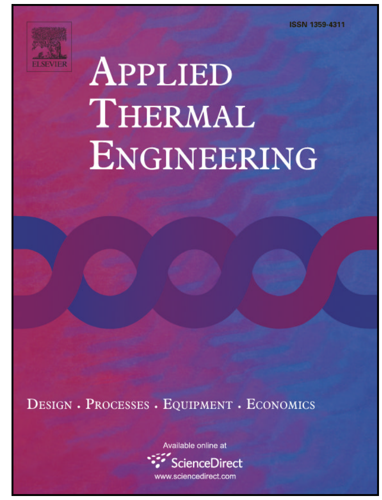
Accepted Manuscript



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PII: S1359-4311(16)33514-1
DOI: http://dx.doi.org/10.1016/j.applthermaleng.2017.06.054
Reference: ATE 10573

To appear in: *Applied Thermal Engineering*

Received Date: 21 November 2016
Revised Date: 25 April 2017
Accepted Date: 11 June 2017

Please cite this article as: S. Graf, F. Lanzerath, A. Bardow, The IR-Large-Temperature-Jump method: Determining heat and mass transfer coefficients for adsorptive heat transformers, *Applied Thermal Engineering* (2017), doi: http://dx.doi.org/10.1016/j.applthermaleng.2017.06.054

The IR-Large-Temperature-Jump method: Determining heat and mass transfer coefficients for adsorptive heat transformers

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Abstract

The design of adsorptive heat transformers (adsorption heat pumps and chillers and adsorption thermal energy storage) requires knowledge on the heat and mass transfer resistances in adsorbents. However, heat and mass transfer cannot be distinguished in conventional experimental setups, since only pressure data is available. In this work, we present an approach to distinguish 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 as an additional information. Subsequently, the data from the IR-LTJ setup is used in dynamic models to quantify time-resolved heat and mass transfer coefficients. We conducted experiments for one layer of granulated Fuji Siogel for use in an adsorption chiller with the temperature set 10/30/70. We show that the suggested method is able to determine heat and mass transfer coefficients.

Keywords: Adsorption chiller, Adsorption heat pump, Adsorption thermal energy storage, Adsorption dynamics, Coupled heat and mass transfer, Siogel - Water

1. Introduction

Adsorptive heat transformers are driven by thermal energy from waste heat or the sun [1]. They can either store thermal energy (adsorption thermal energy storage) [2, 3] or can provide heating or cooling (adsorption heat pumps and chillers) [4, 5]. Adsorption heat pumps and chillers are a sustainable alternative to conventional compression heat pumps and chillers. However, compared to compression heat pumps, adsorption heat pumps exhibit a lower performance [6]. The performance of adsorption heat pumps depends highly on the kinetic processes in the adsorbent [7]: Water vapor has to diffuse into the porous adsorbent before being adsorbed; heat released in the adsorbent has to be transferred through the adsorbent to the heat exchanger. Both processes, diffusion and heat transfer, can limit adsorption and consequently the

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