Proceedings of the 10th World Congress on Momentum, Heat and Mass Transfer (MHMT 2025)
Barcelona, Spain - April 10 - 12, 2025
DOI: 10.11159/icmfht24.001

High-Temperature Chemical Heat Pump Systems with Alloy Selections, Characterisations, Simulation and Experiment Development

Yunting Ge
Centre for Civil and Building Services Engineering (CCiBSE)
School of the Built Environment and Architecture
London South Bank University, 103 Borough Road, London, SE1 0AA, UK
yunting.ge@lsbu.ac.u

ABSTRACT

In an energy-intensive industrial site such as a steel plant, plenty of medium and low□temperature waste heat could be recovered for heating purposes with advanced and feasible technologies such as chemical or metal hydride (MH) heat pumps. Compared to other heat pump systems such as those with compression and absorption cycles, the MH heat pump has some distinctive advantages including a low carbon system in terms of less electricity input and environmentally friendly working mediums, compactness, and most importantly achievable heat output with relatively high temperature. Therefore, the MH heat pump is investigated with a funded project, and some of the research outcomes are explained and demonstrated in this presentation. These include MH alloy selections, MH alloy characterisations, dynamic model simulation, and experiment development. For the MH alloy selections, a comprehensive procedure to select alloys for the high-temperature MH heat pump systems is explained based on the operating temperatures, system efficiencies, and thermodynamic equilibriums. For the MH alloy characterisations, two correlative models have been developed for the pressure, concentration, and temperature (PCT) profiles with limited measurements of thermophysical property data for characterisation of each MH alloy.

In addition, the reaction kinetics model for various MH alloys has been developed. For the dynamic model simulation, comprehensive steady and transient (CFD) system models have been developed with a new and revised intrinsic kinetic correlation inclusive of the essential operating controls and applicable process conditions of regeneration, heating, and transitions in between. For the experiment development, a test rig for the MH heat pump system has been built and relevant measurements have been carried out. Some experimental measurement results will be demonstrated and presented.