WSSET
World Society of Sustainable Energy Technologies

NEWSLETTER

Volume 9, Issue 4, September 2017

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Important Dates

10th February 2018
SET 2018 – deadline for abstracts submission

31st March 2018
Deadline for entries to 3rd WSSET Innovation Awards 2018

2nd WSSET Innovation Awards 2017 - WINNERS

WSSET Innovation Awards 2017 have been awarded to the following:

Fatang Jiang – *Sustainable Materials*
Jose Miguel Corberan Salvador – *Energy Efficiency (Heat Pump)*
Ray Luke – *Low Carbon Buildings & Future Cities*
Chi-Hwa Wang – *Waste Management & Water Recycling*
Srinivas Reddy – *Water Treatment & Desalination*
Li Zhao – *Power Generation Technologies*
Xudong Zhao – *Renewable Energy Systems*
Ben Hughes – *Low Carbon Buildings & Future Cities*
Yanjun Dai – *Energy Efficiency (Heat Pump)*

....awarding of plaque and certificate to the winners – at the Gala Dinner – SET 2017!

230 delegates from over 30 different countries attended the SET 2017 conference in the beautiful city of Bologna

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SET 2018

21-23 August 2018 - Wuhan, China

The next International Conference on Sustainable Energy Technologies – SET 2018 – will be held in Wuhan, 21-23 August 2018. The conference venue will be the convention centre which is close to 4/5 star hotels, malls, restaurants and bars. Wuhan's economic strength is ranked 9th among all Chinese cities. Some of the places to visit are Yellow Crane Tower, East Lake and Hubei Provincial Museum. We are planning to take a river cruise on the Wuhan Yangtze River.

Wuhan is close to Shanghai. You will have the opportunity to see this vibrant city and also visit several interesting places such as The Bund, Shanghai Tower (world's second tallest building), Yu Garden, Shanghai Museum, Shanghai Circus and Jade Buddha Temple.

The deadline for abstract submissions is 10th February 2018.
All WSSET members will receive a 20% discount on the conference registration fees.

Selected papers will be published in several international journals. You could also submit your research projects to the 3rd WSSET innovation Awards (please see www.wsset.org).
The awards will be announced at the SET2018 Conference.

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A decentralized bio-and-thermal hybrid system for waste conversion to energy and resources in megacities

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In megacities, municipal solid wastes (MSW) including food wastes, sewage wastes, paper, leaves, plant trimmings and etc. are generated in huge quantities. Typically, MSW is incinerated at a centralized facility, and incineration is often associated with environmental concerns such as emission of toxic and greenhouse gases. With improved living conditions and increase in environmental awareness, a more advanced, green and sustainable means of waste disposal and treatment is desired.

Here, we propose a biological and thermal hybrid system for delocalized and decentralized recovery of energy and resources from wastes (Figure 1). This system includes not only the core technology for waste treatment/conversion, i.e. anaerobic digestion (AD) and gasification, but also covers waste sorting and heat recovery technologies. An agent-based behaviour system model on waste sorting utilization and system planning has been developed, integrated with environment, economy, energy, transport, public health and social affairs. In addition, waste heat in the system can be recovered in the form of low grade thermal energy to drive cooling and dehumidification systems, suitable for cities with hot and humid climate. (Figure 2).

The core technology – the coupling and integration of AD and gasification – offers several benefits in the treatment of biomass waste. After the AD process of typical biomass wastes, further treatment of the AD residue is usually in need, of which gasification has shown its advantage in high treating capacity, large volume decrease and generation of gas fuel and in-house heat. Integration of AD and gasification has the added advantage that the heat generated during the gasification process can be recycled for the drying process of the wet AD residue, which can help enhance the overall efficiency of the hybrid system. Additionally, besides producing biogas and syngas as additional energy source, the solid residues at the end can also be used as valuable resources in other applications such as ash (extracting its useful metals) in catalysis, biochar in soil and water remediation, and etc.

It is estimated that with this decentralized waste-to-energy & resources system, it will reduce the overall cost of waste transportation by 70%, and reduce the decentralized cooling and dehumidification by about 10-30%. Furthermore, with decreasing size of equipment, it minimizes the consumption of auxiliary fuel and lowers emissions of heavy metals in flue gases and fly ashes. In view of all the above benefits, we think that this is a very promising solution for both dry and wet biomass waste treatment, and we are currently in the test bedding stage with reactors of different scales (Figure 2).

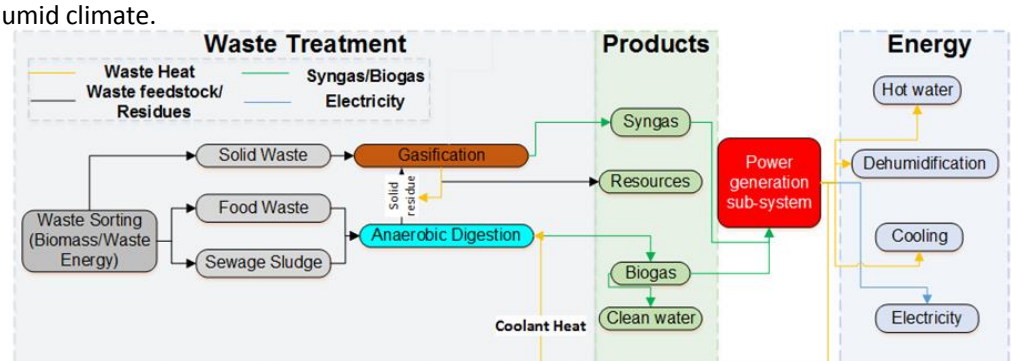

Figure 1: Schematic diagram for the decentralized bio-and-thermal hybrid waste management system.

Test bedding videos available: http://cheed.nus.edu.sg/stf/chewch/group2014/index.htm *(Gasification Technology> Integrated waste- to-energy system> Test bedding videos)*

Figure 2: Pictures for test bedding equipment of different scales.

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A novel PV/T space heating and hot water supply system

Professor Xudong Zhao
University of Hull, UK

Solar PV/T heat pump systems are recently applied to deliver space heating for buildings. At present, such a system, however, has very high initial and running costs, owing to the continuous operation of the heat pump and large PV area employed.

To overcome this disadvantage, this invention developed a hybrid PV/T heat pump space heating and hot water supply system which, comprising of large number of micro-channel thermal panels and small number of PV/T panels that are connected in a hybrid series/parallel manner, and a stand-by heat pump that operates 2-3 hours a day, is 20% lower in the initial cost, and 30% higher in the solar efficiency compared to existing equivalent systems. This system can deliver near-to-zero-bill space heating and hot water supply for the rural houses in Northern China, and can be extended to other parts of the world. The diagrams of the system are as shown in Fig.1 and Fig.2. This technology, through around 3-years' development and 4 major revolutionary up-grading, has become a mature commercial product that are currently protected by a registered patent (CN 201610090634.X).

Figure 1: The on-site PV/T space heating and hot water supply system in Lvliang city

The major features and innovations of the system lie in: (1) Micro-channel tubes can be perfectly bound to the PV cells, while their interior spaces are smaller than the existing flat-plate panels, thus creating a higher flow velocity, higher heat transfer rate and enhanced solar efficiencies; (2) Hybrid series/parallel connection can increase the solar thermal efficiency and overall efficiency of the system; (3) Thermal and PV/T panels are mixed up to minimize the use of PV modules and overall capital costs of the whole system; (4)Heat pump is placed to idle position during most time of a day, which can significantly reduce electrical demand of the whole system. The combination of the above innovations has resulted in the increased solar efficiency and decreased cost of the system, as well as near-to-zero-bill space heating and hot water supply operation.

With the rapid economic growth, massive building projects are currently in place in China, resulting in huge energy demand for space heating, hot water and power supply to these buildings. In line with the fact, the potential market growth for solar thermal, PV and PV/T system in China is huge.

Deployment of the technology will help (1) accelerating the economic development and welfare growth of China; (2) promoting China's sustainable development and mitigating its environmental pollution by reducing the fossil fuel consumption and carbon/dust emissions and increasing the use of renewable solar energy in buildings; and (3) helping reduce the poverty in China and enhance the living and health standards of Chinese people.

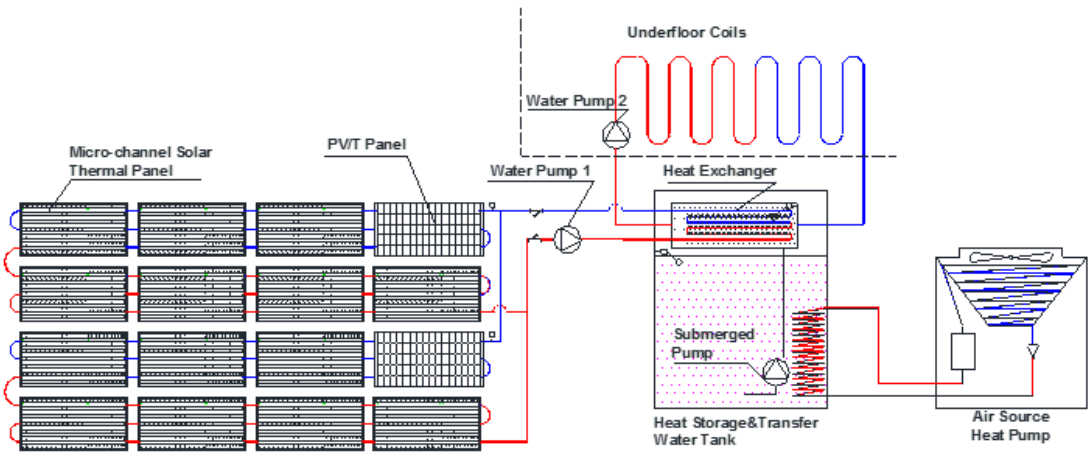

Figure 2: Schematic diagram of the system

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Eco-aerogel materials for heat, sound insulation and air filtration

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Aerogel is a synthetic porous ultralight material derived from a gel, in which the liquid component of the gel has been replaced by gas, result in forming a solid with extremely low density, large surface area and high mechanical strength. Aerogels are widely used in insulation, catalysis, adsorption, etc. Currently, most aerogel materials are prepared from inorganic or petrochemical-based feedstocks, such as silica aerogels and resorcinol-formaldehyde aerogels. However, these aerogels degrade with difficulty in nature and can cause harm to the environment. Therefore, alternative polysaccharide-based aerogels that are new, green and sustainable have attracted a lot of interest from researchers.

Aerogels are usually prepared by sol-gel process and drying under supercritical fluid (SCF) extraction conditions. In recent years, freeze-drying has been proved to be an ideal method to substitute traditional supercritical drying for its safety and minimal effect on both product and environment, for example, this method was used in the preparation of polymer/clay materials process from aqueous mixtures. The freeze-drying method can be also applied to the preparation of the polysaccharide aerogels, leading to porous aerogel structure with the required performance.

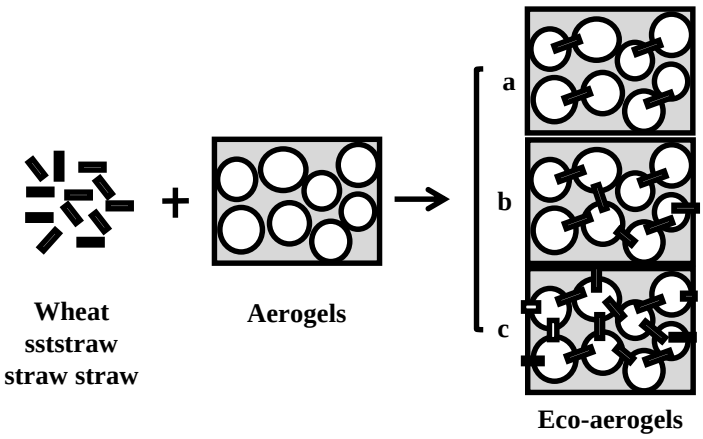

Figure 1: Composite sketch of wheat straw and aerogels

In our work, biodegradable eco-aerogels were prepared from natural, sustainable and renewable polysaccharides, i.e., konjac glucanmannan (KGM), gelatin, starch and wheat straw, using low environment impact free-drying method. It is a novel approach to employ KGM as a skeleton micro-pore structure, and to use starch, or other biomasses to enhance the mechanical performance of the aerogel. For the preparation, the freeze-drying technology is easy to operate and more environmentally friendly, and can achieve industrial continuous production. The pore structure and pore size distribution of the aerogels can be controlled by regulating the growth of ice crystals in freeze-drying process. Eco-aerogels are expected to have good insulation performance due to high porosity and uniform distribution of micro-pore size.

To the best of our knowledge, there have been very limited studies on polysaccharide aerogels as insulation and filtration materials. Therefore, we have carried out investigations on eco-aerogels prepared from modified KGM and starch to be hydrophobic for insulation (heat and sound) and filtration application. The composite aerogels were obtained via sol-gel process and freeze-drying. The microstructure, mechanical properties, thermal conductivity, thermal resistance and thermal diffusivity of composite aerogels were also investigated. The results indicated that starch-enhanced KGM aerogel has shown a very good thermal and sound insulation performance, along with a good air filtration properties, so the eco-aerogels could be the great candidates for sustainable insulation and filtration materials.

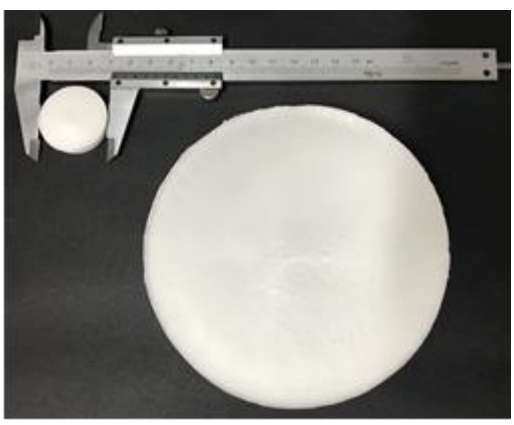

Figure 2: Photo of eco-aerogels

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A novel solar assisted heat pump desalination unit for drinkable water

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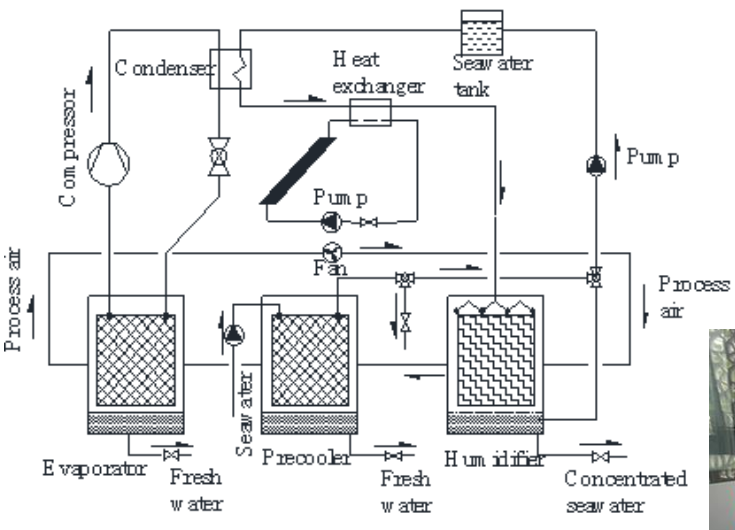
With the development of the society and the continued increase of the world population, seawater desalination technology has become an effective method to alleviate the pressure of fresh water supply due to people on the increasing demand for fresh water and the global fresh water storage quantity decreasing. For the solar desalination system, the system performance will be highly influenced by the solar irradiation. Furthermore, there is a shortage in the utilization of the heat and mass for the heat pump desalination system which leads to a low energy efficiency. Meanwhile, the structure of above setup of heat pump desalination system is also not compact.

In this study, a novel desalination system with compact-sized was designed and the experimental setup was built to test the system performance, as shown in Figure 1.



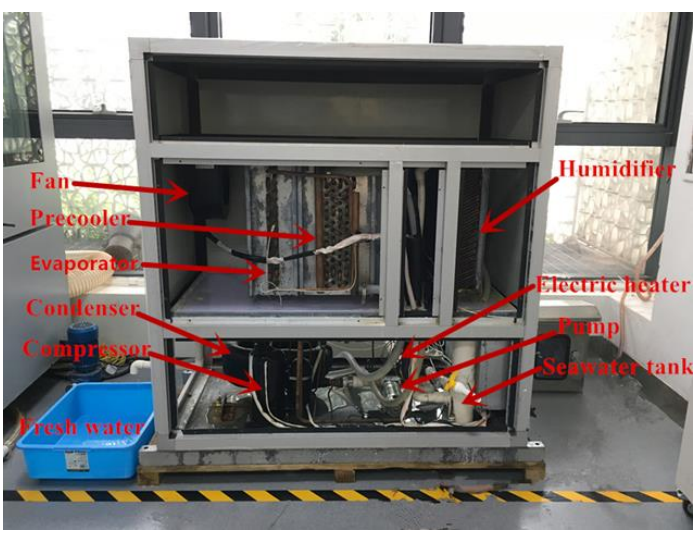


Figure 1: Schematic diagram and experimental setup photograph

The unit consists of four main loops: a heat pump loop that provides a heat and cold source respectively, a hot seawater loop that can produce hot seawater by the heat pump condenser and solar collector, a cooling seawater loop with the function of providing cold seawater for precooler and supplying seawater for the hot seawater loop, a process air loop.

In the hot seawater loop, generated hot seawater is uniformly sprayed to form the falling film at the surface of the humidifier. In the process air loop, within the humidifier, the process air will become hot and humid because of heat and mass transfer between seawater and process air, and then pass through the precooler. Part of the water vapor is condensed into fresh water. After precooling, the resulted process air pass through the heat pump evaporator where water vapor condenses and turns into fresh water again. Finally, the process air out of the heat pump evaporator will be refeed to the humidifier. In the cooling seawater loop, the cold seawater is fed to the precooler to condense the process air coming from the humidifier. The latent heat of condensation is utilized to preheat the feed cold seawater. A part of the preheated seawater is applied to supply seawater to the seawater tank.

It is shown that the maximum productivity and yield of the unit are 12.38kg/(kW·h) and 12.75kg/h respectively when the cooling seawater and process air flow rate is 0.3m^3/h and 450m^3/h.

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Innovative passive ventilation system FREECOOL

Dr Ben Hughes
University of Sheffield, UK

Dr Ben Hughes and his team, from the University of Sheffield, are the winners of the Low Carbon Buildings and Future Cities category of the 2nd WSSET Innovation Awards for their innovative passive ventilation system FREECOOL.

FREECOOL is a passive ventilation system integrated with low-energy cooling technology, designed to radically reduce the energy demand of mechanical air-conditioning systems, which can account for more than 60% of building demand in hot climates during the cooling season by lowering the supply air temperature. Wind towers are a passive ventilation system that have been used for centuries in the Middle East and through modern development, been utilised more recently in other parts of the world. FREECOOL ventilates a building above the recommended ventilation rates of 10l/s/person, regardless of wind velocity and direction. FREECOOL minimises the use of mechanical systems in buildings by lowering the inlet air temperature by 12-15°C, reducing the demand placed on mechanical systems up to 40%.

Development of FREECOOL has been funded from TRL 1-4 by QNRF and from TRL 4-8 by EPSRC IAA. Following the successful award of an Innovate UK 4th Round Energy Catalyst grant, a full scale pilot study of FREECOOL will be undertaken at the Shaikh Khalifa School, Abu Dhabi, in partnership with the Advanced Manufacturing Research Centre (AMRC) at the University of Sheffield, to create the first passively ventilated and cooled school campus in the UAE. Twenty four passive cooling units will be installed at the school campus and used continuously to provide passive cooling to the school building, thereby mitigating the demand placed on mechanical HVAC systems and reducing the energy costs.

FREECOOL uses heat pipe heat recovery technology integrated into the wind tower to provide cooling. Heat pipes are sealed tubes partially filled with a fluid used to transfer heat between fluid streams at different temperatures. This is a passive process as no energy input is required to transfer heat. Using advanced Computational Fluid Dynamics (CFD), an optimised design and arrangement of the heat pipes has been configured. This configuration has been validated using field testing, showing that adequate ventilation rates are achieved by the FREECOOL system, as compared to a wind tower without cooling technology integration. This is the first passive cooling system to achieve this.

FREECOOL provides a number of advantages over existing ventilation systems, both mechanical and passive. As a passive system, with no additional energy input for ventilation required, FREECOOL has significant advantages over mechanical HVAC systems. Reduced energy demand is a cost benefit to building operators and managers as lower costs are required for operation. Further to this, energy reduction leads to reduced CO_2 and other greenhouse gas emissions to the atmosphere. A further benefit of passive ventilation provided by FREECOOL is the improved indoor air quality stemming from the supply of outdoor air compared to recirculated air by mechanical HVAC systems.

A number of other passive ventilation systems are currently available that provide the same advantages and benefits that FREECOOL provides. The differentiator between these passive ventilation systems and FREECOOL, is the ability to cool the incoming supply air due to the integration of heat pipe system with the wind tower unit. No other closed-loop passive ventilation system is currently able to regulate air temperature, and no mechanical system is able to do so with as little energy input. The innovation shown in this design has been proved following the granting of a number of patents, publications and funding relating to this work. The WSSET Innovation Awards will help to build the profile of FREECOOL as a system for passive ventilation and cooling, along with the research team developing this technology.

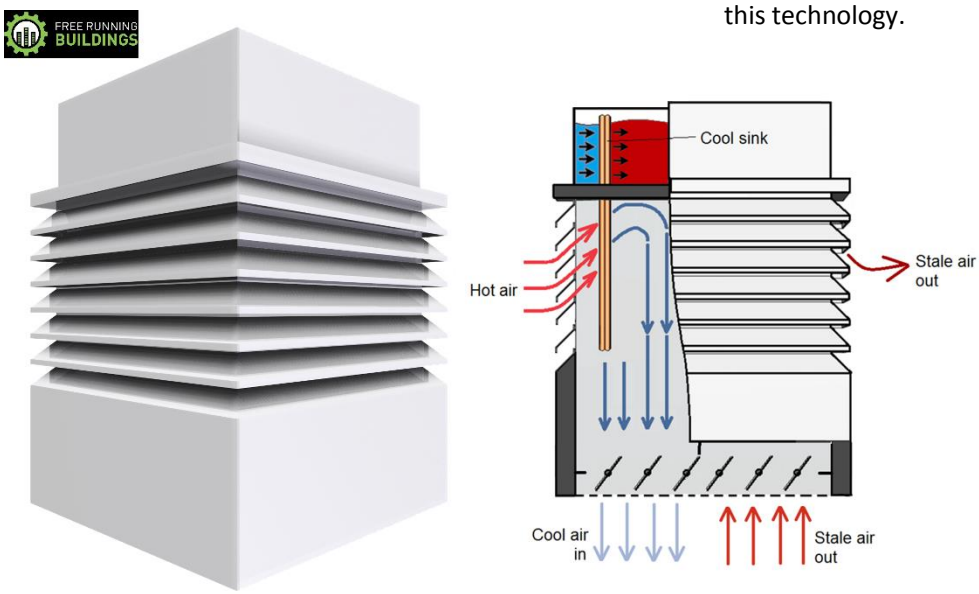

Figure 1: Schematic of FREECOOL system

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Heat pump booster for high temperature water production from waste heat recovery

José Miguel Corberán Salvador

Decarbonization, renewable energies and efficient technologies are the focus of Europe for the next years. In this frame, any source at higher temperature than the ambient could be a valuable heat source. Sewage water - in domestic sector- or water from condensing loops in refrigerating installations - within the industrial sector- are two heat sources usually wasted to the ambient. Heat pumps are a mature technology able to recover this heat in order to warm up another source up to useful levels.

Current trends in the energy production market towards a more sustainable and efficient sector require the independence between the energy demand and the energy production. A short-term solution is the system composed by heat pumps and water storage tanks. Figure 1 shows an example of the proposed system for residential cases. The system is based on a heat exchanger to firstly recover heat from low-grade temperature sources, a water-to-water high efficient heat pump, a storage tank and the respective installations.

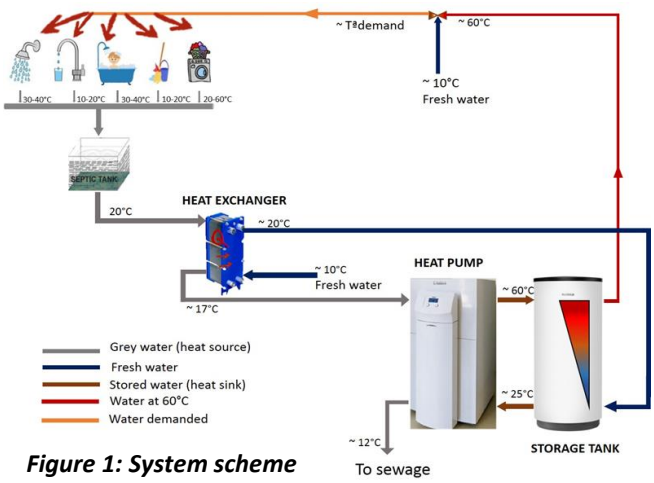

Figure 1: System scheme

The heat pump booster employs a hydrocarbon as refrigerant (propane) which has a minimum Global Warming Potential. In addition, this natural refrigerant is able to operate with large temperature lifts maintaining the maximum temperature of the cycle (compressor discharge temperature) much lower than current refrigerants (HFCs) increasing the life and reliability of the heat pump components.

The developed heat pump is able to operate with higher efficiencies (COPs) than the best technology currently available in the market (COPs greater than 5) thanks to the following:
(a) The refrigerant cycle modification allowing the system to operate with a high degree of subcooling (optimal) function of the operating conditions. The application of the optimal subcooling improves the efficiency up to 30% compared to a system with null subcooling for high water temperature lifts.
(b) The development of an optimal control strategy by means of a throttling valve able to adapt to the optimal operation at any external condition following a fast and reliable control.
(c) Another important point is that no special component has been used in this heat pump. Instead, it only requires the addition of a throttling valve and a liquid receiver placed at the outlet of the condenser in order to allocate the charge of the refrigerant in the system. Thus, the innovation is cost-competitive compared to other existing alternatives in the market that operate with cycles that are more complex.
Figure 2 shows the innovative heat pump prototype.

Figure 2: Heat pump prototype

The combination of the described HP booster with a recovery heat exchanger and a storage tank has led to a recovery system able to reach efficiencies much greater than the required in order to be considered as renewable technology according to the European Directive 2009/28/CE. Hence, making this a potential alternative to conventional hot water production technologies.

The applications are very wide: from the residential sector to produce domestic hot water, to the industrial sector (for any process that requires hot water until 90°C). For instance, hotels, gyms, supermarkets, hospitals and industries with high refrigeration demand.

Just as an example, for a single dwelling assuming a SHW demand at 60°C of 122.4 liter/day/house, a grey water temperature at 20°C, a tap water at 10°C, a recovery heat exchanger of 1.3kW, a heat pump with a heating capacity of 5.5 kW, and a COP of the system of 6.4, based on measured performance, the payback period is only 3.1 years with annual savings up to 850€ compared to a gas boiler production for a cost ratio of 3.7 (electric price/gas in Spain).

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Experimental investigations of polymer hollow fibre integrated evaporative cooling system with the fibre bundles in a spindle shape

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Guangzhou 510640, China

A novel hollow fibre integrated evaporative cooling system, in which the hollow fibre module constitutes as the humidifier and evaporative cooler, is proposed in this paper. In order to avoid the flow channelling or shielding of adjacent fibres, the fibres inside each bundle were made into a loose state to allow maximum contact between the air stream and the fibre. The experimental obtained cooling effectiveness, pressure drop and specific water consumption with respect to various incoming air velocity were reported. The variations of heat and mass transfer coefficients with respect to Reynolds number under three different testing conditions are discussed. The main conclusions in this research are:

1. With inlet air temperature of 28◦C and RH of 27%, by changing the air velocity from 0.15m/s to 3.5m/s, the experimental determined air outlet temperature and RH were approximately 22.3◦C and 41% respectively. These experimental obtained values were in good agreement with the simulation results, with percentage deviations of 3.95% and 4.82% respectively.
2. By changing the air velocity from 0.15m/s to 3.5m/s, the experimental obtained cooling effectiveness deceased from 0.45 to 0.15. With ai inlet dry bulb temperature more or less the same, while relative humidity difference of 7.8%, condition 1 with lower relative humidity yielded higher cooling effectiveness.
3. The experimental obtained pressure drop with respect to various air velocities was reported. The pressure drop increased from 0.45Pa to 2.1Pa as the air velocity improved from 0.15m/s to 3.5m/s. These values were about 10-40% of the pressure drops obtained by Zhang[22], in which the fibre numbers were 4 to 10 times higher than our proposed system.
4. With the Reynolds number in the range of 10-160, the heat and mass transfer coefficients were in the range of 25-170W/m^{2}K and 0.04-0.25m/s. Two sets of non-dimensional heat and mass transfer correlations with respect to Reynolds number were deviated from the experimental results, which showed good agreements with other correlations from literature.

Acknowledgements
The authors would like to acknowledge the funding contribution from the EPSRC and Innovate UK.

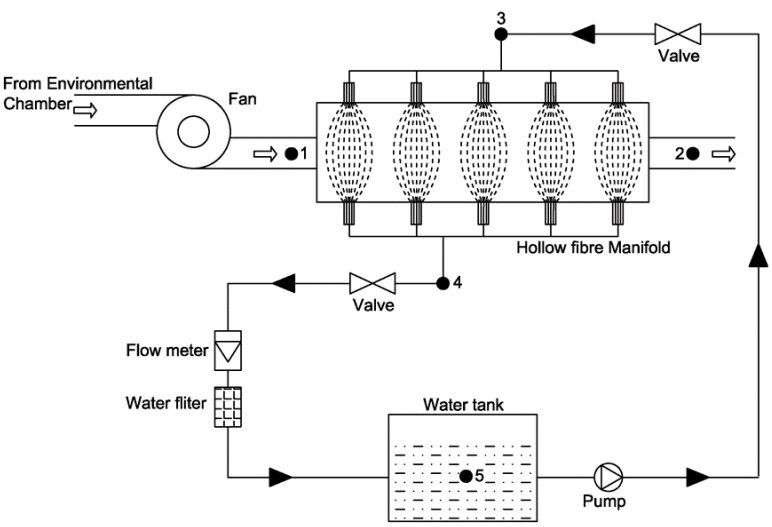

Figure 1: Schematic diagram of polymer hollow fibre integrated evaporative cooling system

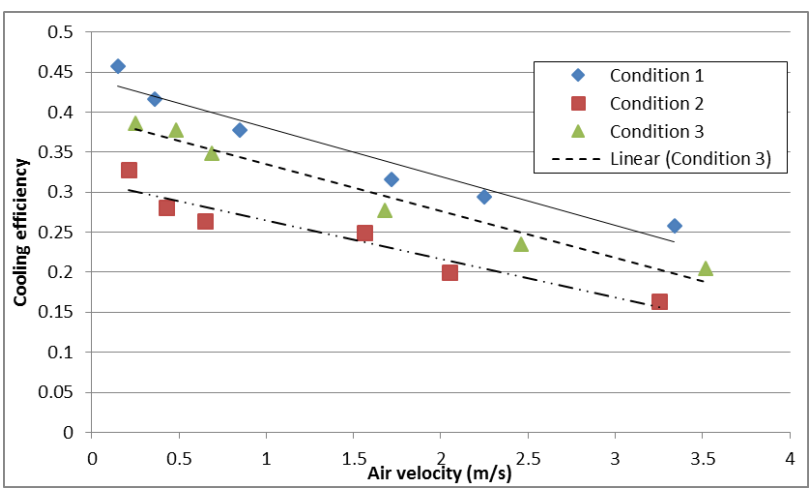

Figure 2: Variations of simulation and experimental obtained cooling effectiveness with respect to the air velocities

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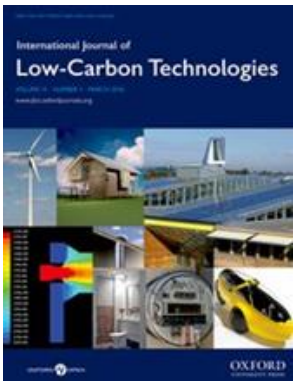

WSSET exclusive offer – IJLCT

WSSET in conjunction with the International Journal of Low-Carbon Technologies (IJLCT) are introducing a 50% discount to the APC (article processing charge) for WSSET members wishing to publish a paper in IJLCT (open access). This would cost WSSET members £475 as opposed to the full charge of £950. The authors will need to quote they are WSSET members when it comes to payment. Please visit: http://ijlct.oxfordjournals.org/

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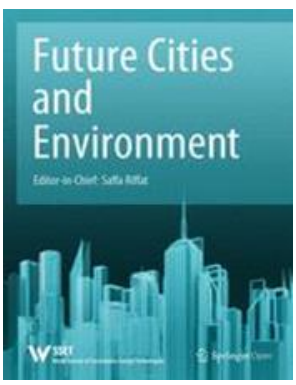
Exclusive article processing charges for WSSET members!



WSSET exclusive offer - FCaE

Also in conjunction with the Future Cities and Environment (FCaE) there will be a 50% discount to the APC (article processing charge) for WSSET members wishing to publish a paper in FCaE (open access). This would also cost WSSET members £475 as opposed to the full charge of £950. Please send your articles to Professor Saffa Riffat: saffa.Riffat@Nottingham.ac.uk

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3rd WSSET Innovation Awards 2018

You can submit your entries now
Deadline: 31st March 2018

Please visit: www.wsset.org to download an entry form.
Winners will be announced at the SET 2018 in Wuhan, China

Donations are welcome and greatly appreciated!

We would like to remind our members that WSSET is a non-profit organisation, hence providing free membership. We would not be able to play a significant role in consolidating practical partnerships between academic and industrial organisations without the help of our members.

Whether you would like to get more involved or contribute financially, please get in touch with us at: secretary@wsset.org

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All WSSET members are kindly invited to submit articles for publication in future WSSET newsletters. Articles can be on a range of topics surrounding the word of sustainable energy technologies. With over 1000 active members, the WSSET newsletter provides a great opportunity to publicise new ideas, technologies or products – all free of charge!

Articles should be no more than 400-500 words and one or two photographs would be very much appreciated. Submissions should be emailed to secretary@wsset.org

Furthermore please contact secretary@wsset.org regarding any conferences, seminar or symposiums relating to topics of sustainable energy technologies that wished to be advertised in the newsletter.

Once again thank you for your continued support to WSSET.