


Editorial

Special Issue on Sciences and Innovations in Heat Pump/Refrigeration: Volume II

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1. Introduction

Heat pumps and refrigeration are key technologies to realize carbon neutrality, and active research is being conducted around the world. With this background, “Sciences in Heat Pump and Refrigeration” was published as a Special Issue in applied sciences. This Special Issue is a continuation of the previous Special Issue “Sciences in Heat Pump and Refrigeration”, which was closed in December 2019, and we have intended to attract publications related to heat pump and refrigeration. As heat pump and refrigeration are technologies used in a variety of applications (air conditioning, food preservation, hot water and steam generation, drying, cryogenic storage, etc.), the related research area’s span is very broad and includes both basic science and advanced engineering.

Based on the paper submitted to a Special Issue previously published on the same topic, five important issues related to heat pumps and refrigeration were derived as follows. They are low-global-warming-potential refrigerants, absorption/adsorption heat pump and refrigeration, desiccant air conditioning, heat and mass transfer enhancement for innovative heat exchangers, and the application of AI for air conditioning. In this editorial, the 10 papers submitted to this Special Issue [1–10] are categorized into the above 5 topics and summarized.

2. Low-Global-Warming-Potential Refrigerants

As a response to climate change, research on low-GWP refrigerants is very important, but unfortunately, there was no study directly using low-GWP refrigerants in this Special Issue. Instead, Yun and Chang [5] contains techniques for diagnosing refrigerant leaks that will cause global warming problems. Most of the existing refrigerant leak prediction models were based on steady-state conditions. In this paper, the results of developing a refrigerant charge prediction model using dynamic experimental data are presented. In the proposed dynamic model, the refrigerant charge was estimated within 2.54% by introducing the condensation temperature and subcooling.

The paper introduced in this Special Issue is expected to contribute greatly to the control of refrigeration systems. In the future, it is expected that papers on low GWP refrigerants and systems will be published more actively.

3. Absorption/Adsorption Heat Pump and Refrigeration and Low-Grade Thermal Energy Utilization

Absorption and adsorption are mainstreams of thermally driven heat pump and refrigeration, which would enhance the utilization of low-grade thermal energy. The important factors to improve the performance of these technologies are materials, such as absorbent, adsorbent, and refrigerant. In this context, Rahmawati et al. [3] investigated activated carbon production from bagasse. The produced activated carbon is expected



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to be used by many applications including adsorption heat pumps. The study revealed adsorption characteristics from both physical and chemical point of views. Adsorption heat pump with a new combination of adsorbent–refrigerant pair, activated carbon-R1234yf, was investigated by Seo et al. [6]. The adsorption isotherm data provided in the study are very useful to design adsorption heat pump and refrigeration. Although the system performance of the pair was not comparable with conventional adsorption heat pumps using water as a refrigerant, the study expanded a scope of adsorption heat pump application. Raza et al. [1] investigated evaporative cooling system, which is also capable of utilizing low-grade thermal energy. The study focused on the application of evaporative cooling to the poultry house section from the viewpoint of enhancing thermal comfort, and the applicability of several options of the system was discussed.

4. Desiccant Air Conditioning

Desiccant air conditioning can mitigate global warming by using water as a refrigerant and can contribute to solving the energy crisis by using heat instead of electricity as the main energy source. In this Special Issue, two papers related to desiccant air conditioning were published.

Since desiccant air conditioning includes dehumidification and ventilation functions, it shows thermal comfort different from conventional air conditioners. Ahn and Choi [2] presented thermal comfort in a residential space equipped with desiccant air conditioning. Three thermal comfort indexes were evaluated by measuring the local temperature, global temperature, and humidity in the cooling space and combining the wind speed obtained by simulation. The change in thermal comfort in three spaces where cooling is performed according to the supply angle of supply air was compared.

Desiccant cooling often consists of a hybrid system depending on the outdoor conditions. At this time, it is necessary to analyze the performance according to the contribution of desiccant cooling and heat pump. In this Special Issue, Kim and Ahn [7] simulated a hybrid desiccant cooling system powered by gas engine cogeneration using TRNSYS. They presented the performance of the hybrid system according to the desiccant capacity.

5. Heat and Mass Transfer Enhancement for Innovative Heat Exchangers

Heat exchangers are the key components of heat pump/refrigeration and air conditioning. Effort to enhance heat transfer is going on in this research field. Attempts to increase heat flux on the subcooled flow boiling using high sintered fiber were reported by Otomo [4] and by Galicia et al. [10]. They showed that the heat flux was enhanced by 56% and wall superheat was reduced by 12 K in the case of a high-porosity sintered fiber attached surface compared with those of the bare surface. The study visualized bubble formation and pattern flow and the mechanism of heat flux enhancement and wall superheat reduction were also clarified.

6. Application of AI for Air Conditioning

Recently, artificial intelligence technology has been applied in many fields, and the heat pump/refrigeration field is no exception. In this Special Issue, two related papers were published.

AI technology can be used very effectively to process image information. Garniwa [8] published a study on estimating solar radiation from satellite images in this Special Issue. Solar radiation information is very important in determining heating and cooling loads in air conditioning. They compared the four models, confirmed that the Hammer model is the best, and introduced a long/short-term memory (LSTM) model to increase the prediction accuracy. As a result, it was shown that the LSTM model can increase the prediction accuracy up to 11.2%.

Deep learning is the most representative example of artificial intelligence technology. Rajagukguk [9] predicted cloud cover from images of a sky camera using deep learning technology. Their study showed that deep learning could predict cloud cover in sky images

and was useful for predicting solar radiation on partially cloudy days with high variability in solar radiation.

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