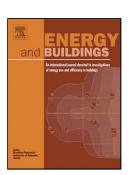
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Numerical study on heat and mass transfer characteristics of the counter-flow heatsource tower (CFHST)

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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 | Т | temperature (°C) | |
| В | width of the packing material (m) / correction coefficient | T _a | air temperature (°°C) | |
| С | 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) | |
| Ca | 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 ($cm^3/g \cdot mol$) | |
| h_c | heat transfer coefficient ($W/m^2 \cdot K$) | Х | horizontal direction | |
| h_m | mass transfer coefficient ($W/m^2 \cdot K$) | Ζ | vertical direction | |
| k _a | thermal conductivity of air (W/m \cdot °C) | Le | Lewis number | |

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