HEAT AND MASS TRANSFER MECHANISMS IN ADSORPTION HEAT PUMPS: EXPERIMENT AND DYNAMIC MODELING

Stefan Graf, Daniel Becker, Jan Ackermann, Franz Lanzerath, André Bardow

RWTH Aachen University
Institute of Technical Thermodynamics
Schinkelstraße 8, Aachen, Germany
phone: +49 241 80 – 95381; fax: +49 241 80 – 92255
email: bardow@ltt.rwth-aachen.de

Abstract

For designing adsorption heat pumps, quantifying heat and mass transfer resistances in adsorbents is crucial. However, heat and mass transfer occur as two resistors in series and can therefore not be separately identified in conventional setups. In this work, we present an approach to separate and quantify heat and mass transfer resistances in adsorbents. For this purpose, we extended the Large-Temperature-Jump method (LTJ) with an infrared camera (IR) and combined the new IR-LTJ method with dynamic modeling. The IR camera determines the surface temperature of the adsorbent, allowing us to distinguish the heat and mass transfer resistances. Subsequently, the data from the IR-LTJ setup is used in dynamic models to quantify heat and mass transfer coefficients. We conducted experiments for one layer of granulated silica gel 123 and determined the heat transfer coefficient to 165 $W/(m^2 \cdot K)$ for adsorption and to 255 $W/(m^2 \cdot K)$ for desorption. For mass transfer, the effective diffusion coefficient is 2 to $3 \cdot 10^{-7}$ m^2/s for adsorption and $7.5 \cdot 10^{-8}$ m^2/s to $2.5 \cdot 10^{-7}$ m^2/s for desorption. The IR-LTJ method allows to identify the limiting effects for heat and mass transfer in adsorption heat pumps.