International Journal of Technology (2016) 2: 185-188
ISSN 2086-9614 

# THERMOFLUIDS ON RENEWABLE ENERGY, REFRIGERATION AND AIR CONDITIONING, AND FLAME AND COMBUSTION

Agus Sunjarianto Pamitran[1*], Nandy Putra[1], Hendri Dwi Saptioratri Budiono[1]

[1]*Faculty of Engineering, Universitas Indonesia, Kampus Baru UI Depok, Depok 16424, Indonesia*

Increasingly limited sources of fossil energy are driving people to seek alternative energy resources. The use of photovoltaic (PV) and biogas for electric power generation continues to be accompanied by efforts to improve their system performance. Electrical ratings on PV systems, and the design of the digester in the biogas combustion process, are two of the relevant issues presented in this edition.

Absorption cooling systems for buildings with solar power is one type of environmentally friendly system. In addition, the use of the natural refrigerant propane and a small channel can provide a higher heat transfer coefficient. In the heating and cooling process, the heat transfer characteristics are changed due to the phase change of the working fluids or material. Therefore, research on phase change material or working fluids has become an important way to support energy savings. Adsorption cooling systems that work with certain materials have shown better system performance, are environmentally friendly, and are energy-saving. System performance is determined by the properties of the material or the working fluid; it can be improved by modifying the serial or parallel stages of the process, which can be implemented in the dehumidification process.

The pyrolysis process is another example of an application of thermofluids that uses flame and combustion; here, a carbonaceous solid is thermally degraded via heat in the absence of oxygen. For safety in flame and combustion, controlling the oxygen concentration can reduce the propensity for ignition and lower the fire propagation rate. Related applications on the engine and controlling the conditions of combustion in the engine room can improve engine performance.

The 8th International Meeting on Advances in Thermofluids (IMAT) took place in Jakarta, Indonesia from November 11–12, 2015. The conference featured discussions and paper presentations on current issues surrounding the theme of the application of thermofluids in renewable energy systems, air conditioning and refrigeration, and flame and combustion.

The first paper, written by M. Burhan, C.K.J. Ernest, and N.K. Choon, proposes an electrical rating methodology that provides a common playing field to planners, consumers, and PV manufacturers to evaluate the long-term performance of PV systems. The authors conclude that, after comparing the systems' electrical ratings, the CPV (concentrated photovoltaic) system is more feasible than other conventional PV systems because it produces almost twice the power output in tropical environments, although it can only respond to beam radiations. They also report that electrical ratings are an easy method for calculating $CO_2$ emissions savings because they account for the carbon emission factor.

The second paper, written by A.I. Siswantara, A. Daryus, S. Darmawan, G.G.R. Gunadi, and R. Camalia, simulates a slurry flow in an anaerobic digester as a basic biogas digester development to produce biogas that meets the requirements of the Proto X-3 Bioenergy Micro Gas Turbine. The authors investigate the optimum design of the flow circulation of the anaerobic digester using the CFD (Computational Fluid Dynamics) simulation method with different baffle clearances. They conclude that the maximum velocity in the compartments is in the 50 mm baffle clearance digester (measuring 69.5 cm/s). They suspect that it creates greater recirculation in the flow.

The third paper, written by A. Daryus, A.I. Siswantara, S. Darmawan, G.G.R. Gunadi, and R. Camalia, presents the results of a CFD simulation in the Micro Gas Turbine Bioenergy Proto X-3 combustor to determine which model is best suited to actual conditions from two $k$-$\varepsilon$ turbulence models (i.e., STD $k$-$\varepsilon$

*Corresponding author's email: pamitran@eng.ui.ac.id, Tel. +62-21-7270032, Fax. +62-21-7270033
Permalink/DOI: http://dx.doi.org/10.14716/ijtech.v7i2.3098

and RNG *k-ε*). The authors report that the temperature and the mass fraction of $CH_4$, $H_2$, $O_2$, and $CO_2$ distributions has similar results; thus, both models (STD *k-ε* and RNG *k-ε*) can be used to represent the combustion process phenomenon without many significant differences.

The fourth paper, written by H. Yabase, K. Saito, A. Lubis, I. Alhamid, and Nasruddin, observes the outline and the performance of a 239 kW solar air-conditioning system using a single-double effect combined absorption chiller. The authors report that the gas reduction by solar heat amounts to 25% or more, but the cooling load rate is as low as 35%. They conclude that the solar air-conditioning system can operate even if the solar hot water temperature is as low as 60–70°C. They also find that the gas reduction amount tends to be larger as the hot water temperature decreases.

The fifth paper, written by S. Ahlatli, T. Mare, P. Estelle, and N. Doner, observes the heat transfer behavior of carbon nanotube-water nanofluid in a micro-channel solar collector. The authors use an exchanger composed of 16 micro-channel with hydraulic diameters of 1 mm and a glass or quartz cover with a surface area of 25 $cm^2$; here, solar radiation is simulated using a halogen lamp. They report that as the weight fraction of nanofluids increases, the measured heat transfer, pump power, and pressure drop increases. They conclude that the high-weight-fraction nanofluids become more effective when quartz is used on the top surface of the heat exchanger.

The sixth paper, written by N. Ghazali, Q.A. Yousif, A.S. Pamitran, S. Novianto, and R. Ahmad, report the optimization outcomes obtained from GA (Genetic Algorithm), minimization of the friction factor, and frictional pressure drop of R22 and R290 under optimized mass flux and vapor quality using a genetic algorithm. In their study, the variable parameters include the mass flux and vapor quality, and the objective function is first set to the Darcy friction factor. The authors report that the differences between the values of the Darcy friction factor in the two refrigerants are very small, with the frictional pressure of R-290 being higher than that of R-22. Authors also find that the smaller channel induces a much higher frictional pressure drop.

The seventh paper, written by S. Novianto, A.S. Pamitran, R. Koestoer, E.A. Kosasih, and M.I. Alhamid, investigates the flow boiling void fraction to observe its characteristics and to develop a new correlation of a void fraction based on the separated model. The authors propose a new void fraction correlation as a function of liquid and vapor Reynolds number based on the model of separated (slip ratio). Their new correlation reveals that the comparison with homogeneous model shows that the best prediction of void fraction with a 2% mean deviation.

The eighth paper, written by N. Putra, E. Prawiro, and M. Amin, investigates the thermal properties and behaviors of beeswax/CuO nano-phase change material (PCM) as a means of thermal energy storage for low-temperature applications. In their experiment, the melting temperature and thermal capacity of the nano-PCM are measured with a differential scanning calorimetry apparatus. The authors conclude that there are no chemical reactions of the nano-PCM that prove the compatibility of CuO and beeswax; further, the addition of nano-particles increases the thermal conductivity but reduces the latent heat and heat capacity of the nano-PCM.

The ninth paper, written by Nasruddin, D. Alamsyah, D. Budiman, and J. Ericsson, simulates the effect of adsorption granular size on a zeolite-water solar adsorption chiller at the Universitas Indonesia. The authors conduct a simulation with different diameters of granule zeolite to determine the running characteristics of adsorption chillers in a tropical climate. The study concludes that the smaller the average granular size of the zeolites, the less the time needed to reach the maximum hot water temperature and the faster the time needed to reach the balance state of a chilled out temperature.

The tenth paper, written by Nasruddin, E.A. Kosasih, B. Kurniawan, Supriyadi, and I.A. Zulkarnain, presents a combination of semi-empirical, theoretical, and force-matching methods to determine the optimum adsorption capacity of an open-ended single-walled carbon nanotube (SWCNT) as the diameter function. They find that the range of SWCNT exterior physisorption energy ranges from 1.35–1.62 kcal/mol, while for the interior, it ranges from 1.22–2.43 kcal/mol. The authors obtain a maximum adsorption capacity of 1.75 wt% at a temperature of 233 K and a pressure of 10 MPa. They also find that at room temperature and at a pressure of 10 Mpa, the maximum adsorption capacity is 1.1 wt%.

The eleventh paper, written by A.B. Ismail, K.M. Sabnani, L. Ang, and K.C. Ng, presents an advanced universal isotherm model that allows for a higher degree of regression of all six types of IUPAC isotherms. Using statistical rate theory approach, the authors propose a single asymmetrical distribution function of the adsorbent–adsorbate pairs that exhibit single and multiple peaks in accordance with the adsorption energy distribution of the working pair. They conclude that this relationship, along with others established in this work, provide a better understanding of a unified theoretical link between various types of adsorbent–adsorbate statistical rate theory characteristics with the observed macro-scale adsorption phenomenon.

The twelfth paper, written by H.M. Kamar, N. Kamsah, M.I. Alhamid, and K. Sumeru, investigates the effects of varying the regeneration air temperature (50$^{o}$C, 60$^{o}$C, and 70$^{o}$C) on a desiccant wheel's performance. They consider three performance criteria: condition of the process outlet air, dehumidifier efficiency, and dehumidification rate. The authors conclude that increasing the regeneration air temperature increases the sensible heat but reduces the latent heat of the processed air leaving the dehumidifier. Both the thermal and dehumidification efficiency are reduced as the regeneration air temperature is raised.

The thirteenth paper, written by E.A. Kosasih and N. Ruhyat, observes the performance of a thermodynamic refrigeration system with two condensers coupled in series to an electric air heater system. In this study, the heating process is conducted with an electric air heater; then, the heat was added by the refrigerating effect of the two condensers coupled in series in a thermodynamic simulation. The study shows that a dehumidifier has the following influence on the rate of drying: air is able to pick up steam on more material in a drying chamber.

The fourteenth paper, written by E.A. Kosasih, Harinaldi, and R. Trisno, observes the characteristics of the SJA (Synthetic Jet Actuator) by varying the shape of the cavity and the size of the orifice diameter by giving the frequency of oscillation to the membrane in order to obtain a vortex ring of these changes. The authors find that the maximum speed that can be generated in the SJA is in the frequency range of 110Hz–130Hz. They also discover that the highest-velocity jet is produced by the K3-type cavity, which is conical in shape and has an orifice diameter of 3 mm. The authors conclude that the vortex ring cavity can occur at B3, T3, T5, K3, and K5; however, the vortex ring does not form on any type of cavity with an orifice diameter of 8 mm.

The fifteenth paper, written by J. Julian, Harinaldi, Budiarso, R. Difitro, and P. Stefan, investigates reduced drag coefficients. Ahmed Body serves as the experimental object that is put inside a suction-flow wind tunnel with varying inputs of flow velocity. The authors used a plasma actuator device powered with an AC power supply and installed in three different placement configurations on the aerodynamic model. They conclude that the optimal configuration of the actuator placement is on the leading edge, the optimal wind flow velocity is 1.7 m/s, and the reduction percentage that results from the induced flow is 22% of the initial drag coefficient.

The sixteenth paper, written by A.L.C. Yang and F.N. Ani, presents the characteristics of pyro-oil and the effect of a microwave absorber on the yield of the pyro-oil. The authors use a modified domestic microwave with a controlled heated stirred bed system to pyrolyse used rubber tires into pyro-oil. They find that the product yield is dependent upon the heating temperature of the pyrolysis. The pyrolysis process is strongly affected by the type of catalyst and the temperature. They conclude that the addition of activated carbon as a catalyst in microwave pyrolysis has the potential to enhance the process in terms of product yield and saving input energy.

The seventeenth paper, written by S.K. Leong, S.S. Lam, F.N. Ani, J.H. Ng, and C.T. Chong, investigates the pyrolysed liquid product derived from the microwave-assisted pyrolysis method. The authors use coconut shell-based activated carbon as a catalyst to assist in heat transfer and cracking the glycerol into gaseous and liquid products. Their study shows that liquid and gaseous pyrolysis products are in the range of 15–42% and 55–82% by mass, respectively. Analysis of the liquid product shows that glycerin, methanamine, and cyclotrisiloxane are among the highest derived compounds in the pyrolysed liquid yield. They conclude that the derived pyrolysis products can potentially be used as alternative fuels in combustion systems.

The eighteenth paper, written by A. Pangaribuan, Fadhil, M.A. Santoso, I.M.K. Dhiputra, and Y.S. Nugroho, presents an experimental study of the effect of reducing oxygen concentration on the fire growth in cable networks in horizontal orientation. Their research concerns electrical fires caused by electrical cables sized $1.0mm^2$–$1.5mm^2$. The authors conclude that controlling the oxygen concentration at levels lower than atmospheric concentrations effectively reduces the propensity for cable ignition, thus lowering the fire propagation rate.

The nineteenth paper, written by W.H. Tan, S.L. Lee, J.H. Ng, W.W.F. Chong, and C.T. Chong, presents an experimental study focuses on using the premixed flame method to synthesize and characterize Carbon nanotubes (CNTs). Their experiment is performed using a premixed flame burner with propane used as the fuel source to generate a premixed rich flame, providing the carbon source for CNT growth. Carbon nanotubes formed on the substrate are harvested and characterized using scanning electron microscopy (SEM), field emission scanning electron microscopy (FESEM), energy dispersive X-ray spectroscopy (EDX), and thermogravimetric analysis (TGA).

The twentieth paper, written by A.A. Aziz, K. Sumeru, M.F.M. Said, M.R.M. Perang, and H. Nasution, observes how stepped-piston engines can mitigate current problems that restrict the role of conventional crankcase-scavenged two-stroke engines. The authors also study how to overcome the excessive use of lubricating oil, which causes white smoke. They begin with experimental engine trials that they subsequently make into engines using an eddy-current dynamometer facility. The trial produces an engine output rate of 6.5 kW at this safe limit of engine trial, with the best specific fuel consumption registering as 250 gram/kWh at 3500 rpm. The emission levels are acceptable and within the limits specified by the Environmental Protection Agency (EPA) for the small engine category.

We hope this special edition of IJTech brings useful information and knowledge, and we invite you to join us in this venture by sending your work for consideration.

With warmest regards from editorial board members,

Dr. AgusPamitran

Prof. Dr. Nandy Putra

Dr. Hendri D.S. Budiono