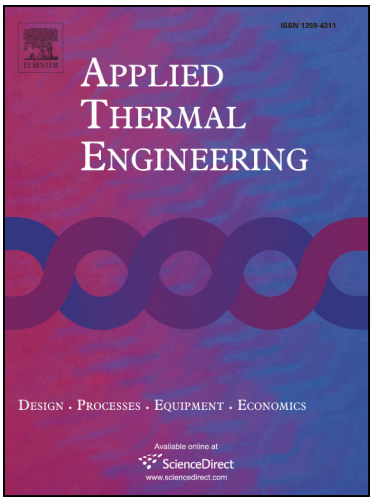

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J. Emhofer, B. Beladi, P. Dudzinski, T. Fleckl, H.C. Kuhlmann

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Analysis of a cross-flow liquid-desiccant falling-film

J. Emhofer[a,*], B. Beladi[b], P. Dudzinski[a], T. Fleckl[a], H. C. Kuhlmann[b]

[a] *AIT Austrian Institute of Technology, Energy Department, Giefinggasse 2, 1210 Vienna, Austria*
[b] *TU Wien, Institute of Fluid Mechanics and Heat Transfer, Getreidemarkt 9, 1060 Vienna, Austria*

Abstract

Liquid desiccant systems are promising candidates for energy-efficient dehumidification systems. Compared to state-of-the-art dehumidification technologies, the air stream must not be cooled to the dew point and heated again. Hence, up to one third of the cooling energy could be saved using a liquid desiccant system. Despite of this advantage, state-of-the-art systems may still operate more economically at certain operating conditions if the liquid-desiccant system, which requires auxiliary energy and additional investment, is not optimized. Therefore, accurate models for the absorption and desorption process are needed to calculate the performance of a liquid-desiccant absorber and desorber for a given geometry. With the aid of such models the absorber and desorber can be optimized. We present a mathematical model which takes into account the heat and mass transfer and numerically predict the behavior of a cross-flow liquid-desiccant absorber using finite differences. The model consists of absorbing vertically falling films on two facing walls of a tall air channel in which the air flow is horizontal (cross-flow configuration). The flow in the liquid film is assumed to be a fully-developed Nusselt flow, while the air flow develops downstream from the channel inlet. A detailed analysis of a cross-flow liquid desiccant absorber was carried out including simulations for a LiBr/water working pair. The cross-stream diffusive transport of water vapor in the air was found to be the limiting factor of the absorption process at practicable air speeds. Several effects caused by the geometry of the absorber and the arrangement of the vertical plates supporting the falling films are discussed. Finally, the system is simulated for an ionic-liquid/water working pair under distinguished operating conditions. The results are verified by comparison with experiments.

Keywords: Falling film, liquid desiccant, absorption, dehumidification, ionic liquids, LiBr

*Corresponding author. Tel.: +43 50550-6061; fax: +43 50550-6679

Email address: johann.emhofer@ait.ac.at (J. Emhofer)

URL: www.ait.ac.at (J. Emhofer)