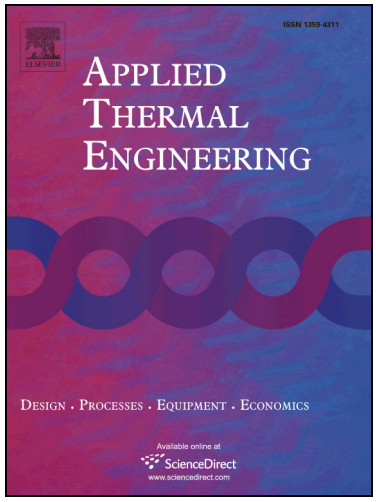
Accepted Manuscript



Dynamics study of ethanol adsorption on microporous activated carbon for adsorptive cooling applications

Vincenza Brancato, Larisa Gordeeva, Alessio Sapienza, Angelo Freni, Andrea Frazzica

PII: S1359-4311(16)30826-2
DOI: http://dx.doi.org/10.1016/j.applthermaleng.2016.05.148
Reference: ATE 8363

To appear in: *Applied Thermal Engineering*

Received Date: 16 February 2016
Revised Date: 11 April 2016
Accepted Date: 24 May 2016

Please cite this article as: V. Brancato, L. Gordeeva, A. Sapienza, A. Freni, A. Frazzica, Dynamics study of ethanol adsorption on microporous activated carbon for adsorptive cooling applications, *Applied Thermal Engineering* (2016), doi: http://dx.doi.org/10.1016/j.applthermaleng.2016.05.148

Dynamics study of ethanol adsorption on microporous activated carbon for adsorptive cooling applications

Vincenza Brancato[1], Larisa Gordeeva[2, 3], Alessio Sapienza[1], Angelo Freni[1], Andrea Frazzica[1*]

[1]Consiglio Nazionale delle Ricerche (CNR), Istituto di Tecnologie Avanzate per l'Energia "Nicola Giordano" (ITAE), S. Lucia Sopra Contesse 5, 98126 Messina, Italia

[2] Boreskov Institute of Catalysis, Pr. Lavrentieva. 5, Novosibirsk, Russia

[3] Novosibirsk State University, Pirogova str. 2, Novosibirsk, Russia

[*]Corresponding author: Tel.: +39 090 624 243; fax: +39 090 624 247, email address: andrea.frazzica@itae.cnr.it

Abstract

The present paper reports the experimental characterization of dynamic performance of three Ad-HEx configurations based on the activated carbon / ethanol working pair. The kinetic behavior of ethanol adsorption onto activated carbon was studied by the LTJ (Large Temperature Jump) method that reproduces the real conditions of isobaric stages of adsorptive cooling cycles. The study consists of two main parts: the first one is related to the adsorption kinetics of the Flat Adsorbent Bed configuration, composed of loose adsorbent grains placed on the metal support. While the second one describes the performance evaluation of finned flat – tube HEx configurations loaded with adsorbent grains. The effects of the grain size, the ratio S/m of heat transfer surface to the adsorbent mass and the Ad-HEx geometry are explored in detail in order to find the main factors affecting the adsorption dynamics. On the base of the main findings obtained, the practical recommendations on optimization of the Ad-HEx unit are formulated in order to enhance the specific cooling power of an adsorptive chiller. Furthermore, a comparison of the adsorption characteristic times between the activated carbon and a properly synthesized porous composite, composed of LiBr inside a silica gel host matrix is shown.

1. Introduction

Improvement of cooling power density of adsorption heat transformation (AHT) units is becoming one of the key issues to be addressed for wider commercial diffusion of this emerging technology [1]. The adsorption dynamics of the adsorbent-heat exchanger (Ad-HExs) units play a crucial role to improve the specific cooling power of AHT units [2]. For this reason, currently, many efforts are focused on the study of adsorption dynamics in Ad-HEx units and optimization of their configurations [3,4,5,6].

Various experimental methods have been developed to study adsorption dynamics. First works were based on the Isothermal Differential Step [7,8] and the Large Pressure Jump methods [9,10]. Nevertheless, previous approaches are not satisfactory since they do not replicate isobaric adsorption stages of real AHT cycle. This limit was overcome by introducing a Volumetric Large Temperature Jump (V-LTJ) method [11], which is based on a constant volume - variable pressure apparatus. The development of this apparatus allowed the deep investigation of several parameters affecting the adsorption kinetics, namely, adsorbent nature [12], the grain size [13,14], presence of residual air [15], isobar shape, and cycle boundary conditions [14,16].