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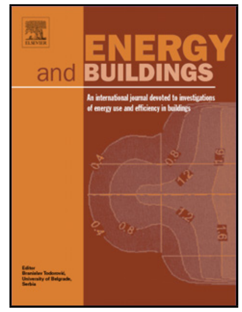

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Numerical study on heat and mass transfer characteristics of the counter-flow heat-source tower (CFHST)

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HIGHLIGHTS

- The heat and mass transfer characteristics of the proposed system were studied.
- Seven design and operating parameters of the proposed system were investigated.
- The characteristics of solution dilution were numerically investigated.

ABSTRACT

The heat-source tower heat pump (HSTHP), as a novel energy-saving unit, extracts low-grade thermal energy from air that can be a promising alternative of boiler in Yangtze River basin, China. A numerical model for analysis of the heat and mass transfer characteristics of a counter-flow heat source tower (CFHST) operating in winter is developed and validated by using experimental results. In this proposed numerical model, the changeable Lewis number is considered, and the effects of various operating, environmental including inlet air dry bulb temperature, inlet air humidity ratio, inlet air flow rate, inlet solution temperature and inlet solution flow rate on the thermal behavior of the heat source tower are studied. Furthermore, the proposed model will also be used to analyze the impact of the porosity and spacing of packing on the heat exchange in the CFHST. Finally, the moisture transfer characteristics inside CFHST under various environmental conditions are also studied. This work can provide a theoretical foundation for performance evaluation and practical design of CFHST.

Keywords: counter-flow heat source tower; numerical study; heat transfer; mass transfer

Nomenclature

A	area (m^2) / correction coefficient	T	temperature (°C)
B	width of the packing material (m) / correction coefficient	T_a	air temperature (°C)
C	correction coefficient	$T_{a,i}$	inlet air temperature (°C)
c_{da}	specific heat of dry air (J/kg・K)	$T_{a,o}$	outlet air temperature (°C)
c_a	specific heat of moist air (J/kg・K)	T_s	solution temperature (°C)
c_s	specific heat of solution (J/kg・K)	$T_{s,i}$	inlet solution temperature (°C)
c_v	specific heat of water vapor (J/kg・K)	$T_{s,o}$	outlet solution temperature (°C)
D	spacing of the packing material (m)	V_A	molar volume of water vapor (cm^3/g・mol)
D_v	water vapor diffusion coefficient	V_B	molar volume of air (cm^3/g・mol)
h_c	heat transfer coefficient (W/m^2・K)	X	horizontal direction
h_m	mass transfer coefficient (W/m^2・K)	Z	vertical direction
k_a	thermal conductivity of air (W/m・°C)	Le	Lewis number