2020 年度研究活動報告

Research activities in 2020

機械科学・航空学科　齋藤　潔

Kiyoshi Saito, Dept. of Applied Mechanics and Aerospace Engineering,

論文，Published papers

- Sholahudin, Niccolo Giannetti, Seiichi Yamaguchi, Kiyoshi Saito, Katsuhiko Tanaka ,Hiroto Ogami, A cost effective and non-intrusive method for performance prediction of air conditioners under fouling and leakage effect, Sustainable Energy Technologies and Assessments, Volume 42, 2020, Article 100856.
- Falk Cudok , Niccolo ` Giannetti , Jos´e L. Corrales Ciganda , Jun Aoyama , P. Babu ,Alberto Coronasf, Tatsuo Fujii , Naoyuki Inoue , Kiyoshi Saito , Seiichi Yamaguchi , Felix Ziegler, Absorption heat transformer - state-of-the-art of industrial applications, Renewable and Sustainable Energy Reviews, Volume 141, 2020, Article 110757.
- Niccolo GIANNETTI, Kiyoshi SAITO and Hiroaki YOSHIMURA, Formulation of steady-state void fraction through the principle of minimum entropy production, International Journal of Thermal Sciences, Vol.15, No.3, 2020, Pages JTST0025.
- Sholahudin, NiccoloGiannetti, SeiichiYamaguchi, KiyoshiSaito, Yoichi Miyaoka, Katsuhiko Tanaka, Hiroto Ogami, Experimental implementation of artificial neural network for cost effective and non-intrusive performance estimation of air conditioning systems, Applied Thermal Engineering, Volume 181, 25 November 2020, Article 115985.
- Niccolò Giannetti, Seiichi Yamaguchi, Kiyoshi Saito, Hiroaki Yoshimura, Semitheoretical formulation of annular flow void fraction using the principle of minimum entropy production, International Journal of Thermal Sciences, Volume 158, December 2020, Article 106522.

学会発表，Presentations in conferences

- Hifni M. ARIYADI, Niccolò GIANNETTI, Jongsoo JEONG, Seiichi YAMAGUCHI, Kiyoshi SAITO, Changhoon LEE, Jungtae KIM, Seungbeom LEE, Jiyong LEE, and Kwangyeol JEONG, Flow Characteristics and Noise Diagnosis of Hydrogen Charging Solenoid Valve in Hydrogen-Fueled Automobile, ECOS 2020, Jun.2020, Osaka, Japan.
- Adriano MILAZZO, Niccolo GIANNETTI, Seiichi YAMAGUCHI, Kiyoshi SAITO, Thermodynamic investigation of asynchronous open inverse air cycle integrated with compressed air energy storage, GL2020, DEC. 2020, Tokyo, Japan.
- Richard Jayson Varela, Seiichi Yamaguchi, Niccolo Giannetti, Kiyoshi Saito, Xin-Ming Wang, Hiroshi Nakayama, Experimental performance analysis and simulation of an internally cooled liquid desiccant air conditioning system using a novel ionic liquid, , GL2020, DEC. 2020, Tokyo, Japan.

- Niccolo Giannetti, Luca Rametta, Ryota Fukui, Masayoshi Hirasawa, Noriyuki Nishiyama, Seiichi Yamaguchi, Kiyoshi Saito, Assessment of surfactant-induced Marangoni convection within high-temperature aqueous Lithium-Bromide solution, GL2020, DEC. 2020, Tokyo, Japan.
- Yulianto Muhamad, Suzuki Takaoki, Miyaoka Yoichi, Ohno Keisuke, Giannetti Niccolo, Saito Kiyoshi, Yamaguchi Seiichi, Numerical Investigation of CO2 Heat Pump Water Heater Performance, GL2020, DEC. 2020, Tokyo, Japan.
- Hifni Mukhtar Ariyadi, Niccolo Giannetti, Jongsoo Jeong, Seiichi Yamaguchi, Kiyoshi Saito, Seungbeom Lee, Jiyong Lee, Kwangyeol Jeong, Euidong Ro, Jaebeom An, Noise Diagnosis in Solenoid Valve inside Hydrogen Tank Solenoid System during Refuelling, 2020 JSAE Congress, Oct. 2020, Tokyo, Japan.
その他，国内学会　10 件

研究成果

ヒートポンプシステムの高性能化を大きな指針として，2020 年には，低 GWP 冷媒を導入した中小型規模の冷凍空調機器の性能を高精度に数理解析するために，機器を構成する各種デバイスの数理モデル，数値解析手法を確立してきた．そして，多様な冷媒の解析も可能とする熱交換器,圧縮機,膨張弁の数理モデルを構築し,システムとしての運転特性並びに性能評価を行った．
モデリングが困難と判断された物理現象については，深層学習を含む機械学習及び進化計算等の人工知能関連技術（AI）も活用しながら最適な熱交換器の冷媒流路を推定し，システムの最小限の運転状態の条件から高精度なシステムの性能を把握することができた．
さらに，次世代冷媒の最適な選定を目標として，冷媒の物理的な構造と化学的な見地から多様な冷媒の理論性能を推定する手法を開発しその予測精度の検討を行うことができた．
また，イオン液体を吸収材として用いた中間冷却型気液接触器の熱・物質移動特性を解明し，気液接触器の省スペース化を遺伝的アルゴリズムを導入し評価した．
そして，吸収式システムを対象として吸収器の高温域における濡れ特性と流下液膜におけるマランゴニ対流の現象を可視化実験と数値解析により比較検討ができた．
これらの成果は，ヒートポンプシステムのさらなる高性能化につながることを強く期待する．

Research achievements

In 2020, we have established mathematical models and numerical analysis methods to simulate precisely the performance of small and medium refrigeration and air-conditioning equipment with low GWP refrigerant. And we constructed applicable mathematical theory on the simulation of heat exchanger, compressor, and expansion valve with various refrigerants, and evaluated the characteristics of system performance. For Physical phenomena to have difficult modeling on the heat exchangers, Artificial Intelligence(AI) of machine learning including deep learning and evolutionary computation was attempted and

utilized to predict the optimum refrigerant flow path. And we made sure the performance prediction of system with the least number of operation parameter.

Furthermore, to decide the best next generation refrigerant, the methods to predict the ideal system performance has been developed with physical structure of refrigerant and chemical point of view for various refrigerants.

And, we clarified heat and mass transfer characteristics of a precooler and gas - liquid contactor using ion liquid as absorbent in liquid desiccant air-conditioning system, and the size saving of the gas-liquid contactor was discussed by utilizing genetic algorithms.

Moreover, we performed the experiment and numerical analysis of the falling film considering surface wettability and Marangoni convection at condition of the range of high temperature in absorber of absorption system.

From these achievements, we were able to extract very important guidelines for improving the performance of heat pumps.