ABSTRACT

Due to their high heat transfer capabilities with no external power requirement, wickless heat pipes are often used in heat exchange equipments. The wickless heat pipe is a two phase closed thermosyphon and is an effective heat transfer device, it utilizes the evaporation and condensation of the working fluid inside the wickless heat pipe to transport the heat.

In present study, the objective of the research is to investigate the effect of cross sectional geometries, working fluid fill volume, heat input and inclination angle on the performance of wickless heat pipe. Wickless heat pipes with two different cross section geometries (circular and elliptical) were designed and manufactured. Each wickless heat pipe under test was 800 mm long, having evaporator, adiabatic and condenser section of lengths 350 mm, 100 mm & 350 mm respectively. Distilled water, ethanol, methanol and acetone were used as a working fluid in each cross section geometry wickless heat pipe.

An experimental test rig has been designed and fabricated to carry out experimental investigation on wickless heat pipes. Experiments were carried out at different electric heat inputs and the inclination angles (β) towards the vertical position. The coolant mass flow rate of 0.0083 kg/s (30 lph) at condenser was kept constant throughout the test.

For elliptical geometry wickless heat pipes the temperature distribution along the wall surface of ethanol, methanol and acetone charged pipe was observed to be higher than water-charged wickless heat pipe for the same fill volume. The effect of inclination angle on temperature along wall surface was also studied experimentally. The wall temperature in evaporator section was observed to be lower at inclination angles 0°, 10° and 20°, after that wall temperatures increases and reached maximum at 60°. The maximum heat transfer rate was found to be higher for water compared to other working fluids such as ethanol, methanol and acetone. The effect of working fluid properties on Q/Q_{90} was investigated at different inclination angles. The maximum heat transfer rate (Q/Q_{90}) for all working fluids was observed at 10°.

Maximum condensation heat transfer coefficient was observed at 10° angle of inclination. Higher heat transfer coefficient was observed for water charged pipes than the ethanol, methanol and acetone charged wickless heat pipes at same
heat input. The effect of working fluid (water, ethanol, methanol and acetone) had significant effect on heat transfer characteristics of wickless heat pipe.

The experimental results also indicate that the temperature distribution along wall surface of elliptical cross section was observed to be higher than circular section geometry wickless heat pipe. Deforming the circular section wickless heat pipe to have elliptical cross section significantly improves the heat transfer coefficient at condenser section. The elliptical cross section pipes showed better performance than circular cross section wickless heat pipes at higher heat inputs and highest heat transfer coefficient was observed at an inclination of 10°, for water, ethanol, methanol and acetone charged wickless heat pipe.

Correlations were developed for water, ethanol, methanol and acetone charged wickless heat pipe that show good agreement with the experimental results. The correlations were also found to be in good agreement with previously published experimental data.