Adsorption cooling (AC) technology is one of the most promising ways to solve the environmental issues and reduce the energy consumption as compared to traditional air conditioning and refrigeration systems. However, AC systems suffer from poor heat and mass transfer inside the adsorption beds, which is the main obstacle to commercialization of adsorption cooling units. The main goal of this study is design an efficient adsorption cooling cycle. In this research work, an in-depth scaling analysis of heat and mass transfer in an adsorption packed bed has been performed to identify and quantify how the effective thermal diffusivity of an adsorption bed and the surface diffusion rate of an adsorbate in a nanoporous adsorbent affect the specific cooling power (SCP) of an adsorption cooling system. An experimental setup is designed and built to measure the adsorption kinetics and isotherms of any working pair accurately. The equilibrium uptakes of Fuji silica-gels Type-RD and RD-2060, which are commonly used in adsorption cooling systems, are measured experimentally. Based on the adsorption rate and the adsorbent temperature measured simultaneously, a new approach is proposed to measure the surface diffusivity in the temperature and pressure ranges typical of those during the operating conditions of adsorption cooling systems. By using the derived scaling parameters, a newly designed packed bed for use in AC systems is proposed and evaluated. The proposed design is modular in nature, and each module is an open-cell aluminum foam packed with silica-gel to enhance the overall thermal conductivity of the bed from 0.198 to 5.8 W/m.K. The experimental test rig is used to evaluate the performance on the new adsorption bed. The effect of pores per inch (PPI) of the foam, silica-gel particle size, bed height and adsorption isotherm of different types of silica gel on the bed performance are investigated.

Major: Mechanical Engineering

Educational Career:
Bachelor's of Mechanical Power Engineering, BS, 2008, Zagazig University
Master's of Mechanical Power Engineering, MS, 2013, Zagazig University
Master's of Aerospace Engineering, MS, 2017, University of Central Florida

Committee in Charge:
Louis Chow, Chair, Mechanical and Aerospace Engineering
Hansen Mansy, Mechanical and Aerospace Engineering
Tuhin Das, Mechanical and Aerospace Engineering
Steven Duranceau, Civil, Environmental and Construction Engineering

Approved for distribution by Louis Chow, Committee Chair, on March 18, 2019.

The public is welcome to attend.