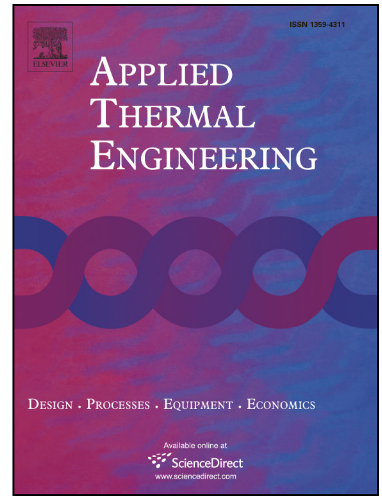

Research Paper

Theoretical And Experimental Study Of The Ammonia/Water Absorption Process Using A Flat Sheet Membrane Module

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THEORETICAL AND EXPERIMENTAL STUDY OF THE AMMONIA/WATER ABSORPTION PROCESS USING A FLAT SHEET MEMBRANE MODULE

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ABSTRACT

A hydrophobic microporous membrane contactor was proposed and studied as an absorber for an ammonia/water absorption cycle. The heat and mass transfer process in the adiabatic flat sheet membrane module was investigated experimentally and analytically. For the experimental study, a membrane absorber test bench was designed and built. Moreover, a unidimensional model was developed and validated with the experimental results. The influence of the temperature, concentration, flow rate and membrane characteristics on the absorption process was evaluated. For the conditions considered in this study, the results indicate that the absorption flux is clearly governed by the mass transfer in the liquid phase. The maximum absorption flux was 4.7 $\cdot 10^{-3}$ kg/m^{2}s with a solution flow rate of 45 kg/h. According to the model, the hydrophobic membrane should be as thin as possible and the pore diameter between 0.03 µm and 0.10 µm.

Keywords: Flat sheet membrane; ammonia/water; absorption; heat and mass transfer.

HIGHLIGHTS

- An experimental NH_3/H_2O membrane absorber test bench was built and tested.
- A unidimensional coupled heat and mass transfer model was developed and accuracy was validated.
- The effect of the inlet solution conditions and membrane characteristics was studied.
- The absorption process was governed by the mass transfer in the liquid phase.

NOMENCLATURE

A	[m^2]	Area
COP	[-]	Coefficient of performance
D	[m^2/s]	Diffusion coefficient
D_k	[m^2/s]	Knudsen diffusion coefficient
d_h	[m]	Hydraulic diameter
d_p	[m]	Pore diameter
h	[J/kg]	Specific enthalpy
H	[m]	Height of the rectangular channel
h	[J/kg]	Specific enthalpy
J	[kg/(m^2·s)]	Mass flux
K_b	[m/s]	Mass transfer coefficient in the liquid phase
K_m	[kg/(Pa·s·m^2)]	Mass transport coefficient in the pores of the membrane
N_u	[-]	Nusselt number
m	[kg/s]	Mass flow rate
M_{NH3}	[g/mol]	Ammonia molecular weight
p	[Pa]	Pressure
R	[J/(K·mol)]	Gas constant
R_m	[Pa·m^2·s/kg]	Mass transfer resistance in the membrane