Thermal-Economic analysis of Heat Pipe Heat Exchanger (HPHE) for energy recovery in Air conditioning applications

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Abstract

Due to their high thermal conductivity and no need for pumping power, heat pipes are used to recover energy in both heating and cooling modes in air conditioning applications. In heating mode heat is recovered from the exiting warm indoor air to preheat the incoming cold fresh air. In cooling mode heat pipes are used to precool the incoming warm fresh air by transferring heat to the exiting cold indoor air. The computer simulation and working fluid selection of such a heat pipe heat exchanger (HPHE) system are performed in this paper. The studied heat pipes had the screened mesh wick and Methanol working fluid. Various numbers of heat pipes and different values of return to the total outlet air mass flow rate ratio, were considered. The heat transfer rate in HPHE was computed by ε-NTU method by considering appropriate heat pipe thermal resistance.

Due to its higher evaporation enthalpy and appropriate working limits, Methanol was selected as working fluid. Checking the heat transfer limits, showed that the minimum heat transfer rate was well above the required heat transfer rate.

Furthermore, the economic analysis of the HPHE was performed considering initial (investment) and operational costs as well as annual savings due to energy recovery for different numbers of heat pipe and various values of return air ratio. The results showed that there was a design point at which, the savings of energy recovery was the maximum. The characteristics of this point at various values of return air ratio were determined and reported for the most economical HPHE design and manufacturing purposes.

Keywords: "Heat pipe heat exchanger (HPHE)", "Heat recovery", "Economic analysis", "ε-NTU method"

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