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Study of heat flux in Heat Exchangers by using ZnO Nano fluid

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Abstract

Heat transfer in anticipation of the heat transfer between two objects because of the temperature difference arises deals.Nano fluids are a class of heat transfer fluids which are created by dispersing solid nanoparticles in traditional heat transfer fluids. This work describe an empirical design and a numerical method to illustrate the forced convective heat transfer using traditional fluid and Zinc Oxide/Water Nano fluid in double-pipe heat exchanger utilizing commercially available equipment. The test results are shown that the heat transfer rate and heat transfer coefficients of the Nano fluid is higher than that of the base liquid (i.e., water). Increasing in the overall heat transfer coefficient is more forcible at high cold flow rate for a given hot fluid flow rate. The heat transfer rate and heat transfer coefficients, finally increase with increase in mass flow rates of hot and cold streams.

Keywords: Convective heat transfer-Heat exchanger-Nano fluid

Introduction

The thermal capability of the working fluid must be increase to enhance the thermal efficiency of the heat exchangers [7]. A novel approach to engineering fluids with better heat transfer properties are based on the rapidly emerging field of nanotechnology. Nano fluid is the name conceived by Argonne National Laboratory to describe a fluid in which nanometer-sized particles are suspended. Nano fluids are a class of heat transfer fluids created by dispersing solid nanoparticles in traditional heat transfer fluids. Results of this work show that Nano fluids have thermal properties that are very different from those of conventional heat transfer fluids such as water or ethylene glycol.

Experimental setup

The applied experimental setup is shown in Figure 1.

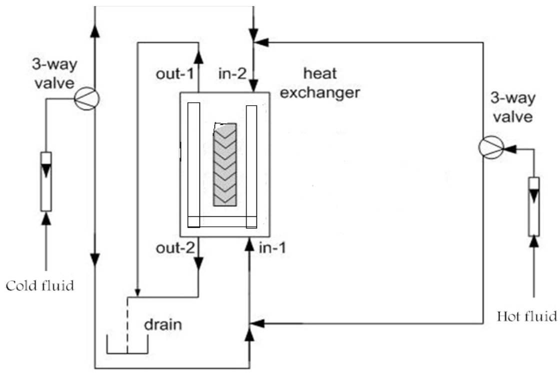

Figure 1. Schematic diagram of the experimental unit

The Q_c, and, Q_h are calculated by Eqs. (1) and (2). It is confirmed that they are practically equal.

$$Q = Q_C = m_c C_{pc}(\Delta T_C) \quad (1)$$

$$Q = Q_H = m_H C_{pH}(\Delta T_H) \quad (2)$$

The flow rates of the hot and cold fluids were set and after steady state was achieved the temperatures were recorded, during each experiment. Temperature data are acquired using high accuracy T-type thermocouples, situated at the inlet and outlet of the hot and cold streams, respectively.
Then, the mass flow rate of hot fluid was increased and new data were obtained. The aforementioned procedure was also repeated for various cold fluid flow rates. The overall heat transfer coefficients and heat transfer rates can be calculated from the mentioned equations, finally.

Results and discussions

Concentric tube heat exchangers are the simplest type of heat exchanger. Essentially it is a tube inside of a tube. In one part a hot fluid flows and transfers its heat through the wall of a metal (stainless steel) to another cold fluid. The counter flow configuration has been used through all of the experimental works.

Nano fluid flows inside the inner tube as a hot stream while distilled water entered annular section as a cold stream. The effect of hot and cold fluids flow rates on the heat transfer rate and heat transfer coefficients of Nano fluid has been investigated.

Figure 2 show the heat transfer rate and total heat transfer coefficients versus hot fluid mass flow rate for various cold fluid flow rates. Also the comparison between the heat transfer of Nano fluid and base fluid is illustrated in Figure ۲. It can be shown the heat transfer rates increases with increasing in hot and cold liquid flow rates. Also, the heat transfer rate and total heat transfer coefficient of the Nano fluid is higher than the distilled water for a given hot or cold flow rates. Increasing the hot fluid flow rate leads to an increase in the heat transfer rate and results in an increase in the heat transfer coefficient.

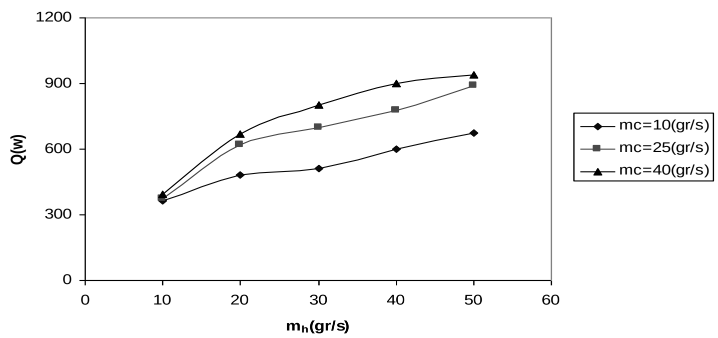

Figure 2. The effect of hot and cold flow rate on heat transfer rate of Nano fluids in double pipe heat exchanger

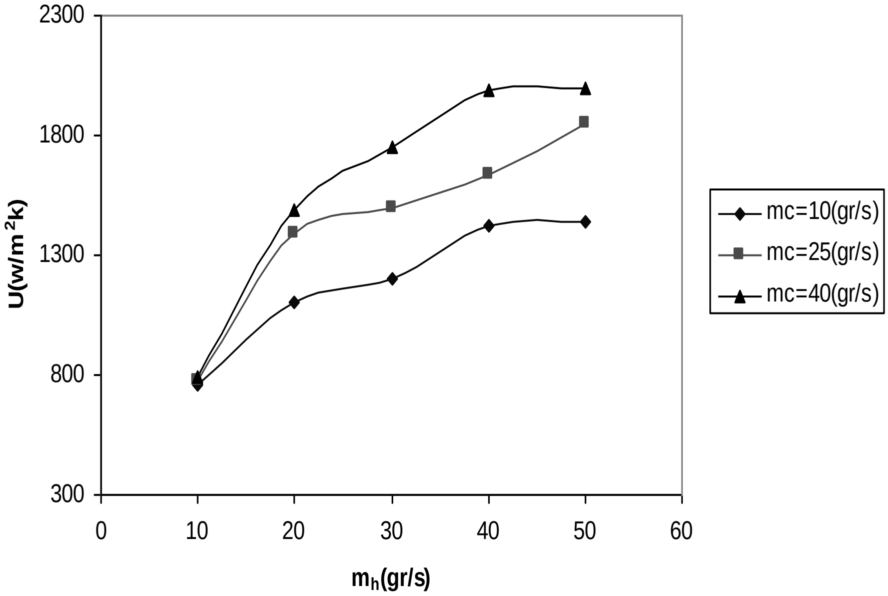

Figure 3. The effect of hot and cold flow rate on overall heat transfer coefficient of Nano fluids

This paper shows overall heat transfer coefficient of Nano fluid and distilled water versus hot fluid mass flow rate. This Figure shown for a constant mass flow rate, heat transfer coefficients of Nano fluid are much higher than distilled water. For example at the m_h=30 gr/s, and m_c=40 gr/s, the heat transfer coefficient of Nano fluid is about 18% higher than distilled water.

Conclusion

For a given hot or cold flow rate, the heat transfer rate and total heat transfer coefficient of the Nano fluid is higher than the distilled water. Increasing the hot fluid flow rate leads to an increase in the heat transfer rate and results in an increase in the heat transfer coefficient.
For a given hot fluid flow rate; the increase in the overall heat transfer coefficient is more forcible at high cold flow rate. For example in the $\dot{m}_{cold} = 10$ gr/s and $\dot{m}_{hot} = 40$ gr/s the increase in U is 7.5% but in the $\dot{m}_{cold} = 40$ gr/s and $\dot{m}_{hot} = 40$ gr/s, the increase is 14.1 %.
In a constant mass flow rate, heat transfer coefficients of Nano fluid are much higher than base fluid (distilled water). For example in a double pipe heat exchanger, at the m_h=30 gr/s, and m_c=40 gr/s the heat transfer coefficient of Nano fluid is about 18% higher than distilled water.

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