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ORIGINAL PAPER

Investigation of heat pipe heat exchanger effectiveness and energy saving in air conditioning systems using silver nanofluid

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Abstract The present study attempts to use the methanol–silver nanofluid filled heat pipe heat exchanger and compares the effectiveness as well as the energy saving with pure methanol. A heat pipe heat exchanger has been tested in a test rig under steady-state conditions. The lengths of both the evaporator and the condenser sections of the heat exchanger were 700 mm, and its central adiabatic section had a length of 160 mm. The heat exchanger had 36 plate finned copper thermosyphons arranged in three rows. The inlet air temperature across the evaporator section was varied in the range of 33–43 °C while the inlet air temperature to the condenser section was nearly constant to be 13 °C. First, pure methanol was used as the working fluid with a fill ratio of 50 % of the evaporator section length, and then dilute dispersion of silver nanoparticles in methanol was employed as the working fluid. The nanofluid used in the present study is 20 nm diameter silver nanoparticles. The experiments were performed to compare the heat pipe heat exchanger effectiveness and energy saving, using nanofluid and pure methanol. The inlet air relative humidity across the evaporator section was varied between 35 and 80 %. The sensible effectiveness of the heat pipe heat exchanger obtained from experiments varied about 5–22 % for pure methanol and 9–32 % for methanol–silver nanofluid. Based on these experimental results, using methanol–silver nanofluid leads to energy saving around 8.8–31.5 % for cooling and 18–100 % for reheating the supply air stream in an air conditioning system.

Keywords Dry-bulb temperature · Methanol–silver nanofluid · Relative humidity · Sensible energy effectiveness

Introduction

One of the important applications of heat pipe heat exchangers (HPHE) for reducing energy consumption is in air conditioning (HVAC) systems. The most interesting function of HPHEs is to increase the dehumidification capacity of the conventional air conditioning systems. In a conventional HVAC system, the humidity is controlled by cooling the supply air stream below its dew point temperature. The cold air is then reheated to a temperature that is suitable for the conditioned space.

For this purpose, external energy such as electric energy is used. The evaporator of HPHE functions as the air precooler before cooling coil and the condenser of HPHE functions as the air reheat before electric coil in a HVAC system.

Key factors affecting on thermal performance of a HPHE are: velocity, relative humidity (RH) and dry-bulb temperature (DBT) of input air, type and filling ratio (FR)

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