Thermal Systems—An Overview

Ivan CK Tam ^{1,*} and Brian Agnew ²

¹ NewRIIS-Newcastle Research & Innovation Institute, Newcastle University, 80 Jurong East Street 21, Singapore #05-04, Singapore

² NewRail-Newcastle Centre for Railway Research, Newcastle University, Newcastle upon Tyne NE1 7RU, UK; brian.agnew@newcastle.ac.uk

* Correspondence: ivan.tam@newcastle.ac.uk

We live in interesting times in which life as we know it is being threatened by human-made changes to the atmosphere we live. On the global scale, concern is focused on climate change due to greenhouse gas emissions and atmospheric pollution produced by combustion processes. The increase in global warming, added to the scarcity of fossil fuels, has motivated the development of new technologies to improve the efficiency of existing processes in power plants. To meet the dual challenges presented by these factors, consideration needs to be given to energy efficiency and pollution reduction in transport and energy conversion processes. A possible approach is through development of new ideas and innovative processes to current practices. Among the available options, multi-generation processes such as trigeneration cycles, battery storage systems, solar power plants and heat pumps have been widely studied as they potentially allow for greater efficiency, lower costs, and reduced emissions. On the other hand, some researchers have been working to increase the potential of energy generation processes through heat recovery with steam generators, organic Rankine cycles, and absorption chillers. This Special Issue is a collection of fundamental or applied and numerical or experimental investigations. Many new concepts in thermal systems and energy utilization are explored, discussed, and published as original research papers in the “Thermal Systems”.

The first paper, presented by Ochoa et al. [1], offers an extensive thermo-economic analysis of a heat recovery steam generation system integrated with an absorption refrigeration chiller and a gas micro-turbine. The effect of compressor inlet air temperature on thermo-economic performance of trigeneration systems was studied and analyzed in detail based on a validated model. They found some operational conditions where exergy was highly destroyed due to the exergy inefficiencies of the equipment such as combustion chamber, microturbine, compressor, evaporator, heat exchanger and generator which are found to be important as exergo-economic factors.

In another investigation, Ochoa et al. [2] present an analysis of a waste heat recovery system based on the organic Rankine cycle from the exhaust gases of an internal combustion engine. They studied the exergy destroyed values and the rate of fuel exergy, product exergy, and loss exergy. They found exergo-economic analysis was a powerful method to identify the correct allocation of the irreversibility and the real potential for improvement between components.

Zhang et al. [3] perform an experimental investigation to enhance the working performance and temperature control of electric vehicle batteries through a thermal management system with a heat pipe and thermoelectric cooler. Heat pipes with high thermal conductivity were used to accelerate dissipating heat on the surface of the battery with an additional thermoelectric cooler to increase discharge rate. The findings support the results generated from engineering simulation and show that the combined system can effectively reduce the surface temperature of a battery.

Qian et al. [4] propose the application of oscillating heat pipes to reduce thermal damage in an abrasive milling tool. Heat pipes are passive heat transfer devices with

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excellent heat transport capacity and they are applied to the machining process to enhance heat transfer. The experimental investigation studied the effects of centrifugal acceleration, heat flux, and working fluids, hence, methanol, acetone, and water, on their thermal performance. Based on their theoretical analysis, centrifugal acceleration will increase the resistance for the vapor to penetrate through the liquid slugs to form an annular flow, which was supported by slow-motion visualization. The phase change occurs, and vapor moves to the condenser to release heat by condensing into liquid.

Sartor and Dickes [5] validated numerical results obtained from a heat transport model with experiments in large solar thermal plants at the Plataforma Solar de Almeria in Spain. They argued that the previous work done had limitations in the assessment of temperatures and computational time required for simulating large pipe networks. They proposed to model the dynamic behavior of the whole system based on a few data inputs. Some atmospheric conditions, such as local clouds, could have significant influence on the outlet temperature and other dynamic behavior of the solar field. An alternative method was used to validate a solar thermal plant considering the thermal solar gain and the inertia of the pipes in their investigation. The accuracy of the model was found to be similar to those of the one-dimensional finite volume method with a reduced simulation time.

Alexopoulos et al. [6] validate design procedure from a simulation model with an experimental study of an air finned tube CO₂ gas cooler. Based on the model, the evaluation of various physical parameters such as length and diameter of tubes as well as ambient temperature was conducted. The researchers attempted to identify the most suitable design in terms of pressure losses and required heat exchange area for selected operational conditions. Hence, a simulation model of the gas cooler was developed and validated experimentally by comparing the overall heat transfer coefficient. The comparison between the model and the experimental results showed a satisfactory convergence for selected operational conditions.

Barrella et al. [7] present a feasibility study which analyzed the use of a centralized electrically driven air source heat pump for space heating. Two models were developed to obtain variables in the hourly thermal energy demand and the off-design heat pump performance. The proposed heat pump is driven by a motor with variable rotational speed to modulate the heating capacity in an efficient way. An eco-friendly refrigerant (R290 or propane) was selected for the heat pump. A back-up system was used to meet the peak demand. Renewable energy used via the heat pump showed significant reduction in CO₂ which would otherwise have been produced via normal fossil fuel consumption. The researchers claimed that these results showed that the proposed technology was among the most promising measures for addressing energy demand in vulnerable households.

Kim et al. [8] propose an alternative method of swaging which is claimed to be more efficient than the traditional coating technology in the fabrication of accident-tolerant fuel cladding. In their study, it was found that the specimen exhibited a pseudo-single tube structure with higher thermal stability. They reported that the specimen had a uniform and well-bonded interface structure under optical microscopy and scanning electron microscopy images. The specimen did not show significant structural collapse, even after being stored at 1200 °C for one hour. The experimental results show that tube process has a high potential for development of an ATF cladding with a length of several meters with their geometries calculated according to the design.

Grabowski et al. [9] present a numeric heat transfer investigation validated with an experimental study in flow boiling of water through an asymmetrically heated, rectangular and horizontal mini-channel, with transparent side walls. The mathematical model assumed the heat transfer process in the measurement module to be steady-state with temperature independent thermal properties of solids and flowing fluid. Grabowski et al. applied laminar characteristic flow in the Reynolds numbers study. The experimental data taken were temperatures at strategic points, volume flux of flowing water, inlet pressure and pressure drop, current, and the voltage drop in the heater power supply. They defined

two inverse heat transfer problems which were solved by the meshless Trefftz method with two sets of T-functions.

Kim et al. [10] demonstrate the use of vortex tube in an air conditioning system with the objective to get rid of the use of refrigerant gas. The success of the eco-friendly technology will avoid environmental impact due to refrigerant. The vortex tube is a temperature separation system capable of separating air at low and high temperatures with compressed air. In their experimental study, both direct and indirect heat exchange were investigated to test low-temperature air flow rate according to temperature and pressure. The direct heat exchange method was found to have low flow resistance, and ease in control of temperature and flow-rate. As a result, it is judged to be a more feasible method for use in air-conditioning system by the authors.

The papers in this special issue reveal an exciting area, namely the “Thermal Systems” that is continuing to grow. The pursuit of work in this area requires expertise in thermal and fluid dynamics, system design, and numerical analysis as well as experimental validation. We are extremely delighted to be invited as the Guest Editors of this “Special Issue”. We have received great support from many colleagues and top researchers of prestigious universities and research institutions. We are heartened to see such a contribution with the aim of tackling the environmental impact or providing low-cost energy options to the humble communities. We firmly believe that, with the continuing collaboration of all researchers, we can enhance our contribution to tackling the numerous challenges faced by global society. We hope that this Special Issue helps to bring the research community into closer contact with each other. Finally, we would like to thank all our authors, reviewers, and editorial staff who have contributed to this publication. I am sure all readers of this Special Issue of *Energies* will find the scientific manuscripts interesting and beneficial to their research work in the years to come.

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