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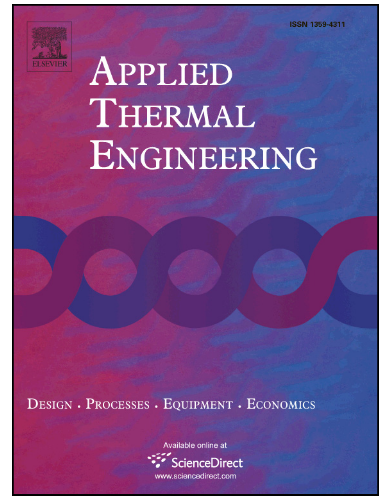

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Effect of environmental pressure on heat and mass transfer characteristics for fin-and-tube heat exchangers under non-unit Lewis Factor

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Abstract

The heat and mass transfer characteristics for fin-and-tube heat exchangers with low environmental pressures have been experimentally investigated. The variation trends of the j_h factor, j_m factor and Lewis factor were examined in this study when environmental pressure decreases from 101.3 to 40kPa. The errors caused by non-unit Lewis factor when calculating the total heat transfer rate using the logarithmic mean enthalpy difference (LMED) method were discussed. It was found that the inlet humidity ratio for the incoming air is inversely proportional to environmental pressure under the experimental conditions. Both the heat and mass transfer performances decrease when the environmental pressure is reduced. However, the j_m factor shows a transient rise when Re<1100. Test results show that the heat and mass transfer analogy is roughly applicable, and the Lewis factor is in the range of 0.73-0.96. The maximal relative deviation of the total heat transfer rate calculated by the LMED method is about 18.7%. However, a modified LMED (m-LMED) method can describe the total heat transfer rate within 3.8%.

keywords： Environmental pressure; Heat transfer; Mass transfer; Lewis factor; LMED

1、Introduction

The plain fin-and-tube heat exchangers are the most commonly used air heat exchangers, and have been continuously promoted with the application of refrigeration and air-conditioning systems. The heat exchangers can be used for evaporators in which surface may be wet provided the fin temperature is below the inlet air dew point temperature. On the wet surface, the water vapor condenses out from the air and simultaneous heat and mass transfer takes place along the fin surfaces. Because of the complexity of convective heat and mass transfer with phase change for the fin-and-tube heat exchangers under dehumidifying conditions, it is difficult to theoretically analyze and simulate.

In general, two conventional heat exchanger design methods are usually preferable for overall performance evaluation. The logarithmic mean temperature difference (LMTD) method is used for single sensible heat transfer process, while the logarithmic mean enthalpy difference (LMED) method is used for sensible heat and dehumidification process [1]. With the LMTD method, mean temperature difference is the driving potential of the sensible heat transfer. The mean enthalpy difference may be regarded as the driving force of moist air heat and mass transfer processes. So the LMED method is