oscillation of Nusselt number in the helical section is due to the secondary flow developed and the geometry of the coil. It can be noted that the heat transfer rate is comparatively higher in the helical section than the spiral section. The friction factor drastically drops in the spiral section and remains constant in the helical section. The friction factor ranges between 0.01 to 0.05 in spiral section and 0.01 to 0.02 in the helical section for different flow rates. The figure of merit is estimated in terms of ratio of pressure drop and heat transfer rate and it varies between 1 and 540 for different flow rates and DNI. The thermal efficiency of the receiver is found in the range of 70 - 80%. The present model can be used to estimate heat transfer/gain and pressure drop across the helical-spiral coil receiver of solar dish collector used for process heat applications.

Keywords: Solar dish, helical receiver, pressure drop, process heat

322: Solar Thermal Collector Component for High-resolution Stochastic Bottom-up Domestic Energy Demand Models

PAUL HENSHALL, EOGHAN MCKENNA, MURRAY THOMSON, PHILIP EAMES

Centre for Renewable Energy Systems Technology (CREST), School of Electronic, Electrical and Systems Engineering, Loughborough University, LE11 3TU, UK.
e.j.mckenna@lboro.ac.uk

High-resolution stochastic 'bottom-up' domestic energy demand models can be used to assess the impact of low-carbon technologies, and can underpin energy analyses of aggregations of dwellings. The domestic electricity demand model developed by Loughborough University has these features and accounts for lighting, appliance usage, and photovoltaic micro-generation. Work is underway at Loughborough to extend the existing model into an integrated thermal-electrical domestic demand model that can provide a suitable basis for modelling the impact of low-carbon heating technologies. This paper describes the development of one of the new components of the integrated model: a solar thermal collector model that provides domestic hot water to the dwelling. The paper describes the overall architecture of the solar thermal model and how it integrates with the broader thermal model, and includes a description of the control logic and thermal-electrical equivalent network used to model the solar collector heat output.

Keywords: Solar thermal collector, domestic, energy demand, dynamic.

323: The Potential of External Shading Devices for Comfort Extension and Energy Savings in Kenya

LORNA KIAMBA[1], LUCELIA RODRIGUES[2], BENSON LAU[3]

1 University of Nottingham, NG7 2RD, Nottingham, UK.
Email: laxlk2@nottingham.ac.uk
2 University of Nottingham, NG7 2RD, Nottingham, UK.
Email: Lucelia.Rodrigues@nottingham.ac.uk
3 University of Nottingham, NG7 2RD, Nottingham, UK.
Email:Benson.Lau@nottingham.ac.uk

The use of shading systems for climate control in tropical climates is well documented. Previous research has indicated that if shading devices are installed on the exterior of the building, they are able to block solar radiation effectively before it passes through glazing and in so doing reduce the overheating potential. A review of contemporary office buildings in the warm humid city of Mombasa, Kenya reveals the predominance of highly glazed buildings which often rely on active air conditioning systems for cooling purposes. Following an initial study of suitable design strategies for warm-humid climates, the authors found that responsive sun shading could be used to significantly improve indoor thermal comfort conditions and in so doing reduce the need for electricity for cooling. In this paper, using results obtained from the dynamic simulations of a typical office building in Mombasa, the authors focus on quantifying the effect of external shading devices on indoor thermal comfort and energy use. First, the performance of horizontal, vertical and egg crate sun shading devices was investigated. The results indicated that the egg crate shading has the most significant impact in decreasing discomfort hours by up to 50% more than horizontal or vertical shading. Next, solar heat gain coefficients were derived for various shading types (horizontal, vertical and egg crate) and their impact on indoor thermal comfort and energy savings calculated. The solar heat gain coefficients (as a result of external shading) and curve fit equations/graphs suitable for use with various projection factor ratios (a simple ratio used to define the relationship between the shading element depth and window size) were derived for the four cardinal compass orientations. Using these equations and graphs, it was possible to estimate the potential annual energy savings (of up to 120kWh/m2 or 74.68% improvement) with building information of the glazing area, orientation of the window and the PF ratio. It was suggested that these solar heat gain coefficients, equations and graphs show potential for use by local building practitioners in deriving the potential comfort and energy savings during early design stages of similar type buildings.

Keywords: external shading devices, solar gain, PF ratio, warm humid climate.

327: Performance Assessment of SageGlass Electronically Tintable Glazing

DAN JESTICO[1]

[1] Hilson Moran, Shackleton House, 4 Battlebridge Lane, London SE1 2HP,djestico@hilsonmoran.com

SAGE Electrochromics have developed a glass coating which can be controlled electronically to be clear or tinted, reducing solar heat gain and glare in buildings whilst remaining transparent and therefore not blocking views out. The glazing can be controlled in a variety of ways, including integration into the building management system (BMS).

The potential benefits of installing SageGlass electrochromic glazing in office facades for four different European climate zones have been assessed, comparing the performance of SageGlass against a number of typical façade systems for each climate zone. Performance metrics such as energy consumption, CO2 emissions, utility costs, chiller sizing, chiller cost, lettable area impact and façade cost were assessed.

In order to analyse the performance of SageGlass, a control methodology had to be developed and implemented into the DTM software to allow for dynamic switching of the façade states. This algorithm was assumed to be implemented via a BMS to minimise unwanted solar gain during summer, whilst ensuring sufficient daylight was admitted to reduce artificial lighting energy consumption.

Results showed that SageGlass was able to provide performance benefits in the following areas:

Reduced annual energy consumption, and therefore lower CO2 emissions and utilities costs.

Optimised daylight penetration through the façade, and control of glare, whilst maintaining thermal comfort conditions and outside views for occupants.

Removing the need to add external shading devices to control solar gain with no impact on net lettable area.

Reduced peak cooling demand with similar or lower costs than comparable façade systems.

These benefits were found to be enhanced in warmer climate zones.

Keywords: Facades, smart buildings, solar control, glazing, demand optimisation

329: Computational Investigation of Unsteady Conjugated Heat Transfer in Microchannel Active magnetic Regenerator

MUHAMMAD SAJID KAMRAN[1,2], JIE SUN[1,3], HASSAN ALI[2], HU ZHANG[4], YI LONG[4], HUA SHENG WANG[1*]

[1]School of Engineering and Materials Science, Queen Mary University of London, Mile End Road, London E1 4NS, UK
[2]Department of Mechanical Engineering, University of Engineering and Technology, Lahore, Pakistan
[3] Institue of Engineering Thermophysics, Chinese Academy of Sciences, Beijing 100190, China
[4]School of Materials Science and Engineering, University of Science and Technology Beijing, Beijing 100083, China

Materials such as Gd and LaFeCoSi alloy show significant entropy or temperature change during magnetisation and demagnetisation in a varying magnetic field. This is referred to as the magnetocaloric effect (MCE) on which room temperature magnetic refrigeration operation is based. An active magnetic regenerator (AMR), made of magnetocaloric material (MCM), is one of the key components of a room temperature magnetic refrigerator/heat pump. The working fluid, normally water, oscillates in the AMR and therefore the heat transfer in the AMR is essentially transient. The AMR in the present work is a microchannel heat exchanger made of Gd MCM. The paper describes a computational model of the transient conjugated conductive heat transfer in MCM microchannel wall and convective heat transfer in fluid flow in channels. The model is solved using Ansys Fluent. The temperature span, transient variation of Nu and effect of the ratio of channel spacing to diameter (porosity) are examined. Heat transfer enhancement and AMR dimension optimisation are presented.

Keywords: *Magnetic refrigeration, Active magnetic regenerator, Transient conjugate heat transfer, Heat transfer enhancement, Numerical simulation*

331: The Investigation of the Luminous Environment in ETFE Structures

DAWA MASIH[1], BENSON LAU[2]

[1] University of Nottingham, Nottingham, UK, NG7 2RD, Email: dawaazad@yahoo.com
[2] University of Nottingham, Nottingham, UK, NG7 2RD, Email: Benson.Lau@nottingham.ac.uk

ETFE (ethylene tetra fluoro ethylene) is a lightweight material that is increasingly used in building applications. Typical ETFE cushions can provide a degree of thermal insulation with reduced initial cost investments and fewer supports compared with a glazed roof. However, there is limited research regarding the luminous environment inside the ETFE cushion or panel covered structures and limited availability of information on its optical properties, which necessitated the current study. This paper presents a qualitative and quantitative study to assess the lighting performance of an encapsulated ETFE panel structure. Through on-site monitoring and the physical modelling, this research project aims to: understand the existing luminous environment and the current lighting problems identified inside this ETFE structure; develop and test the design alternatives to deal with glare, visual comfort, three-dimensional modelling; and develop workable solutions to improve the normally dull and uniform lighting conditions inside ETFE enclosures. This study concluded that by careful manipulation of the opacity and transparency of the ETFE structure, the luminous environment can be significantly improved or enhanced.

Keywords: ETFE structures, Luminous environment, Daylighting performance, ratio, Field Studies, Experimental Testing

335: Technological and commercial maturity of aviation biofuels

REBECCA MAWHOOD[1], EVANGELOS GAZIS[1]*, RAPHAEL SLADE[1]

1Imperial Centre for Energy Policy and Technology, Imperial College London
**Correspondence: e.gazis@imperial.ac.uk*

Airline operations generated 705 Mt of CO2 in 2013, representing around 2% of global anthropogenic CO2 emissions. 99% of airline emissions are caused by the combustion of kerosene. Aviation biofuels (biojet) have the potential to provide a near-term solution to the twin challenges of decarbonisation and security of fuel supply. However, production costs of biomass-derived kerosene are considerably higher than the selling price of petroleum-derived kerosene due to the relative immaturity of conversion technologies, small number of producers and competition with other biofuel markets.

This paper reviews the commercial and technological maturity of various technologies for converting biomass to synthetic jet fuel and evaluates them according to their Fuel Readiness Level (FRL). This work is part of the EIT Climate KIC project 'Fuel Supply Chain Development and Flight Operations' (RENJET) which aims to accelerate the development of renewable jet fuel, simultaneously increasing availability and stimulating demand.

This work draws on an extensive literature review and uses the Commercial Aviation Alternative Fuels Initiative's Fuel Readiness Level scale to evaluate seven conversion pathways. The pathways were characterised according to their technological and commercial maturity, progress towards international certification, compatibility with existing infrastructure, economic viability and the opportunity costs of producing biojet.

Biojet production pathways vary considerably in terms of their technological and commercial maturity, with the most highly developed being in the very early stages of commercialisation. The breadth and depth of available data is considerably greater for pathways which are at the higher end of the FRL scale and/or which are being pursued by multiple developers.

Keywords;

339: Heating and ventilation flow pulsation for energy saving and indoor air quality

M. EMBAYE[1], R. K. AL - DADAH[2], S. MAHMOUD[3]

1 School of Mechanical Engineering,
University Of Birmingham,mxe964@bham.ac.uk
2 School of Mechanical Engineering,
University Of Birmingham, R.K.AL-DADAH@bham.ac.uk
3 School of Mechanical Engineering
University Of Birmingham S.M.MAHMOUD@bham.ac.uk

Heating and ventilation of buildings is the second largest energy consumption after transportation and significantly contribute to the CO2 emission. The current heating and ventilation systems operate at constant flow strategy with On/Off control which leads to higher energy consumption. Therefore there is a need for alternative ways of operating the heating and ventilation systems so that energy can be saved without compromising the occupant's wellbeing including indoor CO2 and humidity levels. Flow pulsation has been applied for various applications to enhance heat transfer for heating and cooling appliances. This work mathematically investigates the effect of radiator hot water and inlet air ventilation pulsation for a living room in a 4 bedroom house with 5 occupants to improve the energy consumption and indoor air quality (IAQ) using demand based embedded control system in MatLab/Simulink software. The developed model is targeting to control the indoor air quality and thermal indoor comfort of occupants, including temperature of 20± 2 (OC), CO2 level of 1000 ± 100 (PPM) and relative humidity of 50± 10 (%). Flow pulsation for both heating and ventilation was applied at flow frequency of 0.016 (Hz) with the amplitudes of the water and air flow pulsation vary depending on heated space environment. Results showed that pulsating the flow of hot water through the panel radiators of the central heating system can achieve an average of 20(%) energy saving compared to the constant flow currently use. Also, using pulsating air flow to the heated space (for ventilation purpose) can achieve energy saving of 34.5% in the fan power consumption of the ventilation system by keeping the level indoor CO2 concentration and relative humidity at an acceptable level. The significant saving achieved by flow pulsation indicates the potential of using this approach to reduce energy consumption and improve the indoor air quality.

Keywords: Heating and ventilation, flow pulsation, indoor thermal comfort and indoor air quality

341: Experimental Investigation of Impact of Diesel Particulate Filter on Performance and Emissions of a Bharat Stage-1 C.I. Engine

PRADEEP KUMAR GUPTA[1],*, DILIP SHARMA[1], SHYAM LAL SONI[1], RAHUL GOYAL[1], DHEERAJ KISHOR JOHAR[1], ASHOK SINGH TANWAR[2], ANMESH KUMAR SRIVASTAVA[1]

1Mechanical Engineering Department, MNIT Jaipur, J L N Marg, Jaipur (Rajasthan), India.
2Carriage Workshop, Indian Railways, Ajmer (Rajasthan), India
**Corresponding author. Tel.: +91-9928257700. E-mail: pkrgupta@gmail.com*

Automobile emissions are the main source of GHG accumulation in environment. With an increasing concern for world environment, it is of great importance to analyze the reasons for vehicle emissions and to figure out the ways to minimize these emissions without sacrificing vehicle performance. Since old engines produce more emissions and it will be difficult to entirely stop their usage especially in developing and under-developed nations, it is desired that appropriate emission reduction technologies are tested on such old engines to see if these technologies could reduce the emissions from such engines substantially with economical acceptability. This study tried to fulfill this requirement by testing an uncoated wall-flow type ceramic DPF with a Bharat Stage-1, variable speed, direct injection, water cooled, 4 cylinder, C.I. engine in laboratory in India. Engine was run at 1500, 2000, 2500 and 3000 rpm at 0, 25, 50, 75 and 90 Nm torque, both with and without the DPF. Gas analyzer and smoke meter were used to measure emissions. The results, in form of engine performance (BSF and BTE) and smoke, NOx, CO and CO_2 emissions, were analyzed and conclusions were drawn. It was found that using DPF, particulate matter emissions (smoke) were almost entirely eliminated, without impacting the engine performance adversely, and this was the biggest need. Also, it does not involve a big investment and the regeneration cost is also small. Off-board regeneration was done for maximum effectiveness by taking out and heating the DPF in an electrical resistance furnace at 650^{o}C for 10 hours.

Keywords: Diesel Particulate Filter; Particulate matter; Exhaust emissions; Automotive emissions; Emission reduction

342: Sustainable educational buildings

A proposal for changes to investment evaluation policies in Chile through the incorporation of thermal comfort and air quality criteria

JAIME SOTO-MUÑOZ[1], MAUREEN TREBILCOCK[2], ALEXIS PÉREZ-FARGALLO[3]

[1] Universidad del Bío-Bío, Departamento de Ciencias de la Construcción, Collao 1202, Concepción, Chile, jsotom@ubiobio.cl
[2] Universidad del Bío-Bío, Departamento de Teoría y Diseño de la Arquitectura, Collao 1202, Concepción, Chile, mtrebilc@ubiobio.cl
[3] Universidad de Sevilla, Departamento de Construcciones Arquitectónicas II, Avda. Reina Mercedes, 4 A, 41012-Sevilla. España, alexisfargallo@us.es

The constructive configuration of an educational institution influences its indoor comfort variables; while at the same time comfort variables have an effect on the metabolism and stress of students and teachers. In turn, each architectural project depends on the factors that define its design. When the investment is assessed, costs are determined to compare alternative architectural strategies for the project. However, public policies in most countries in Latin America do not consider factors related to thermal comfort or air quality in their educational indicators since it has not been possible to gauge the effect of physical variables on school outcomes in the Southern Cone. This study addresses the current constructive reality of public schools located in different geographic areas of Chile. Data was obtained on temperature, humidity, CO2 concentration and other indicators of environmental conditions using sensors installed in 4th-grade classrooms in summer and winter. Fieldwork demonstrated that the quality of the indoor environment in schools is deficient and therefore it is necessary to establish strategies for economic evaluation when heating and cooling systems are not present. Taking into consideration this information, Chilean state policies and methods of investment evaluation were reviewed. Mandatory criteria were determined and a proposal for public policy improvements was developed that integrates indicators and monitoring of student productivity and energy efficiency variables based on the data collected. This has the potential to encourage energy savings and increase understanding of the value of an optimal indoor environment that includes thermal comfort and air quality as factors conducive to better learning. If these comfort parameters are adequate, they will positively influence the development of education in regards to student productivity and learning.

Keywords: educational buildings, sustainability, energy and environmental policies, educational indicators, indoor environmental comfort.

347: Public spaces for resilient cities

A design proposal to address climate variability and changes

LUCA MARICCHIOL[1]

1 PhD candidate in Architecture - Theories and Project at Sapienza University of Rome, via A. Gramsci 53 - 00197 Rome - Italy, e-mail: luca.maricchiolo@libero.it

This work is based on the belief that sustainability and resources management problems are not only referred to ecological systems, but are strictly linked with human activities, and concern socio -ecological systems of cities as a whole. Therefore, the study addresses the question of the balance between people and environment. Cities resilience depends on the stability of this balance in its projection in time, assuming the concept of resilience not just as the ability of the system to maintain a stable equilibrium condition, but, according with "resilient thinking" theories, as the ability to generate new stability landscapes that keep similar performances, identity and structure.

This research investigates socio-ecological urban systems resilience, and it focuses on urban environment and specifically on city public spaces. The base hypothesis is that resilience of urban systems as a whole it is mainly determined by the balance of his social substratum, and that this is possible through a combination of strength and fragility in urban development. Public domain is the base structure of the city, where it comes, and it develops over time, the sense of citizenship on which depends the cooperation between people and its balance with environment. Hence, this is the field where this study investigates the concepts of persistence and change, and where it identifies stability frames and adapting elements.

The first goal of this study is to demonstrate the relevance of public domain in keeping general resilience of the city. Then, it will investigate how public spaces could be designed based on the balance of persistence and change, which are the frames in public spaces that shouldn't change over time, to keep urban quality and collective identity, and, conversely, which elements should adapt to absorb stresses and to ensure general resilience. This will be verified through the comparison of recent studies and case studies, and a design of the author.

Keywords: urban resilience, public space, sustainability

348: Assessing the Benefits of Installing Energy Storage in a Household Equipped with Photovoltaic Panels

CHRISTIAN KLUMPNER[1], ALAA EL BOUDALI[2]

[1]*University of Nottingham, Faculty of Engineering, Department of Electrical and Electronic Engineering, University Park, Nottingham, NG7 2RD, UK, klumpner@ieee.org*
[2]*University of Nottingham, Faculty of Engineering, Department of Electrical and Electronic Engineering, University Park, Nottingham, NG7 2RD, UK, aelboudali@gmail.com*

This paper evaluates the technical and financial impact of installing energy storage in a house equipped with Photovoltaic (PV) panels subject to the Feed-In Tariff (FIT). An additional benefit of installing energy storage is the possibility to purchase electricity off-peak (overnight) at a cheap rate and replace consumption during day/peak time and for this reason, the Economy7 tariff is considered.

The studies carried out are using real data of PV generation and household consumption continuously recorded over a week for each of the four seasons, from a UK installation. A functional model of the battery system is implemented that includes voltage dependency versus state of charge and maximum charging and discharging currents, that account for the limitations of the amount of charge - size dependant and current that can reflect the power capability of the battery to preserve high conversion efficiencies and lifetime.

As initial investigations point to a rather large battery system to maximize the synergy between PV and energy storage, the paper investigates how the performance indicators vary with the battery size. It is found that there may be a critical battery size up to which the peak rate consumption and the PV energy export decrease more rapidly. Above this critical point which in this study lies at around 25-30% of the battery size that would allow full local use of PV energy generated, the impact of increasing the battery size reduces, therefore the return of investment as a percentage decreases.

Keywords: battery sizing, energy storage, off peak tariff, photovoltaics

351: A Comparative analysis of the dairy milk cooling systems in selected farms in the Eastern Cape Province of South Africa

RUSSEL MHUNDWA[1], MICHAEL SIMON[2],
STEPHEN TANGWE[3], EDSON MEYER[4]

[1] *Fort Hare Institute of Technology, University of Fort Hare, Alice Campus, Private Bag X1314, Alice 5700, South Africa,rmhundwa@gmail.com*
[2] *Fort Hare Institute of Technology, University of Fort Hare, Alice Campus, Private Bag X1314, Alice 5700, South Africa, MSimon@ufh.ac.za*
[3] *Fort Hare Institute of Technology, University of Fort Hare, Alice Campus, Private Bag X1314, Alice 5700, South Africa,STangwe@ufh.ac.za*
[4] *Fort Hare Institute of Technology, University of Fort Hare, Alice Campus, Private Bag X1314, Alice 5700, South Africa,emeyer@ufh.ac.za*

Milk as a raw material is easily perishable since bacteria which contaminate it may multiply rapidly and render it non sanitary for processing and also unacceptable for human consumption. But however, the rate of multiplication of these bacteria can be reduced by refrigeration. This paper presents an overview of the milking process in selected dairy farms in the Eastern Cape Province of South Africa. A comparative analysis of dairy milk cooling systems was done through a survey. The aim of the survey was to establish the best dairy milk cooling technology which best suit the local conditions with special emphasis on the energy consumption during cooling of raw milk from 20 – 35 ^{o}C to the critical storage temperature of 4 – 4.5 ^{o}C for preservation before it can be processed. A simple multiple linear regression model was used to predict the cooling savings for a water to milk ratio of 2:1 with input parameters as water inlet temperature and milk outlet temperature for cooling savings as the output. An average cooling savings of 36 - 49% can be achieved using a pre-cooler which also translates to avoided CO2 and water usage. The refrigerant used in these systems was also evaluated on its thermo-physical properties in regards to the heat removal from the milk so as to meet the cooling load demand. The study will also lead to determining crucial parameters in the selection of an effective as well as efficient milk cooling system alongside its feasibility potential.

Keywords: Diary milk, Cooling system, Refrigeration, Cooling load, Refrigerant

354: Improving illumination and temperature distribution uniformity in high concentrating solar cells

ABDULRAHMAN ALDOSSARY[1], ABDULMAGED ALGAREU[1], ADEL ALDIHANI[1], RAYA. AL-DADAH[1], SAAD. MAHMOUD[1]

1University of Birmingham, Edgbaston, Birmingham, United Kingdom. B15-2TT,axa281@bham.ac.uk

High concentrating Photovoltaic (HCPV) has the potential to replace the expensive PV material with cheaper optical elements. The use of high solar concentration ratios with the triple junction III-V solar cells offers potential of high solar cell efficiency and power output. However, non-uniformity of the incident flux is detrimental to the CPV technology as this tends to cause hot spots and current mismatch leading to reduced electrical efficiency of the system and degrade the life of the solar cell. In this work, a point focus Fresnel lens was developed and the influence of using a small square reflector placed above the PV surface as a Secondary Optical Element (SOE) in alleviating the non-uniform illumination and temperature distribution was investigated. Also, the SOE height and material reflectivity influence on the optical performance was examined. This was done by implementing optical and thermal simulations using advanced ray tracing method and Multi-physics finite element software respectively. Incident rays distribution uniformity was evaluated using the standard deviation from the mean value. A low standard deviation indicates that most received rays by the solar cell are close to the mean value i.e. more uniform. Results show that a combination of introducing a short SOE (60mm) made from 95% reflective material above the PV and increasing the distance between the PV and the Fresnel lens (l) to 500mm significantly improve the surface illumination uniformity. The achieved uniformity standard deviation is less than 3 with minimum loss in received power i.e. 48.25W in case of introducing SOE and l=500mm compared to 49.07W where receiver placed at focus point.

Keywords: Multi-junction PV, optical efficiency, high concentration, Fresnel lens, non-uniform illumination

355: Effect of Dusty Environment on the Electrical Performance of Different Photovoltaic Modules

ADEL ALDIHANI[1], ABDULRAHMAN ALDOSSARY[1],
RAYA AL-DADAH[1], SAAD MAHMOUD1, AYMAN AL-QATTAN[2]

1 University of Birmingham, School of Mechanical Engineering,
AXA178@student.bham.ac.uk
2Kuwait Institute for Scientific Research, energy and building research centre,
aqattan@kisr.edu.kw

With high solar radiation during most parts of the year (7.65 kWh/m2.day), Kuwait is showing increased interest in solar energy technology. Despite the high solar radiation, Kuwait suffers from dust and high ambient temperature. This work experimentally investigates the performance of two types of solar PV modules based on monocrystalline and polycrystalline silicon cells under Kuwait environment. The effects of dust and ambient temperature on the PV modules performance were investigated over a period of 12 months where measurements of input solar radiation, voltage, current, cell surface temperature and accumulated dust were carried out. Measurements at two different days where ambient temperatures are 41°C and 15°C with similar radiation level of 1000 W/m2 revealed that the percentage power output reduction of dusty polycrystalline module was higher than dusty monocrystalline module compared to the clean testing. Compared to the clean PV, the monocrystalline dusty module has shown 21% and 19.5% reduction in power output while the polycrystalline dusty modules showed 28% and 25% loss in power output at hot and cold day, respectively, therefore, the monocrystalline is more suited for hot and dusty environments like Kuwait.

Keywords: crystalline PV cell, dust, irradiance, Kuwait

356: Working Fluids and Technologies to Cool and Power the Future

SAFFA RIFFAT[1], DEVRIM AYDIN1, RICHARD POWELL[1], YIJUN YUAN[1]

[1]Faculty of Engineering, University of Nottingham, University Park, Nottingham, NG7 2RD, UK, saffa.riffat@nottingham.ac.uk

Energy technologies and energy management strategies has been gaining attention in the last decade as energy is vital for a safer and sustainable future. Dependency on energy is much higher than the past due to the industrial growth, increasing population as well as the comfort demand. However, recognising that global energy demand is rising but the world can burn only 20% its established fossil fuel reserves by 2050 if global warming is not to exceed 20C represents a major threat to the future of all humans (Berners-Lee and Clark, 2013). The present rate of fossil consumption means that this will be achieved by ~2030.

Yet domestic sector is count as the leading energy consumer as more people around the world aspire to comfort living standards which will drive the demand for air conditioning and electric power. Urgent solutions are required not only to increase share of renewable resources but also more efficient usage of fossil fuels which could be achieved with innovative power, air conditioning and refrigeration cycles utilising "Long term sustainable" (LTS) fluids, especially air, water and CO2.

In the paper we provide a rational approach to the future use of working fluids based on our interpretation of the available technical evidence. We consider it self-evident that volatile fluids will continue to play major role in cooling and power generation, however new technologies will be needed that optimise energy efficiency and safety with minimum environmental impact. Concordantly we discuss the past and current situation of volatile fluids and look at four innovative technologies for future, using natural refrigerants including dew point cooling, combined heat and power generation, heat networks and heat storage systems.

Keywords: working fluids, sustainability, dew point cooling, combined heat and power, heat networks, heat storage systems.

357: Optical Analysis of Flux Uniformity and Efficiency in Low Concentrating PV Systems

ABDULMAGED ALGAREU[1] ,ABDULRAHMAN ALDOSSARY[1],
SAAD. MAHMOUD[1], RAYA. AL-DADAH[1]

1University of Birmingham, Edgbaston, Birmingham, United Kingdom. B15-2TT, aoa124@bham.ac.uk

Solar concentration has the potential to replace the expensive PV cells with cheaper optical elements and enhancing the overall output. Two main types of concentrators are used in CPV systems which are either reflective or refractive (Fresnel lens). One of the advantages can be achieved from using refractive concentrators is compact height which is not available in reflective concentrators especially in high concentration ratios. But the main problem with refractive concentrators is the hot spot generated at the centre of the PV cell. In this paper, different Fresnel lens parameters affecting the optical efficiency and flux distribution have been investigated, including groove width, draft angle, focal length, f/number, lens thickness and PV cell position beneath the Fresnel lens. Then, a Square Fresnel Lens (SFL) of Concentration Ratio (CR = 10) and design focal length (f = 145 mm), was compared with a reflective Square miniature Concentrator (SMC) with the same CR in terms of uniformity, optical efficiency and compactness. Results showed that optical efficiency increases with the decrease of groove width and draft angle. Simultaneously, optical efficiency is fixed with different lens concentration ratios of the same f / number, and decreases if the focal length is fixed to different concentration ratios. The best position of the PV cell for the square Fresnel lens of a focal length of 145 mm that gives good uniformity (with Standard Deviation = 3.38) is 185mm beneath the Fresnel lens with optical efficiency of 76.46% compared to the 79.47% achieved at the focal distance of 145mm but with point concentration. As for the reflective concentration with CR = 10, the optical efficiency achieved is 76.56% which is comparable to that of the Fresnel but with larger height of 230mm.

Keywords: Optical efficiency, low concentration, reflective concentrator, flux uniformity, Fresnel lens.

359: New composite materials based on anodic alumina for adsorption heat transformers

ALEXANDRA GREKOVA[1,2], ILYA GIRNIK[1,2], VASILY NIKULIN [1,2], MICHAIL TOKAREV [1], LARISA GORDEEVA [1,2], YURI ARISTOV [1,2]

[1] Boreskov Institute of Catalysis, Ac. Lavrentieva av. 5, Novosibirsk 630090, Russia, grekova@catalysis.ru
[2] Novosibirsk State University, Pirogova str. 2, Novosibirsk 630090, Russia

At present, due to high energy saving potential adsorption heat transformers (AHTs) – chillers and heat pumps - are considered as promising alternative to compression systems. Development of new efficient adsorbents of water and methanol specialised for AHT can essentially advance this emerging low-carbon technology. This work addresses the synthesis and study of novel composite sorbents based on inorganic salts inside pores of an anodic aluminium oxide (AAO) consolidated with aluminium support. The AAO texture is modified by varying the electrolyte nature (H2SO4, H3PO4, H2C2O4) and the current-voltage characteristics during the synthesis, and its duration. The AAO layer thickness reaches 350 □m that is superior to appropriate data presented in the literature. The AAO pore diameter can be intently varied from 30 to 70 nm, and the pore volume - between 50 and 170 cm3/m2 of the Al plate. CaCl2 and LiCl are confined into the AAO pores to increase the sorption capacity that rises up to 23 and 84 g/m2 of the plate for water and methanol, respectively. The amount of sorbates exchanged under the working conditions of a typical air conditioning cycle reaches 13 and 30 g/m2. The composites cooling capacity is estimated as 27-30 kJ/m2. Dynamics of water sorption was investigated by Large Temperature Jump method, imitating conditions of the isobaric stages of real AHT cycle. The desorption runs are found to be extremely fast and ensure the maximal power of 17 kW/m2. The results obtained have clearly demonstrated that a) these new materials can be interesting for making compact AHT units with short working cycles, and b) more R&D effort are necessary for further progress towards practical implementation.

Keywords: anodic aluminium oxide, adsorption heat transformation, energy efficiency

360: Renewable Energy Options and the Nigerian built Environment

FERDINAND F O DAMINABO[1*;] SAMUEL C DIKE[2]

1. Department of Architecture, Rivers State University of Science and Technology, Port Harcourt, Rivers State, Nigeria. Email: ferdydaminabo@yahoo.com
2. Faculty of Law, Rivers State University of Science and Technology, Port Harcourt, Nigeria. Email: chisadike@yahoo.com

ABSRACT: The year 2014, saw the Nigerian economy rebased as the largest in the African continent ahead of South Africa but a critical assessment however exposes huge holes in its energy independence and security with gross underperformance in power security. To adequately unbundle the nation's economic and industrial potentials as well as significant inflow of foreign investments which includes energy, the question of energy poverty needs be addressed. More than 60% of Nigerians' population is not connected to the National grid and power is epileptic which has compelled the Nigerian government to set out plan to launch a National policy on Renewable Energy and Energy efficiency to boost power supply in the country. A 7% renewable energy use by 2025 is the government's assumed target taking advantage of new scientific breakthroughs in energy efficiency and delivery of renewable energy technologies and to attain 30,000MW of renewable electricity within a decade. This paper therefore seeks to examine the necessary renewable energy options with attendant advantages to the environment and use of green energy in off-grid locations across the country for up to 60% of a population of 170 million people which is a huge market for Renewables. The existing templates of renewable energy platforms including foreign participation as well as the market in Nigeria will be in sharp focus. A progress report submitted by the presidential task force committee on power reforms in Nigeria in a 2011 assessment showed the largest gap between demand and supply of electricity in the world and this reinforces the need for this research to harness and provide focal point for both national and international efforts on alternative energy options away from fossils and with futuristic perspectives and use within the Built Environment.

KEYWORD: Renewable Energy, Power Security, Built Environment

361: An application of homotopy perturbation method for efficiency and effectiveness assessment of longitudinal porous fins

ERDEM CUCE[1], PINAR MERT CUCE[2]

1 University of Nottingham, NG7 2RD, Nottingham, UK, Email:Erdem.Cuce@nottingham.ac.uk
2 University of Nottingham, NG7 2RD, Nottingham, UK, Email: ezxapm@nottingham.ac.uk

In our previous research, thermal performance investigation of straight fins has been carried out in detail and dimensionless analytical expressions of fin efficiency and fin effectiveness have been presented for the first time in literature via homotopy perturbation method. In this work, previous works have been extended to porous fins. Governing equations have been formulated by utilizing Darcy's model. Dimensionless temperature distribution along the length of porous fin has been developed as a function of porosity and convection parameters. The ratio of porous fin to solid fin heat transfer rate has also been investigated as a function of thermo-geometric fin parameter. The results have been compared with those of finite difference method for a specific case and an excellent agreement has been obtained. The expressions developed are beneficial for thermal engineers for preliminary assessment of thermophysical systems.

Keywords: Homotopy perturbation method, heat transfer, thermal performance, porous fins

362: Cooling Applications with Renewable Energy Powered Resorption Systems

BILSAY PASTAKKAYA[1], ERDEM CÜCE[2], PINAR MERT CÜCE[3]

1 Uludag University Orhangazi Vocational College Machinery Program, 16800 Bursa Orhangazi Turkiye, bilsay@uludag.edu.tr
2 University of Nottingham, Department of Architecture and Built Environment, Faculty of Engineering, NG7 2RD Nottingham, UK, Erdem.Cuce@nottingham.ac.uk
3 University of Nottingham,, Department of Architecture and Built Environment, Faculty of Engineering, NG7 2RD Nottingham, UK,

The use of renewable energy in cooling applications plays a key role in solving the problems related to the energy. Among the thermal energy powered sorption cooling systems, thanks to its operational features, resorption cooling systems with ammonia-water solution has more technical and economic advantages than its alternatives. It will significantly enhance the benefits of the use of the resorption cooling system if the required thermal energy for the system is obtained from the renewable energy sources or the waste heat. Moreover, reduced maximum temperature of required heat, lower pressures adjustable by ammonia concentration and supply of cooling energy below 0 °C provide considerable advantages in residential and industrial cooling applications. Also, the cooling energy can be stored by the use of ice storage tanks and can be used for cooling when the renewable energy sources are insufficient to drive the resorption system.

In this study, technical features of the resorption cooling systems were introduced and the system was compared with the other sorption cooling systems. The cooling applications and the results of the resorption cooling system were presented and the benefits of the renewable energy and waste heat powered systems were defined. The results showed that resorption cooling systems have similar COP values with the conventional absorption systems. Thus, they will have wide spread use in the future because of their advantages among its alternatives.

Keywords: Resorption, Cooling, Renewable Energy

363: Building applications of heat recovery systems:

A review

PINAR MERT CUCE[1],*, KEMAL GANI BAYRAKTAR[2],
SAFFA RIFFAT[1], SIDDIG OMER[1]

[1] Department of Architecture and Built Environment, Faculty of Engineering, University of Nottingham, University Park, NG7 2RD Nottingham, UK
[2] Izocam Tic. ve San. A.S., Altaycesme Mah., Oz Sokak, No:19, Kat:3-5-6, P.K. 34843, Maltepe, Istanbul, Turkey
**Corresponding email: ezxapm@nottingham.ac.uk, Tel: +44(0)747 327 8285*

In the early 21st century, energy consumption levels were specified by sector and the results interestingly indicated that buildings play an important role on global energy consumption. Buildings have a long life span lasting for 50 years or more and thus, minimization of energy consumption levels of buildings has a notable potential to contribute in mitigating greenhouse gas concentrations for longer periods. Most of the energy losses in buildings occur in heating, ventilation and air conditioning systems. Therefore, recovering the waste heat from HVAC systems may considerably contribute to efficient energy utilization and hence, in degrading gas emissions. In this paper, a comprehensive review on building applications of heat recovery systems is presented. The review is given as a clear and understandable summary of the previous works. The review covers detailed description of heat recovery systems with working principle and system components, current typical heat recovery technologies including the building applications. Moreover, environmental impacts of heat recovery systems are evaluated. Future scenarios for heat recovery technologies including some recommendations are also considered in the study. It is concluded from the results that the heat recovery systems are very promising to mitigate the fuel consumption amounts of buildings. Heat recovery system (HRS) provides cost-effective and environmentally friendly energy. Thus, they can remarkably contribute in reducing greenhouse gas emissions in the atmosphere.

Keywords: HVAC, heat recovery, building applications

369: Model Predictive Control Algorithm for Multilevel Inverter in High Performance Load

ALI ALMAKTOOF[1], ATANDA RAJI[2], MTE KAHN[3]

1Cape Peninsula University of Technology, Bellville Campus, 7535, South Africa, 213301091@mycput.ac.za
2Cape Peninsula University of Technology (CPUT), Bellville Campus, 7535, South Africa, rajia@cput.ac.za
3Cape Peninsula University of Technology (CPUT), Bellville Campus, 7535, South Africa, Khant@cput.ac.za

In the applications of high voltage renewable energy systems such as wind and solar farm the use of model predictive control (MPC) in the power conversion stage is very advantageous. The strict requirements of utility or transmission operators or high performance loads for standalone need a very sophisticated and robust control strategy. A three-phase, flying capacitor multilevel converter is considered in this research work for high performance standalone load modelled as a simple resistive-inductive load (RL-load).

Two primary control objectives employed in this work are reference current tracking and flying capacitor voltage balancing, both of which are done concurrently by means of a multivariable control algorithm. A hysteresis-based algorithm is presented to balance the flying capacitor voltage in a complimentary way with the finite state-model predictive current control (FS-MPCC) algorithm. In the implementation stage of FS-MPCC for the control of a three-phase, three-level flying capacitor converter (FCC) for RL-load, the estimation step, predictive step and optimization step are performed. The performance of the proposed control is assessed by parameter mismatching between the model and the actual system parameters. Because of in nearly all systems, the parameters can change or are, to a degree, indeterminate. To evaluate the parameter sensitivity of the proposed control algorithm, different values for the load resistor and inductor are used. These values are estimated in order to determine how robustly the system could track the reference signal, balance the flying capacitor voltage, and the extent of the total harmonic distortion (THD). Co-simulation is effected by means of MATLAB/Simulink with PSIM software.

Keywords: Flying capacitor converter; finite state-model predictive current control; hysteresis-based algorithm; resistive-inductive load; total harmonic distortion

372: Assessing Energy Efficiency in a Newly Designed Office Building:

Case Study Petrojet Company New Head office Building in Cairo, Egypt

NAYERA R. ABDALLAH[1], ALI K. ABDEL-RAHMAN[1], S. OOKAWARA[1,2], ESSAM K. MAHROUS[3]

1 Department of Energy Resources Engineering, Egypt- Japan University of Science and Technology E-JUST, New Borg Elarab, Alexandria 21934, Egypt, nayera.abdelhafez@ejust.edu.eg, ali.kamel@ejust.edu.eg
2 Department of Chemical Engineering, Graduate School of Science and Engineering, Tokyo Institute of Technology, Tokyo, Japan, sokawara@chemeng.titech.ac.jp
3 Department of Architectural Engineering, Faculty of Engineering, Assiut University, Assiut, Egypt, dr_essam_mahrous@yahoo.com

Energy use in buildings is closely linked to their design (form, orientation and building materials), operational and space utilization characteristics and the behaviour of their occupants. Due to demand for sustainability, more passive buildings will be built in Egypt. This study evaluates the energy performance in a newly designed office building in Egypt. In this building, energy efficiency aspects were considered during the design. The evaluation is done using two different tools - Portfolio Manager (PM) and Target Finder (TF) - related to ENERGY STAR (ES) using the Energy Use Intensities (EUI). The only difference is that PM needs at least 12 consecutive months of metered utility bills to perform the evaluation calculations, while TF needs an estimated annual energy use for each type of energy consumed in the building. Energy consumption was determined by two ways: simulation and calculation. DesignBuilder (DB) has been used in the current study to simulate the building energy use for a whole year considering building design, building materials, optimization of thermal comfort, lighting, weather data and activity in the case study building. In addition, calculations for annual energy use were done using the data sheets with each energy consuming system utilized in the building based on operating hours of each. The ES scores for both simulation and calculation results were obtained. The main conclusions were that ES can be used to evaluate energy performance of office buildings in Egypt. Moreover, the results showed that the Egyptian office buildings can compete with the USA office buildings in applying energy efficiency strategies. Results of the optimizations showed significant reduction in terms of energy consumption. Finally, the simulation results showed the relative effect of the applied design, shading, orientation and the energy efficient lighting and HVAC systems on the annual energy consumption and ES score.

Keywords: energy efficiency, ENERGY STAR, Simulation

377: Lighting performance investigation of heat insulation solar glass (HISG) for potential utilization in greenhouses as facade material

ERDEM CUCE[1], SAFFA RIFFAT[1], CHIN-HUAI YOUNG[1]

1 Department of Architecture and Built Environment, Faculty of Engineering, University of Nottingham, University Park, NG7 2RD Nottingham, UK

In this short communication, a novel thin-film photovoltaic glazing material called heat insulation solar glass (HISG), which has recently been developed at the University of Nottingham, is introduced and its lighting efficiency for the potential utilization in greenhouses as a unique facade material is theoretically and experimentally investigated. Within the scope of the research, lighting performance assessment of HISG is presented in a comparable way with the conventional facade technologies such as ordinary single or double glazed building elements. Two test houses consisting of HISG and ordinary glass are constructed, and the lighting efficiency is evaluated for each glass house for different climatic conditions. Visual quality is also investigated through several retrofitting cases. The results indicate that HISG curtain walls provide 24.9% better lighting performance than ordinary glass curtain walls in terms of average values. This result can be attributed to the superior sandwich structure of HISG containing photovoltaic module and highly reflective film, leading to notable increase in light reflection into the house and thus sensible enhancements in lighting levels.

Keywords: Heat insulation solar glass, conventional glazing technologies, lighting performance, greenhouses

378: Integration of Biomass Heating Production into Thermal Storage

JIN HU[1], JULIEN ROPP[2], SÉBASTIEN SAUTY[1], OSMANN SARI[1*]

[1] Institute of Thermal Engineering (IGT), University of Applied Sciences and Arts of Western Switzerland, Av. des Sports 20, CH-1400, Yverdon-les-Bains, Switzerland, jin.hu@heig-vd.ch, sebatien.sauty@heig-vd.ch, osmann.sari@heig-vd.ch
[2] Industrial Systems in Bioenergy, University of Applied Sciences and Arts of Western Switzerland, Av. des Sports 20, CH-1400, Yverdon-les-Bains, Switzerland, julien.ropp@heig-vd.ch

Energy prices are a major challenge for many industrial. The days of cheap energy are over, and energy efficiency is becoming a crucial success factor. European biomass heating systems are typically designed with a smaller boiler compared to the peak heat load. Past research showed that residential biomass boilers designed with a large firebox but without sufficient water storage in the buffer tank as a heat reservoir to meet the full load. These boilers operate inefficiently over the season. To improve the operating efficiency of biomass boilers and link up a number of different heating systems, a pilot insulated water storage tank was built with capacity of 11150 liters. It has equipped with 6 internal heat exchangers to have different temperature levels for multi-functions. In this thermal storage tank, 3 circuits were designed to charge the tank and another 3 circuits for heat discharge. In addition, one circuit is featured as selective evacuation zone aided by 3 internal heat exchangers. This water tank allows the biomass boilers to operate at nominal load for longer periods, avoiding the need for the boiler to be repeatedly shut down and re-ignited when demand is low. By charging the tank during periods of low demand, the system is able to provide low levels of heat without cycling and can respond to sudden peaks by providing additional heat when the boilers are unable to meet the full load on their own.

Keywords: Biomass heating; thermal energy storage; multifunctional water storage tank

383: Numerical investigation of heat transfer in the vertical tube of a supercritical water solar tower receiver

G. ZHANG, Y. LI, Y. J. DAI, R. Z. WANG

Institute of Refrigeration and Cryogenics, Shanghai Jiao Tong University, Shanghai 200240, China, liyo@sjtu.edu.cn

The higher incident radiation flux and the higher thermal to electric efficiency lead the solar tower power with supercritical water as heat transport fluid in central receiver to be one of the most promising solar thermal power. In this paper, heat transfer of supercritical water in a vertical tube of the solar tower receiver has been investigated using Computational Fluid Dynamics (CFD) method. A 3D simulation model is employed to really express distribution of heat flux in the circumferential direction of a circular tube heated by incident solar flux on one side. The RNG k-ε model with the standard wall function is employed to carry out numerical simulations and the results agree with experimental data well. The simulations reveal that the average heat transfer coefficient depends strongly upon the mass flux and incident solar flux. At sufficiently high mass fluxes, the average heat transfer coefficient reaches the peak value at a bulk temperature slightly less than the pseudo-critical temperature. At low mass flux relatively to the incident flux, heat transfer deterioration occurs in the pseudo-critical region. The buoyancy effect which is important factor causing heat transfer deterioration in supercritical water is obviously weakened in downward flow, even can be negligible. and h/h0 are modified to a limit of 10-6 for the onset of mixed convection and 0.45 for the onset of heat transfer deterioration when supercritical water in circular tube is heated by incident flux. And, the relations between the limit incident radiation flux above which the heat transfer deterioration occurs and mass flux for the supercritical water solar tower receiver is given as qin=0.453G.

Keywords: supercritical water, incident solar flux, CFD, heat transfer

384: Energy and Economic Analysis of Different Solutions for the Retrofitting of the Heating and Cooling Plant for a Residential Care Home for Elderly People

MARCO NORO[1], GIACOMO BAGARELLA[2]

1 Department of Management and Engineering, University of Padua, Stradella S. Nicola, 3, 36100 Vicenza, Italy – marco.noro@unipd.it
2 Department of Management and Engineering, University of Padua, Stradella S. Nicola, 3, 36100 Vicenza, Italy – bagarella@gmail.com

Since the last decade, European Union policies are oriented to decrease greenhouses emissions and energy dependence. The main incentives are energy saving, renewable energy and cogeneration, as proved by the 2010/31 EU Directive on energy savings in buildings and by the 2012/27/EC Directive on energy efficiency.

At the same time, about 14 % of European population is over 65 years of age, and it is expected that this number will double by 2050. These figures in Italy assume dramatic values, as actually we have 21.4 % of population over 65 (13 million) and we will have 33.6 % (18.7 million) by 2050. Nowadays about 300000 elderly live in just less than 6000 care homes in Italy. These buildings operate 24 hours a day, 365 days a year, with full occupancy. For these reasons reducing energy consumption in residential care homes is important.

This paper focuses on the study of the energy performance of a residential care home for elderly people in Vicenza (North East of Italy). A preliminary energy audit was carried out in order to obtain appropriate information about energy consumption of the building. Moving from the request of the managers responsible for running the care home, a Trnsys simulation model of the building/HVAC plant system was developed with the aim to test different solutions to retrofit the heating/cooling plant.

Some of the best available technologies (photovoltaic, cogeneration, trigeneration, heat pumps) were compared by an energy and economic analysis in order to assess potential energy investment options to make energy efficient informed decisions.

Keywords: energy efficiency; HVAC plant; cogeneration; trigeneration; photovoltaic

388: A comparison study on direct expansion solar assisted heat pump water heater system with different channel pattern roll-bond collectors/evaporators

YANJUN DAI[1], JINFENG CHEN[1], XIAOLIN SUN[1], RUZHU WANG[1]

1 Institute of refrigeration and cryogenics, Shanghai Jiao Tong University

In this paper, three types of roll-bond collectors/evaporators for direct expansion solar assisted heat pump (DX-SAHP) water heater were designed, fabricated and tested. The roll-bond collectors/evaporators were south-faced and wall-mounted for building integration purpose during the experiment. Results show that, under the test conditions, the roll-bond collector/evaporator with honeycomb and rectangle shaped channel pattern shows significant improvement of COP and heating capacity than the conventional channel pattern. Furthermore, compared with the rectangle shaped channel pattern, the honeycomb shaped channel pattern further improved COP by 6.2%. Finally, the DX-SAHP water heater with optimized channel pattern roll-bond collector/evaporator was tested under a series of different weather conditions. With the fixed initial water temperature, the COP of DX-SAHP water heater varied from 1.76 to 5.54 when the operating condition changed. When operating during night, the sky background temperature significantly influenced the COP of the system. Under the same ambient temperature, the results of COP in cloudy and clear night are 2.82 and 1.76 respectively.

Keywords: Solar Heat pump; Collector/evaporator; Channel pattern

389: Developing Indicators Framework to Evaluate the Sustainability of Urban Infrastructure Systems in Middle Eastern Cities

MUSTAFA AL-ALWANI[1], SUAD ALFATLAWI[2]

1University of Babylon, Hilla, Babel, Iraq, E-mail: mustafalwani@yahoo.com
2University of Babylon, Hilla, Babel, Iraq,E-mail:suadalfatlawi@yahoo.com

Presently, cities face problems in the implementation of sustainable urban infrastructure systems. Sustainable infrastructure systems are essential to achieving sustainable cities because the lack of adequate services affects every aspect of daily life of the community. This research aims to develop indicators framework to evaluate the sustainability of urban infrastructure systems (wastewater treatment, energy, transportation and water resources) taking the city of Hilla, Iraq (as one of the Middle Eastern cities) as a case study. Exploration of an extensive and wide array of literature, interviews and personal communications with stakeholders and experts were conducted to acquire the information necessary for obtaining indicators framework. Moreover, that will identify and examine various issues in urban infrastructure systems and assist formulation, and selection of indicators framework which can then guide the evaluation of urban infrastructure systems' sustainability in Middle Eastern cities. The framework developed in this research succeeded and could be considered applicable, capable and effective in constructing a set of indicators which consist of 10 water resources indicators, 8 wastewater treatment indicators, 14 transportation indicators and 18 energy indicators. These indicators will reflect most of the issues regarding sustainability of urban infrastructure systems and can guide the promotion of the development of sustainable urban infrastructure systems in Middle Eastern cities.

Keywords: framework, indicators, sustainability, urban infrastructure systems, middle eastern cities

392: Environmental effects of ground source heat pump system with vegetation on the ground surface

XUANYU CHANG, YONG LI, RUZHU WANG, HONGYUN ZHOU

Institute of Refrigeration and Cryogenics, Shanghai Jiao Tong University, Shanghai 200240, China, liyo@sjtu.edu.cn

Research on the interactions among Ground Source Heat Pump (GSHP) system, vegetation and microclimate is needed due to exhausted heat from the GSHP system to surrounding environment and ambient temperature reduction by vegetation transpiration. Models in previous study are intended to research the heat transfer underground and to improve the heat transfer efficiency of ground heat exchangers. In addition to these heat transfer models, previous research shows that the performance of a ground heat pump system was found to depend strongly on the moisture content and the soil type, and a number of studies have been conducted to investigate the cooling effect of urban green space using analytical modeling approaches and empirical analysis. The aim of this study is to compare the heat exhausted from GSHP system to the microclimate and the influences of transpiration of vegetation on the surrounding environment in the summer season. In this article, energy balance models of soil and vegetation has been set up to analyze the heat flow among the vertical tubes of a GSHP system, soil, vegetation and the ambient environment. Heat released from GSHP system after long-term operation is predicted on the basis on simulation results. Furthermore, transpiration experiments are conducted to evaluate its cooling effects. The energy influence of the vegetation and GSHP on the environmental atmosphere has been compared. Based on the calculated results and measurement data in Shanghai city (southeast in China), suggestions are given to the application of GSHP system combined with vegetation to balance microclimate.

Keywords: GSHP, vegetation, energy use, transpiration, microclimate

393: Study on performance of multiple air source heat pump system for heating in China

WEILI LUO[1,2], YUNKANG SUN[1], YUXIONG XU[1], RUZHU WANG[1]

[1]Shanghai Jiao Tong University, Institution of Refrigeraiton and Cryogenics, 800 Dongchuan RD. Minhang District, Shanghai, China, luoweili@sjtu.edu.cn
[2] Solar Power and Refrigeration Engineering Research Center, MOE, 800 Dongchuan RD. Minhang District, Shanghai, China

This paper reports a novel application of an air source heat pump system for cooling, heating and domestic hot water production in Shanghai for a typical apartment. The appliance can supply five functions as space cooling, space cooling plus domestic hot water, space heating, space heating plus domestic hot water, and domestic hot water only. In winter, the system was aim to solve the central heating problem in the area of Yangtze river basin and the operating performance under specified weather conditions. The system was combined with a Low-H_2O heat exchanger to decrease the supply water temperature for saving the energy. The heating return water temperature was set at 30^oC, 35 ^oC and 40 ^oC for heating in winter which lower than the conventional air source heat pump system. When the inlet temperature was set at 30^oC, 35^oC and 40^oC, the power consumption was 27.18kWh, 39.84 kWh, 51.48 kWh, respectively. The power consumption of the system increased 89.2% at the inlet temperature of 40^oC and 46.6% at the inlet temperature of 35^oC compared with the one at the condition of the inlet temperature of 30^oC. When inlet temperature increased from 30^oC to 40^oC, the COP of the air source heat pump decreased from 3.50 to 2.22 with the percentage of 36.5% at the conditions of the outdoor temperature of 6-7^oC. The indoor temperature of the apartment was at the range of 19.4 to 20.9^oC with the conditions of the inlet temperature of 30^oC and the average temperature 5.1^oC.

Keyword: Air source heat pump, energy efficiency, temperature distribution, COP

395: Fixed-bed staged gasification of biomass:

Rate-controlled equilibrium modelling

IGOR DONSKOY[1], ALEXANDRE KEIKO[2], ALEXANDER KOZLOV[3], VITALY SHAMANSKY[4], DENIS SVISHCHEV[5]

[1] Melentiev Energy Systems Institute, Russian Academy of Sciences, Russia, 664033 Irkutsk, Lermontova st., 130, e-mail: donskoy.chem@mail.ru
[2] Melentiev Energy Systems Institute, Russian Academy of Sciences, Russia, 664033 Irkutsk, Lermontova st., 130, e-mail: paragraph1@yandex.ru
[3] Melentiev Energy Systems Institute, Russian Academy of Sciences, Russia, 664033 Irkutsk, Lermontova st., 130, e-mail: kozlov@isem.sei.irk.ru
[4] Melentiev Energy Systems Institute, Russian Academy of Sciences, Russia, 664033 Irkutsk, Lermontova st., 130, e-mail: vita@isem.sei.irk.ru
[5] Melentiev Energy Systems Institute, Russian Academy of Sciences, Russia, 664033 Irkutsk, Lermontova st., 130, e-mail: denis.svishchev@gmail.com

Biomass gasification is a technology suitable for small-scale power plants. This is a well-known and environmentally friendly way to convert biomass (such as forest and agricultural waste) into combustible fuel gas. However there are several disadvantages to overcome. Tarry gases call for a costly gas cleaning system, and the process is often unstable. These drawbacks are typical for widely used single-stage gasification processes.

Staged gasification as distinct from the single-stage one allows allothermal and autothermal conversion processes to be separated within the same plant. Separation of the devolatilization and char gasification stages makes tarry volatiles to burn and produce the gasification agent. Such process organization provides both low-tar gas production and better process heat utilization.

The plant being studied consists of two fixed-bed reactors and a gas combustion chamber. It has a number of feedbacks that cause a change in parameters of all reactors at a variation in any of them. A mathematical model is developed to predict staged process behavior and to find stable operation modes. The model consists of blocks describing equilibrium gas combustion constrained by diffusion and kinetics. The results outline the control limits within which a stable and efficient gasification can be performed.

Keywords: gasification, biomass, staged process, mathematical modelling, equilibrium models, kinetic cinstraints.

401: A novel multifunctional PV/Thermal/Daylighting (PV/T/D) panel based on incorporation of miniature prismatic structure and transpired solar collector

YUEHONG SU[1]*, XU YU[1], HONGFEI ZHENG[2], SAFFA RIFFAT[1]

[1] 1Institute of Sustainable Energy Technology, Department of Architecture and Built Environment, University of Nottingham, University Park, NG7 2RD, UK, yuehong.su@nottingham.ac.uk
[2] School of Mechanical Engineering, Beijing Institute of Technology, Beijing 100081, China, author email address

This study presents a novel multifunctional PV/Thermal/Daylighting (PV/T/D) roof panel suitable for atrium buildings and large green houses. The panel contains an array of miniature dielectric compound parabolic concentrators (CPCs) to provide concentration of the solar radiation coming from a certain range of sky angles and meanwhile allow the rest of solar radiation to transmit for daylighting. As a result, the panel will also provide a solar shading function and an option to incorporate concentrating PV for PV/Thermal applications. A novel heat recovery design using the concept of transpired solar collection is adopted to remove heat rejection from PV cells and reduce heat gain to the atrium (or green house) space to mitigate the summer overheating problem. Design and fabrication of a small sample panel consisting of an array of miniature CPCs are described. A commercial optical analysis software Photopia is used to predict the transmittance values of the dielectric CPC panel and meanwhile CFD modelling is employed to predict the performance of heat recovery. Some preliminary testing of this panel under real sky conditions is also described. Furthermore, the energy performance of the proposed roof panel is evaluated for an educational building in Nottingham using EnergyPlus simulation.

Keywords: daylighting, shading, PV/thermal, dielectric CPC, multifunctional, panel, Photopia simulation, testing

402: A Case Study of Energy Efficiency Retrofit and Renewable Technology Utilisation in a UK Schools Group

LI ZHANG[1], MENG TIAN[1], HANBING FAN[1], NHUNG THANH TRAN[1], RICHARD SMEETON[2], SARAH IQBAL[2], YUEHONG SU[1]*

1 Department of Architecture and Built Environment, The University of Nottingham, Nottingham, UK, NG7 2RD
2 3 Burton Walks, Loughborough Endowed Schools, Loughborough, UK, LE11 2DU
** Corresponding Author: yuehong.su@nottingham.ac.uk*

This paper presents a study on assessment for energy efficiency by utilizing a series of renewable technologies in Loughborough Endowed Schools (LES) refurbishments. In the assessment, economic evaluation of energy saving measures was also considered. In light of inefficient energy usage issues identified in the LES project, five measures including internal wall insulation, double glazing, combined heat and power, heat recovery ventilation and PV were chosen and investigated in the simulation by using software packages EnergyPlus and PVSyst. Three representing buildings, which are historic brick building (Boarding House), modern education building (LHS Science Building) and special functional building (Swimming Pool) were simulated as examples to investigate every measure and technology adopted. The results were compared with the original energy consumption. In terms of traditional brick wall building, it has been found in this research that internal wall insulation and double glazing played significant improvement on energy performance. Changing traditional ventilation to heat recovery ventilation in swimming pool and using high performance unit CHP were strong suggested. However, PV presented less saving compared with others. The economic evaluation involved simple payback period, net present value, internal rate of return, levelised cost of energy and benefit-to-cost ratio. The results showed that over the 15-year analysis, combined heat and power, Heat recovery ventilation and photovoltaics were financially feasible, while internal wall insulation was only viable over a longer period.

Keywords: energy efficiency; retrofit; renewable technology; EnergyPlus; PVSyst; economic evaluation

406: A Study on the Optical Separation of Highly Concentrated Solar Radiation Using Hot mirror

YEONGMIN KIM[1], YOUNG SOO LEE[2], SEUNG JIN OH[3], WONGEE CHUN[4]

1 Department of Nuclear and Energy Engineering, Jeju National University, km820426@jejunu.ac.kr
2 Energy Efficiency Research Division, Korea Institute of Energy Research, yslee@kier.re.kr
3 Department of Mechanical Engineering, National University of Singapore, mpeohsj@nus.edu.sg
4 Department of Nuclear and Energy Engineering, Jeju National University, wgchun@jejunu.ac.kr

Highly concentrated solar radiation obtained from a solar concentrator mounted on a solar tracker can be divided into infrared and visible regions before its actual applications. That is, solar rays are separated into infrared and visible regions as they are reflected off the first and second reflectors and channeled into an optical unit called a "hot mirror." The infrared rays could be applied for thermoacoustic applications, while visible rays may be utilized for indoor lighting. This work introduces the separation of two different sources of light; sunlight and artificial light. As for the artificial light, its wavelength extended from 400㎚ to 720㎚ in the visible region and 620㎚ to 940㎚ in the infrared region. A series of tests revealed that the hot mirror used in this work was capable of separating solar radiation whose wavelength extended from 460㎚ to 680㎚ in the visible region. For the artificial light, its wavelength ranged from 620㎚ to 940㎚.

Keywords: Hot mirror, Solar Tracking System, Optical Separation System, Thermal-Acoustic System, Solar Lighting System

417: Sustainable and Renewable Energy Architectural Initiatives for COMSATS Institute of Information Technology Islamabad Campus-Pakistan

AR. ADNAN AMIN

COMSATS Institute of Information Technology, Park Road, Chak Shehzad, Islamabad
adnan_amin@comsats.edu.pk, architectadnan@hotmail.com

Application of sustainable and renewable energy generation initiatives and architectural design solutions can help in making any educational campus energy-efficient and sustainable. These initiatives and solutions are helpful to conserve energy in the built structures and at the same time generate additional energy at the master plan level. The scope of research encompasses the COMSATS campus in Islamabad. In-depth study and research is done, to highlight the significance of application of green design solutions like green roof on an existing building to make it energy efficient and thermally comfortable. The project focuses on different modes of renewable energy generation and conservation of energy by applying appropriate green and sustainable techniques. A comparative study for different architectural design solutions with minimum cost and maximum advantages to reduce heat gain through building envelope that is the walls, the roof and windows of the buildings has been provided. At the same time suggestions have been made to generate additional energy through renewable sources and by application of latest technology.

Keywords: Sustainable Renewable Initiatives, Green Solutions, Educational Campus, Building Envelope, Thermal comfort

422: Pakistan's energy system: integrated energy modelling and formulation of national energy policies

NAYYAR HUSSAIN[1], M. ASLAM UQAILI[1],
KHANJI HARIJAN[1], GORDHANVALASAI[2]

[1]Mehran University of Engineering and Technology, Jamshoro; Sindh, Pakistan
[2]Quaid e Awam University of Engineering, Science and Technology, Nawabshah, Pakistan

Pakistan is facing multiple challenges for harnessing the various indigenous energy resources and devise the energy policy for meeting the ever increasing demand of energy by various sectors of the economy. The country which is believed to have substantial indigenous primary energy resources i.e. Fossil fuels and renewables is facing energy supply gap of over 5,000 megawatts, ending up frequent outages and load shedding. Energy planning in Pakistan was given little consideration before 1980's mainly owing to limited industrial growth and small urban population. However, in the following years there has had been substantial urbanization and industrial growth in the country emphasized to devise the rational energy polices. From 1994 to 2013 various energy polices have been formulated and implemented. The focus of formulation of these policies have varied from policy to policy with major polices devised without undertaking integrated energy modelling exercise, although there has been some efforts at government level as well as by the academicians. Popular energy modelling tools such as MARKAL/TIMES; LEAP, ENPEP and MESSAGE have been developed and successfully used by nations to devise the energy policies. This paper provides brief on Pakistan's Energy System, review of energy modelling tools and their possible application in Pakistan for the formulation of energy policies.

Keywords: Energy Modelling, Energy Planning, Energy Policies

426: Energy Management Systems for Microgrids

VICTOR MARYAMA[1], VITOR S. ZENI[1], FREDERICO V. JORDAN[1],
CESARE Q. PICA[1], GABRIEL A. OLIVEIRA[2]

1 CERTI Foundation, Federal University of Santa Catarina Campus - Sector C Brazil, vma@certi.org.br
2 Tractebel Energy, Pachoal Apóstolo St. 5064 - Florianópolis - Brazil, goliveira@tractebelenergia.com.br

This work presents a pilot hybrid (AC and DC) microgrid, comprised of a gas microturbine emulator, a small wind turbine emulator, photovoltaic panels, an energy storage system, controllable AC and DC loads and static converters. This is a project sponsored by Tractebel Energy Brazil, aimed at studying microgrids in order to evaluate its use in creating value for customers. This allows them to use their energy in the most efficient way, taking advantage of intelligent distributed energy resources.

The focus of this paper is mainly on the microgrid energy management system, which plays the role of the economic dispatcher. The cost of operation is minimized by taking into consideration grid energy costs, fuel costs, O&M and equipment wear as well as diverse operation restrictions of the system, such as grid exchange limits, power limits of the sources, battery dynamics, among others. The resulting optimum power set points for the sources are calculated based on demand and renewable generation forecasts, in order to guarantee the most economic operation.

A simulation platform was developed to evaluate the behaviour and costs of similar microgrids, in which the specification of the sources can be arbitrarily defined. The static operation can be viewed and the resulting electrical transient dynamics can be analysed for user-defined moments within the simulated results. Study scenarios will be presented using this tool, showing the effectiveness of a microgrid management system in real-life representative situations.

Keywords: microgrids, energy management systems, distributed energy resources, economic dispatch

430: Production and Testing of Biodiesel Methyl Ester fuels from Nigerian Tropical Seed oil Feedstocks

GILLIAN OGBENE IGBUM[1] ANDREW C. ELOKA-EBOKA[2], SAMUEL JACOB. ALIYU [3]

[1] Department of Chemistry, Benue State University, Makurdi, Nigeria.
[2] Discipline of Mechanical Engineering, University of KwaZulu-Natal, Howard College, Durban, South Africa.
[3] Department of Mechanical Engineering, Landmark University, Omu Aran, Nigeria.
ogbenebenny@yahoo.com, fatherfounder@yahoo.com, sjaliyu@gmail.com

The urgent need for alternative energy, climate change mitigation and environmental protection in the world today cannot be over-emphasized. Researchers are at top gear in search of non-edible energy crops. The huge environmental benefits of renewable energy notwithstanding, new discoveries in this area arise every day. The potentials of selected tropical seed-oils for biodiesel production and utilization as fuels were therefore explored and subsequently produced. The seed-oils studied include: Sand box tree, fluted pumpkin seed and wild melon seeds. Oils of these seeds were extracted, optimized, synthesized and characterized as biodiesel fuels by transesterification process using different alcohol/oil ratios of (4:1 and 6:1) and catalysts types (NaOH and KOH) at optimization temperatures of 38oC and 55oC and reaction time of 5 mins and 30 mins respectively. Optimized biodiesel produced were investigated for their chemo-physical properties in conformity with ASTM standards of biodiesel. Results showed that sandbox tree seeds, wild melon seeds and pumpkin seeds have high percentage oil content (69.32%; 70.24% and 46.88%) respectively. They also hold great potentials as feedstock for biodiesel production. The chemo-physical properties and their biodiesel fuels and blends with automotive gas oil (AGO) fell within specification. Pumpkin seed oil however showed highest average percentage optimized yield of biodiesel (97%) in (1 wt of oil), NaOH catalyst, and alcohol to oil ratio of 6:1 at a reaction temperature of 55oC. Under the giving conditions, biodiesel fuels and blends were successfully produced from the selected feedstock with properties very close to those AGO. They can therefore be commercialized for large scale utilization as biodiesel fuels or as blends for the replacement of environmentally unfriendly fossil fuels.

Keywords: production, testing, tropical Nigerian seed oils, biodiesel, feedstocks, methyl ester, renewable energy

431: A Study on Performance Improvement of Enthalpy Exchanger with Modified Functional Layers

C.Y.ZHANG[1], J.C.XU[2], T.S.GE3, Y.J.DAI[4], R.Z.WANG[5]

1 Institute of Refrigeration and Cryogenics, Shanghai Jiao Tong University, Shanghai 200240 PR China, ZCY.123@sjtu.edu.cn
2 Institute of Refrigeration and Cryogenics, Shanghai Jiao Tong University, Shanghai 200240 PR China, xujingcui@sjtu.edu.cn
3 Research Centre of Solar Power and Refrigeration, Shanghai Jiao Tong University, Shanghai 200240 PR China, baby_wo@sjtu.edu.cn
4 Research Centre of Solar Power and Refrigeration, Shanghai Jiao Tong University, Shanghai 200240 PR China, yjdai@sjtu.edu.cn
5 Research Centre of Solar Power and Refrigeration, Shanghai Jiao Tong University, Shanghai 200240 PR China, rzwang@sjtu.edu.cn

More and more attention has been paid to the enthalpy exchanger (or total heat exchanger). The function layers, which exchange the heat and water between fresh air and exhausted air, play a demanding role in improving efficiency of the exchanger. Paper with low cost and high mechanical property is widely used as the function materials in the current enthalpy exchangers. In this study different materials have been prepared by spraying the thin paper layer with the calcium chloride solution and drying in the oven to improve the hygroscopicity of the material. The solution concentrations are 5%, 10%, 20%, 30% and 40%. The exchangers made by the modified function layers and normal structural layers are applied for test on the base of the GB standard test condition. In the case of the 0.3m/s (corresponding to 50CMH), the biggest absolute enhance of temperature efficiency, latent efficiency, enthalpy efficiency are 15%, 26%, 24% in heat condition and 23.6%, 21.8%, 22.1% in cooling condition. On the other hand, the pressure drop of the air through the exchanger increases 5 Pa in heat condition and 8 Pa in cooling condition, and it is not difficult for total heat exchanger to overcome the problems caused by increase of pressure drop.

Keywords: enthalpy exchanger, function layer, enthalpy efficiency, pressure drop

439: Domestic Turbine Design, Simulation and Manufacturing for Sub-Saharan Africa Energy Sustainability

EBHOTA WILLIAMS S.[1]* AND INAMBAO, FREDDIE L.[2]

1, 2Discipline of Mechanical Engineering, Howard College, University of KwaZulu-Natal, Durban, South Africa.
**Correspondence Author: willymoon2001@yahoo.com*

The quest for options to the conventional energy sources especially to supply power to remote and rural locations in Sub-Africa has led to several power schemes. The identified options include solar, geothermal, wind and hydro and they belong to renewable energy. However, hydropower has been singled out as the best alternative renewable energy to increase access to power in the region. This study identified inadequate local contents in terms of manufacturing in the small hydropower system technologies in the region as the main hindrance in increasing the rate of power access in Sub-Saharan Africa. The study sees human and manufacturing infrastructure capacities building in small hydropower plant (SHP) technologies as a boost to local production of SHP parts and systems in the region.

For the purposes of design capacity building, a simplified design process was executed for low (3m) and high (60m) heads for Kaplan/Propeller and Pelton pico hydro turbines respectively. The design of a propeller turbine with a river hydrological data of flow rate (Q) 0.2m3/s and head (Hn) 3m using rotational speed (N) of 1500rpm. 6kW turbine power was developed from propeller blade of 0.166m tip diameter (Dt) with specific speed (Ns) of 294. In the case of Pelton turbine, given parameters of flow rate (0.02m3/s), net head (60m) and rotational speed (N) of 1500rpm were used to design a 8.2kW output power Pto of Pelton turbine with specific speed Ns of 26.16. Solidworks modeling and simulation software was used to evaluate the mechanical design of a Pelton bucket. The study concludes that adaptive design and domestic manufacturing are tools for sustainable power development and recommends that a regional joint funding of research on appropriate SHP technologies should be established.

Key words: Power, Design, Turbine, Pelton, Propeller

440: Off-design Thermodynamic Performances of a Typical Solar hybrid Coal-fired Power Plant in China

HUI HONG[1],*, WEI HAN[1], SHUO PENG[1,2], HONGGUANG JIN[1]

1 Institute of Engineering Thermophysics, Chinese Academy of Sciences, Beijing 100190, China
2 University of Chinese Academy of Sciences, Beijing 100049, China

The concept of solar-hybrid coal-fired power plant is to use concentrated solar thermal energy to replace the extracted steam in regenerative Rankine power cycle. In this way, solar heat is capable of assisting coal-fired power plants to increase generating capacity with the same consumption of fuel, or remaining the same generating capacity but reducing its green house gas emissions within the same range. The advantages of a solar-hybrid coal-fired power plant in terms of design have been discussed by many researchers. However, off-design thermodynamic performances have not been well discussed yet. In this study, a typical 330 MW coal-fired power plant in Sinkiang of China is selected as the case study to denote the off-design thermodynamic performance. Influences of three main factors including solar radiation, incident angle and turbine load, on key parameters such as solar-to-electricity efficiency and net solar power ratio are discussed. Annual thermodynamic performances are discussed. The results obtained in this study could provide some guidance for the design and construction of solar-hybrid coal-fired power plant.

Keywords: Solar hybrid coal-fired power plant; Off-design; Thermodynamic performances

441: Shape-Stabilized Phase Change Materials (SSPCM) with balanced thermal property, strength, thermal conductivity and durability

RUI YANG[1]*, YI WANG[2], JIANPING WANG[3], WEIXIA WANG[4]

[1] *Department of Chemical Engineering, Tsinghua University, Beijing 100084, China, yangr@mail.tsinghua.edu.cn*
[2] *Department of Chemical Engineering, Tsinghua University, Beijing 100084, China,skyret@126.com*
[3] *Department of Chemical Engineering, Tsinghua University, Beijing 100084, China,swordabcd@163.com*
[4] *Department of Chemical Engineering, Tsinghua University, Beijing 100084, China, sj15210957403@163.com*

Energy-saving buildings appeal for the application of thermal storage materials with phase change temperature of 20-30℃, and paraffin is a good candidate. For the convenience of practical applications, paraffin should be encapsulated in order to prevent from leakage. Therefore, shape-stabilized phase change materials (SSPCM) were prepared by blending paraffin with high-density polyethylene (HDPE) and elastomers (e.g., ethylene-propylene-diene copolymer (EPDM) and styrene-butadiene-styrene block copolymer (SBS)). With 60 wt% paraffin, the SSPCMs exhibited good strength even when paraffin was melted. Proper crosslinking helped to increase the strength further. Due to the strong absorption ability of the elastomers, the SSPCMs showed much better durability during harsh freezing-thawing cycles. SSPCMs exhibit poor thermal conduction property and thus cannot respond to temperature changes in time. Expanded graphite (EG) and carbon nanotube (CNT) were introduced to improve the thermal conductivity of SSPCMs. Shear and/or ultrasonic treatment of EG and CNT were carried out to realize even dispersion of these fillers in SSPCMs. However, two treatment methods led to different effects on EG and CNT filled SSPCMs. Finally, thermal conductivity of SSPCMs was increased up to 1 W/m•K. Furthermore, the synergistic effect of EG and CNT was also investigated. Therefore, such SSPCMs are very promising for applications in energy-saving buildings.

Keywords: Shape-stabilized phase change material, thermal storage, strength, thermal conductivity, durability

445: Energy uses and climate change mitigation: assessing the roles of robust energy efficiency practices

SAMUEL DIKE [1] AND FERDINAND DAMINABO [2]

1. Faculty of Law, Rivers State University of Science and Technology, Port Harcourt, Nigeria. Email: chisadike@yahoo.com
2. Department of Architecture, Rivers State University of Science and Technology, Port Harcourt, Rivers State, Nigeria. Email: ferdydaminabo@yahoo.com

Energy uses, security of supply of energy and tackling climate change risks, have been regarded as the most important issues that occupied the 21st century. This is due to the difficulties of ensuring adequate supply of commercial energy to more than 1billion population of the world that are energy poor and the challenges posed by climate change risks. Consequently, policy makers and researchers have proffered different solutions for addressing these existential issues of our time. Some of the remedies proffered are the benefits of diversifying energy supplies away from the conventional energy forms to renewable energy sources and the employment of energy efficiency practices. From the perspective of a cost effective approach or a tested legal framework, and due to the slow pace of penetration of renewable energy sources to the world's global energy mix, it has been posited that adopting a robust energy efficiency practice in our homes, industries and institutions, would be the magic wand needed to reduce or stabilise the Greenhouse Gas effect which are responsible for the disturbing growth of climate change risks. The objective of this paper therefore is to examine the benefits of energy efficiency practices in promoting climate change mitigation.

Keywords: Energy, Climate, Renewable Energy, Energy Efficiency

449: Comparative Analysis of the Maisotsenko cycle based Air-conditioning Systems: Ejector cooling vs. Desiccant

OLEXIY BUYADGIE[1], DMYTRO BUYADGIE[2] AND OLEKSII DRAKHNIA[3]

1 buyadgie@wilson-ukraine.com, V.S. Martynovsky Institute of Refrigeration, Cryogenic Technologies and Eco-Energetics/Wilson Ukraine
2 d.buyadgie@wilson-ukraine.com, Wilson, UkraineOleksii Drakhnia
3 drahnya@wilson-ukraine.com Wilson Ukraine

The numerous researches of the Maisotsenko cycle (M-cycle) application for air-conditioning purposes prove 3 to 10 times (depending on air humidity) energy saving compared to the conventional vapour-compression systems. Another important value of air-conditioning through the M-cycle is the air displacement process that serves to supply fresh air into the conditioned premises continuously at the fixed energy input.

Being considered as a pure heat recuperative process, the M-cycle cooling requires water makeup that is obviously high in the dry climate zones. Conversely, in the humid zones, where absolute humidity exceeds 11g/kg of the dry air, the M-cycle based air-conditioners are unable to meet the air dehumidification challenge and require the conventional or state-of-the art technologies to remove the excess moisture from the processed air before its substantial cooling to the set temperatures.

In order to validate the performance of the M-cycle based air-conditioners in the humid zones and minimize the overall energy input for cooling and dehumidification processes, a comparative analysis of the latest desiccant dehumidifiers and ejector cooling systems was performed. The study is devoted to disclose the pros and cons of the existed schemes of the M-cycle based cooling systems for the habitant and technological conditions.

Alternatively, it was proposed the hybrid M-cycle/desiccant/ejector air-conditioner that may serve to be one of the most energy efficient cooling system for the humid climate conditions, where 85% of the world's air-cooling demand is located.

Keywords: desiccant, ejector, cooling, Maisotsenko cycle, dehumidification, humid climate, air-conditioning

453: Are batteries the PV energy self-consumption optimisation solution for homes?

Techno-economic comparison of battery and hot water tank storage technologies in the UK

DAVID PARRA[1,A], GAVIN S. WALKER[2], MARK GILLOTT[3]

[1] University of Nottingham, Energy Technologies Research Institute, Faculty of Engineering, University of Nottingham, University Park, Nottingham NG7 2RD, UK,
[2] University of Nottingham, Energy Technologies Research Institute, Faculty of Engineering, University of Nottingham, University Park, Nottingham NG7 2RD, UK, gavin.walker@nottingham.ac.uk
[3] University of Nottingham, Energy Technologies Research Institute, Faculty of Engineering, University of Nottingham, University Park, Nottingham NG7 2RD, UK, mark.gillott@nottingham.ac.uk
[A] Moved to University of Geneva and current email address is david.parra@unige.ch

Growing support to decarbonise energy systems together with increasing retail energy prices are converting self-generation into a more attractive energy supply option. At the consumption level, solar PV is the most widespread generation technology due to declining capital costs, modularity and easy maintenance. The intrinsic dependence of solar energy generation on weather patterns and conditions affects the performance, final supply to the local demand load (i.e. local self-consumption) and final revenue. Energy storage is an available technological option to increase the value of local PV generation by increasing the self-consumption of PV-generated electricity. Therefore, understanding the performance, cost, value and optimum energy storage technology for managing PV generation is key for current and new customers with rooftop PV installations. In this study, energy storage for single homes is optimised by quantifying the performance, levelised cost, levelised value and profitability of hot water tanks (supplying domestic hot water), lead-acid batteries and lithium-ion batteries (supplying electricity). Although the assumed storage medium cost for Li-ion batteries (350 £/kWh) was 2.5 times higher than that of PbA batteries (140 £/kWh), Li-ion technology's greater round trip efficiency and cycling capability resulted in lower levelised cost (0.37 £/kWh) and higher levelised value (0.15 £/kWh) than PbA technology. The best economic case was for hot water tanks with a size ranging between 100 l and 200 l which were able to achieve internal rate of return values higher than the assumed discount factor (4%), especially when the property already had a hot water tank and domestic hot water was previously met by using retail electricity.

Keywords: PV, battery, hot water tank, levelised cost, internal rate of return

456: The Need for UN Climate Change Policy Reformation

SHARAF ELDIN I. BANNAGA

Director, Physical Environental centre of Khartou, 471, Mamoun Behary St. (63rd street) Alamarat, PO Box 2256 Khartoum, Khartoum, SUDAN
Tel: +249 155145853, +249 155 662773 shbannaga@yahoo.com

This paper discusses the global warming, its causes and consequences. The paper assesses the impact of the polices adopted by the UN organizations including the Intergovernmental Panel on Climate Change (IPCC) to mitigate global warming, and the consequences following failure of the Kyoto Protocol to mitigate global warming. The key issues discussed here include the ineffectiveness of the UN climate change policies and the role of urbanization in greenhouse gases emissions mitigation. It is evident that the UN efforts to combat climate change through mitigation of global warming are ineffective due to many issues. These are summarised in the increasing causes of urbanization and development of "megacities" around the world, and particularly in the less developed nations due to the current global polices and the economic model which favour urbanization.

Keywords: Climate change, UN policies reform, Carbon dioxide, IPCC

460: Assessment methods for selecting organic absorbents of HFC refrigerant in absorption system

WENJIE GUAN[1], ZHANGZHANG YANG[2], HANRU YU[3], XIAOGANG QIAO[4], XIAOHONG HAN[5], GUANGMING GHEN[6]

[1, 2, 3, 5, 6] *Key Laboratory of Refrigeration and Cryogenic Technology of Zhejiang Province, Institute of Refrigeration and Cryogenics, Zhejiang University, Hangzhou, China*
[1] *21327109@zju.edu.cn*
[2] *yzhangzhang@126.com*
[3] *237781472@qq.com*
[4] *Zhejiang College of Construction, Hangzhou, China, 370936192@qq.com*
[5] *hanxh66@zju.edu.cn*
[6] *gmchen@zju.edu.cn*

Absorption refrigeration is one of the refrigeration methods which can make use of low quality heat sources. Some HFC refrigerants have been put forward in the absorption refrigeration systems for their good properties. R161 and R134a are both potential refrigerants. However, which absorbent is more suitable for them in the common absorbents, and how to evaluate the HFC working fluid pairs have not been clearly presented. On the basis of these, we need to obtain an assessment method for selecting organic absorbents of HFC refrigerant. In this work, R161 and R134a were selected as the refrigerants. DMEDEG/DMAC/NMP/DMF were selected as the absorbents of R161, and DMEDEG/MEGDME/DMETrEG/DMF were selected as the absorbents of R134a. Firstly, a single-grade absorption refrigeration cycle simulation was adopted, and the coefficient of performance (COP), the circulation ratio (f) and the power consumption of solution pump (Wp) of the systems with the investigated working pairs were evaluated. Secondly, three assessment criteria including bubble point pressure (p), excess Gibbs free energy (GE) and deflation ratio (dR) were estimated with NRTL model. By comparing the relationships between the criteria and system performance, it could be found that: 1) Bubble point pressure (p) influenced the pressure differential in system but had little relationship with system performance; 2) The GE influenced the system performance remarkably, and the working pair whose extreme value of excess Gibbs free energy (GEmax) within an appropriate range had the best thermal performance, and for R161 and R134a working pairs the range was -400 J/mol ~ -300 J/mol; 3) The bigger dR meant the better cycle performance, and when dR > 6%, the preferable performance could be achieved. Overall, the combined assessment method can preliminarily evaluate the performance of the organic absorbents of HFC refrigerant and help us to select suitable absorbent for the specified refrigerant in absorption system.

Keywords: absorption refrigeration system; working pair; HFC; assessment method.

467: A Novel Building Façade Integrated with TIM and PCM --- Numerical Study for Summer

XIN WANG[1, 2*], SAFFA RIFFAT[1], SUN XIAOYU[2], CHEN HONGXIA[1, 3]

1 Department of Architecture and Built Environment, University of Nottingham, Nottingham NG7 2RD, UK
2 Department of Building Science, Tsinghua University, Beijing 100084 China
3 Energy Power and Mechanical Engineering, North China Electric Power University, Beijing 102206 China
** Corresponding author: wangxinlj@tsinghua.edu.cn*

Transparent insulation material (TIM) not only is of similar function of opaque insulation but also can allow solar transmittance. Phase change material (PCM) can charge and discharge much heat during the phase change temperature range due to the high latent heat. A novel building façade is proposed by the combination of TIM and PCM and there are no moving parts or only a small fan in the structure. It could be used for residential and commercial buildings, providing heating and cooling for the living space as a sustainable low-carbon building. Fluent is adopted and a simple numerical model is set up to study the thermal performance of the novel structure. The fitted formula of overall transmission with solar incident angle is arrived. The numerical results for summer show that: (1) The average heat transfer rate of the exterior surface of the room wall increases with the increasing inlet velocity for the novel structure while decreases for the reference structure. (2) The ventilation heat transfer rate changes little with the increasing inlet velocity for the novel structure while increases for the reference structure. (3) When the inlet velocity is higher, the difference between the novel and reference structures is smaller. (4) The effect of Tm on the ventilation heat transfer rate is higher than that on the average heat transfer rate of the exterior surface of the room wall. (5) The suitable phase change temperature is 308-310K when the inlet velocity is 0.5 m/s and the corresponding total heat transfer rate can be decreased by 33.8% compared with that when Tm is 303-305K.

Keywords: TIM (transparent insulation material), PCM (phase change material),ventilation, building envelope, building energy

471: Dust Accumulation and PV Power Output in the Tropical Environment of Barbados

DARLENE A. FIELD[1], THOMAS ROGERS[1], ANDREA SEALY[2]

1 The University of the West Indies, Cave Hill Campus, St. Michael, Barbados
2 Caribbean Institute of Meteorology and Hydrology, Husbands, St. James, Barbados

Barbados has implemented attractive incentives geared towards increasing its renewable energy capacity to at least 29% of the total energy mix by 2029. Existing incentives include the removal of import duties for renewable energy systems and the introduction of net metering in the form of a renewable energy rider, effectively establishing compensation of up to US$0.16 per kWh for energy supplied to the grid. These changes, in addition to the rapid reduction in price of global solar photovoltaic (PV) modules – from US$4 per Wp in 2009 to under US$1 (Wp) at the end of 2014 – have resulted in a considerable increase in PV installations on the island. Grid-connected solar PV installed capacity has risen from zero in 2009 to over 7MWp by the end of 2014.

As installations continue to increase, there is a need to fully understand the effect of the Caribbean's unique environment on PV performance. Barbados, the easternmost island in the Caribbean, has a strong solar irradiance with 'cooling' winds, and is a good environment for PV utilisation. However, as dust concentrations in the atmosphere vary, so will their accumulation rates onto module surfaces and hence the irradiance received by the cells. Dust accumulation rates are increased by lower tilt angles and increased relative humidity. Rainfall and wind are considered good natural methods for cleaning module surfaces, however they are only effective during intense showers and high winds. In addition, the properties of the dust determine the rate of accumulation based on the ability of dust particles to stick to the module surface.

In this paper, we describe the effect of dust accumulation on four types of PV modules installed at three sites in Barbados – designated as urban, suburban and rural-coastal sites. Crystalline silicon modules were connected separately across resistors and the power output obtained at each site. The power output for April 2015 is described, including a period before and after cleaning.

Keywords: solar PV, module performance, dust accumulation, Caribbean

475: Investigating the energy performance and indoor environmental quality of a social housing building

AFRODITI SYNNEFA[1], ROSA FRANCESCA DE MASI[2], KONSTANTINA VASSILAKOPOULOU[1] , ELENA MASTRAPOSTOLI[1], THEONI KARLESSI[1], MAT SANTAMOURIS[1]

1 National and Kapodistrian University of Athens, Building of Physics - 5, University Campus, 157 84 Athens, Greece, Email: asynnefa@phys.uoa.gr
2 University of Naples Federico II Piazzale Tecchio, 80, 80125 Napoli, Italy

In the framework of the FP7 project HERB: Holistic energy-efficient retrofitting of residential buildings project a 7 story social housing apartment building located in Athens, Greece is being renovated following a holistic energy efficient retrofit process. The retrofit plan includes commercially available technologies like insulation and energy efficient windows, innovative technologies like energy efficient lighting and smart coatings as well as passive techniques like night ventilation, aiming to achieve a reduction in the energy consumption and CO2 emissions by 80% and significant improvement of thermal comfort conditions in the apartments. An experimental campaign is under execution in order to measure and validate the energy savings and indoor comfort conditions before and after the retrofit. In this paper the results of the monitoring prior to the retrofit are reported and analyzed. Measurements include air leakage and thermal imaging for determining leakage rate and heat loss through the fabric of a building, smart meters to record energy consumption and indoor and outdoor environmental measurements (temperature, humidity, light levels, ventilation rate, ambient air temperature and solar radiation levels). Measurement results will be combined with the results of the holistic analysis that has been carried out using dynamic energy modeling in order to determine the optimum retrofit plan

Keywords: energy efficiency, retrofitting, energy monitoring, building envelope, indoor environmental quality

476: Integrated Smart Indoor – Outdoor Web based Energy Management System for University Campuses

KOSTAS GOMBAKIS[1], CHRISTINA GEORGATOU[1],
DIONYSIA KOLOKOTSA[1], SOTIRIS PAPANTONIOU[1],
NIKOLAOS KAMPELIS[1], KOSTANTINOS KALAITZAKIS[2]
MATTHEOS SANTAMOURIS[3], KONSTANTINA VASILAKOPOULOU[3]

[1] Technical University of Crete, School of Environmental Engineering, Crete, Greece
[2] Technical University of Crete, School of Electronic and computer engineering, Crete, Greece
[3] National Kapodistrian University of Athens, Physics Department, Athens, Greece

University campuses can be considered as small towns due to their size, number of users and mixed and complex activities, including numerous actions usually met in urban environments. In the framework of Camp IT project, existing Information & Communication Technology (ICT) is exploited in order to create a micro-grid by integrating sensors, actuators, control algorithms etc, aiming at minimizing energy consumption of buildings and activities within Campuses. The single building is considered part of a "district" approach, where real time interaction of indoor and outdoor spaces is monitored and controlled. The overall aim of the project is to contribute to a future smart grid community by the deploying and testing of a decision support tool and optimization method for a web based energy management system in real time conditions, taking into account indoor / outdoor environmental parameters and user preferences.

The aim of the present paper is to analyze the methodology that has been followed, including techniques of building modelling incorporating outdoor spaces, the use of neural networks for the prediction of environmental parameters and energy load as well as the development of control algorithms, in order to create new frontiers for research and development in energy management of university campuses.

Keywords: University campus, energy management, energy savings, control algorithms, user comfort

480: Potential of Biogas Recovery from Landfills for Sustainable Energy Production:

A Case Study from Jordan

HANI QDAIS

hqdais@just.edu.jo Jordan University of Science & Technology, Jordan

Landfills continue to be part of any municipal solid waste management system. Despite several improvements that took place in landfilling technology, the disposal of solid waste in landfills still imposing adverse environmental impacts. One major impact is the emission of greenhouse gases like methane which has high global worming potential as compared to carbon dioxide. To minimize the adverse impact of the emitted methane, it is possible to collect the generated methane and utilize it for energy production. This paper is investigating the possibility of collecting the biogas from Al Hosaineyat landfill in northern Jordan for possible energy recovery. Solid waste quantities and composition were evaluated. Daily amount of solid waste disposed at the landfill is about 74 tons with more than 60% of it organic matter.

The amount of methane generated from the landfill was estimated using GASSIM simulation software. It was found that currently (in 2015) the annual methane production is about 2 million M3 /day, while by the peak biogas generation will be one year after the landfill closure (in 2021) and amounting to 2.47 million M3 /day. The annual energetic potential of the landfill was found to be 6.14 GWh and 7.59 GWh in the years 2015 and 2021, respectively.

Keywords: Landfill gas, Energy Recovery, Jordan, Solid Waste, Biogas modelling

483: Maintainability:

A Best-Practice Approach to Building Design

OWAJIONYI L. FRANK[1] AND SADDIQ OMAR[2]

[1] Department of Architecture, Rivers State University of Science and Technology, Port Harcourt, Nigeria
[2] Department of Architecture and Built Environment, University of Nottingham, United Kingdom

The development of varying unconventional low carbon and low energy technologies to meet current demands for sustainable solutions and to make our 'buildings feel good' call for good consideration to the maintenance of these buildings and the fitted technologies from design inception. It is more so when we realise that building elements, components and materials are also exposed to the fast changing environmental vagaries which cause wear and tear and ageing. Maintainability is a design characteristic which incorporates function, accessibility, reliability, and ease of servicing and repairs into all active and passive system components, that maximizes costs and benefits of expected life-cycle value of a facility". This paper therefore looks at maintainability design approach as a best-practice approach to low carbon, green and sustainable building designs. It draws data from a research conducted by the authors to explore a best practice approach to operability and maintainability of low carbon buildings in the UK. A mixed method research approach involving across-method and within-method triangulation (interviews, surveys and case studies) were adopted. The study concluded that building designers need to prove the maintainability and operability of their designs before they are constructed, and in so doing will give due attention to how the facilities would be maintained, when they are designing.

Keywords: architects, building design, life cycle, operability and maintainability, sustainable maintenance.

484: Forecast based optimization of distributed energy system control for campus buildings

YAN DING[1], SPENCER DUTTON[2,※], WEI FENG[2], CHRIS MARNAY[2]

1 School of Environmental Science and Engineering, Key Laboratory of Efficient Utilization of Low and Medium Grade Energy, MOE, Tianjin University, Tianjin 300072, E-mail: dingyan@tju.edu.cn
2 Environmental Energy Technologies Division, Lawrence Berkeley National Laboratory, 1 Cyclotron Road, Berkeley, CA 94720, USA, E-mail: smdutton@lbl.gov (Corresponding Author※)

Distributed energy generation, with absorption cooling, and advanced control strategies based on weather forecasts, offer the potential to reduce the carbon emissions associated electricity production by lowering transmission losses and delivering energy where and when it's needed. Recent trends in energy policy throughout the world indicate that distributed energy resources will become increasingly commonplace. However, these gains are contingent on levied energy cost tariffs. In the North China, cheap coal and electricity, and relatively expensive natural gas currently provide a disincentive to invest in distributed combined heat and power (CHP) systems. Using a calibrated energy model of a Tianjin University building, we assessed the economic viability of using CHP and adsorption cooling, under a range of real and hypothetical energy tariffs. Cost optimization was performed using LBNL's Distributed Energy Resources Customer Adoption Model (DER-CAM) platform. Assuming the application of a favorable tariff structure, energy cost and carbon emission savings were assessed for several technology packages that combing the aforementioned technologies. Daily week-ahead scheduling based on weather forecasts, loads, and tariffs, were used by the DER-CAM optimization tool to generate system operation scheduling, projected energy use and carbon emissions. Under the current university energy tariff, CHP was found to not be economically viable, with the optimization platform recommending the use of conventional AC systems. Under alternative energy tariffs intended to support CHP use, the introduction of combination of CHP and adsorption chiller was found to significantly reduce energy related carbon emissions. Operational energy use savings in summer were achieved by daytime use of the absorption chiller utilizing waste heat from the CHP, winter savings were from the CHP meeting both electric and heating loads.

Keywords: *distributed energy generation system, natural gas tariff, combined heat and power, china energy, software-as-a-service, microgrid.*

485: Economic and Environmental Analyses of a BIPV-PCM-slurry Based Energy System

ZHONGZHU QIU [1, 2,*], XUDONG ZHAO[1], XIAOLI MA[1], PENG LI[3]

1 School of Engineering, University of Hull, Cottingham Road, Hull, UK, Xudong@hull.ac.uk
2School of Energy and Mechanical Engineering, Shanghai University of Electric Power, Shanghai, China, Z.qiu@hull.ac.uk
3School of Mechanical Engineering, Tongji University, Shanghai, China, lipeng99@tongji.edu.cn

In this paper, the economic & environmental benefits of the new BIPV-PCM-slurry energy system for use in European buildings were investigated. This involved (1) analyses of the capital and operational cost of the BIPV-PCM-slurry energy system; (2) calculation of increase in the capital cost and saving in operational cost of the system relative to the conventional BIPV, PV/water and conventional heat & power systems; and (3) estimation of the payback period and life cycle cost saving of the system relative to the conventional ones. Furthermore, the carbon emission reduction potential of the system for the use as a replacement of the conventional heat and power systems, BIPV or BIPV/water systems across the European regions was analysed.

It is concluded that the BIPV-PCM-slurry energy system is more suitable for use in the southern Europe region than in the northern Europe region. The economic benefits of the BIPV-PCM-slurry, BIPV/water and BIPV are highly dependent upon its application area and local climatic condition. Among the three comparable systems, BIPV-PCM-slurry type presented the greatest potential in obtaining the quickest economic return in investment.

The environmental benefits of the three systems are also climatic dependant, having more favourite outcome in Southern Europe than in Northern Europe. Again, the BIPV-PCM-slurry system presents the greatest potential in cutting the carbon emission to the environment, over the other two comparable systems.

Keywords: MPCM suspension, solar PV/T module, energy system, economic analyses, environment benefits

486: Research on the Compressor Test Rig for Refrigerant Drop-in Experiment

GILBONG LEE, JOO-SANG KIM, JUNHYUN CHO,
HO-SANG RA AND YOUNG-SOO LEE

Thermal Energy Conversion Laboratory, Korea Institute of Energy Research, 152, Gajeong-ro, Yuseong-gu, Daejeon, Korea

This study is on the compressor test rig for refrigerant change test. Increasing the production temperature is one of the main research topics of heat pump and for that compressor plays the key role. To ensure the reliability of compressor, both analytic and experimental approaches would be used. This study takes the experimental approach to check the reliability. Steam generation is the target operation condition. R245fa is selected as working fluid since it has good characteristics under the temperature range for steam generation. For effective experiments test rig based on bypass cycle is constructed. Long term experiment on refrigerant change is under operation. Change of lubricant will be scheduled later.

Keywords: Compressor, Heat pump, Steam Generation

487: Development of energy monitoring center for demonstrative research of energy network of KIER

HO-SANG RA, GILBONG LEE, SUN IK NA,
JUNHYUN CHO AND YOUNG-SOO LEE

Thermal Energy Conversion Laboratory, Korea Institute of Energy Research, 152, Gajeong-ro, Yuseong-gu, Daejeon, Korea

The energy network technology is needed to maximize energy efficiency through optimal matching of demand with supply and utilization of unused energy. It is expected to maximize the energy availability and minimize the exergy loss. Demonstrative researches have been considered for the headquarter of KIER (Korea Institute of Energy Research). As the first stage of energy network research, an integrated energy monitoring center is developed. KIER uses various types of energies and it also has its own coal-fired power plant. Most of the energy-related facilities and devices are made without consideration of information exchange. Common protocol is selected and devices are connected on the internal network. A web-based monitoring system is developed and data base structure is composed to make web-based EMS possible. This information infra will be beneficial for further demonstrative researches.

Keywords: Energy center, protocol, network, web-based EMS

488: Research on the development of a small-scale supercritical carbon dioxide power cycle experimental loop with a high-speed turbo-generator

JUNHYUN CHO, HO-SANG RA, GILBONG LEE,
HYUNGKI SHIN, YOUNG-JIN BAIK

Thermal Energy Conversion Laboratory, Korea Institute of Energy Research, 152, Gajeong-ro, Yuseong-gu, Daejeon, Korea

A supercritical carbon dioxide power cycle which is known as one of promising power cycle for a concentrating solar power (CSP) has technical challenges of operation near critical point and under high pressure/temperature conditions, and challenges of turbomachinary and bearing technology. Therefore, a small-scale simple supercritical carbon dioxide power cycle experimental loop was designed and manufactured to obtain diverse basic data of operational characteristics, control and stability of this power cycle, and to utilize these data for following scale-up research. As the first step, 1 kWe-class high speed turbo-generator and experimental loop for a 200 oC of supercritical carbon dioxide were designed and manufactured. A carbon dioxide is pressurized up to 130 bar by piston-type pump and heated up by an immersion electric heater, then drive a turbo-generator. A diameter of turbine wheel and rotational speed was designed to 22.6 mm and 200,000 rpm respectively. A commercial angular contact ball bearing was applied to the turbo-generator

Keywords: Supercritical Carbon Dioxide Power Cycle, Turbo-generator

494: Thermodynamic efficiency of IGCC plant with overheated cycle air and two-stage gasification

DENIS SVISHCHEV[1], ALEXANDRE KEIKO[2], IGOR DONSKOY[3], ALEXANDER KOZLOV[4], VITALY SHAMANSKY[5], ALEXANDER RYZHKOV[6]

[1] Melentiev Energy Systems Institute (ESI) SB RAS Lermontov Street 130, Irkutsk 664033, Russian Federation, denis.svishchev@gmail.com
[2] Melentiev Energy Systems Institute (ESI) SB RAS Lermontov Street 130, Irkutsk 664033, Russian Federation paragraph1@yandex.ru
[3] Melentiev Energy Systems Institute (ESI) SB RAS Lermontov Street 130, Irkutsk 664033, Russian Federation donskoy.chem@mail.ru
[4] Melentiev Energy Systems Institute (ESI) SB RAS Lermontov Street 130, Irkutsk 664033, Russian Federation kozlov@isem.sei.irk.ru
[5] Melentiev Energy Systems Institute (ESI) SB RAS Lermontov Street 130, Irkutsk 664033, Russian Federation vita@isem.sei.irk.ru
[6] Ural Federal University (UrFU), 19 Mir Street, Yekaterinburg 620002, Russian Federation af.ryzhkov@mail.ru

The goals to enhance the efficiency and environmental friendliness of power plants burning fossil coal explain the interests in the technologies of gasification in the combined cycle (IGCC). The research is dedicated to a promising IGCC process flow diagram which suggests an intermediate overheating of the cycle air coming to the combustion chamber of the combined cycle plant. After air processor the air goes to the boiler where it is heated to the temperature of 1000˚ C. Compared to the classical IGCC plants, the air overheating makes it possible to reduce the capacity of gasifier and gas cleaning system. The plant flow diagram also includes a two-stage MHI gasifier. The gasifier is fed by overheated cycle air, steam and oxygen from the air separation unit. In the research the operating conditions of gasifier and the whole plant are studied. The efficiency of electricity generation without considering auxiliaries reaches 53-54.4%. The hot gas cleaning and oxygen steam gasification is optimal.

Keywords: IGCC, staged gasifier, cycle air heating, oxygen-rich air, equilibrium modelling

495: The Role of Community-based Energy Management Schemes in Supporting Resilience

TRAVIS O'DOHERTY[1]*, LUCELIA RODRIGUES[2], MARK GILLOTT[3]

[1,2,3] *University of Nottingham, Department of Architecture and Built Environment, Faculty of Engineering, University of Nottingham, United Kingdom, University Park, NG7 2RD,*
[1] *Travis.O'doherty@nottingham.ac.uk*
[2] *Lucelia.Rodrigues@nottingham.ac.uk*
[3] *Mark.Gillott@nttingham.ac.uk*

The world's first energy suppliers were all community-based schemes, in its simplest form a group of people managing a water wheel on a nearby river. The community produced, managed and used its own energy. Eventually, energy production was privatised and today in the UK there are only six large energy suppliers controlling 95% of the market. Energy production and management have become centralised and consumers have become disengaged with the process. This has not only several infrastructure implications but also impacts greatly on people's behaviour and, consequently, energy use.

Localised or distributed energy ownership, common in many European countries but rare in the UK mostly due to existing policy framework, could be of great advantage for society. From a grid perspective, it could lead to a reduction of voltage fluctuations, increased power and improved stability. From a customer perspective, it could help improve energy security, increase power quality, reduce costs and fuel poverty. In addition, from a community perspective, it could give consumer behaviour a role in driving system efficiency and help develop social networks.

The definition of community resilience involves change and adaptation in response to key interventions and the management of local capacities. Some of these interventions are easily quantifiable, such as changes to infrastructure, whereas others, like social change, can only be recognised over time. In this work, the authors explored how the resilience of communities (infrastructure and social) can be affected by distributed energy ownership, greater use of renewable energy, better energy efficiency and improved community resilience. The conclusions are focused on suggestions for the development of a case study in a deprived residential neighbourhood in Nottingham. This neighbourhood is currently the focus of a regeneration scheme, which seeks to reduce the environmental impact of the area and redevelop its reputation.

Keywords: Social Resilience, Community Resilience, Energy Management, Behavioural Change

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