Heat Transfer Enhancement by Using Cuo in Heat Exchanger

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Abstract- *This article reports an experimentalstudyon the forced convective heat transfer and Flowcharacteristics of a nano fluid consisting of water anddifferent volume concentrationsof CuO nanofluid(0.3–2)% flowing in a horizontal shell and tube heatexchanger counter flow under turbulent flow conditions.The CuO nanoparticles of about 30 nm diameter will be used.*

Keywords- Nanofluid, overall heat transfer coefficient, mass flow rate, LMTD.

I. INTRODUCTION

Heat exchanger is a device which transfers heat from hot fluid to cold fluid. Nano fluid is used as a cold fluid in heat exchanger which considered as a three phase fluid i.e. solid phase (nanoparticles), liquid phase (base fluid), and interfacial phase therefore it increases the rate of heat transfer and efficiency of heat exchanger as well. In many field like Automobiles, boilers, cooling towers, and cogeneration systems use of Nano fluid has become one of the emerging topics discussed due to its favorable characteristics in thermal and electrical conductivity. Nano fluid is prepared either by one-step or two-step method. The thermal performance parameter overall heat transfer coefficient is compared for nanofluids with water. The study is done at different mass flow rates and inlet fluid temperatures. It is observed that for high Reynolds number low concentration of nanofluid is useful.

II. LITERATURE REVIEW

a) Bharat Bhosale: The study is done at different mass flow rates and inlet fluid temperatures. It is observed that for high Reynolds number low concentration of nanofluid is used.
b) K Vijay Kumar Reddy: They carried out the heat transfer enhancement using double pipe heat exchanger. The parameters studied were diff. jet flow rates, jet nozzle diameters and conc. Of nanoparticle.
c) Arun Kumar Tiwari: The study shows that after the addition of CuO particles were reported to enhance the resulting thermal conductivities ofbade fluids by upto 30% at partcle volume fraction of CuO 5% conc.
d) JaafarAlbadr: Heat transfer coefficient of a nanofluid increases with an increase in the mass flow rate and with the increase of the volume concentration of the CuO nanofluid.

III. PROBLEM STATEMENT

The need of increasing the rate of heat transfer efficiency in the heat exchanger by using nanofluid. With using the nanofluid in heat exchanger the rate of heat transfer increases and the effectiveness also increases.

IV. MATERIAL SELECTION

a) Nanofluid: May different typesofnanofluids are used wewil be using CuO for our experiment. Base fluids mostly used in the preparation of nanofluids are the common working fluids of heat transfer applications such as, water, ethylene glycol and engine oil. From available materials we have selected water as base fluid and CuO as nanoparticles because of improves viscocity and thermal conductivity.

b) Rotameter: 1. Range – 0 to 5 lpm
2. Range – 0 to 10 lpm

V. NANOFLUID PREPARATION

Preparation of nanofluid is the most important step. Nanoparticles CuOof particles diameter size 30 nm were purchased from Sigma-Aldrich Company. Nanofluid is prepared with the help of mechanical stirrer with electrical motor of 3000 rpm. Nano fluid is prepared with the help of two step method.

VI. EXPERIMENT

1) Dispersed the nanofluid powder with water.
2) Start the water supply. (mixture of water and CuO)

3) Adjust the water supply on hot and cold sides. Firstly keep the valves V2 and V3 open and V1 and V4 closed so that arrangement is counter flow.
4) Switch on the pump and adjust the flow rate. Readings are to be taken at 1, 2 or 3 lpm. Adjust flow rate by using control valves and knobs on Rotameter.
5) Now switch off the pump.
6) Switch ON the heater by adjusting voltage of dimmerstat current. Slowly the temperature of the water will start rising, after temperature become steady, note down the readings and fill up the observation table.

Fig: Heat Exchanger Setup.

VII. CALCULATIONS

For Hot water:

For mass flow rate 100 lph

$Q_h = \dot{m}_h \times C_{ph} \times (t_{h1} - t_{h2})$

$= 0.0277 \times 4.187 \times 10^{-3}$(67.1-50.6)

= 1.913KJ

For cold water:

$Q_c = \dot{m}_c \times C_{pc} \times (t_{c1} - t_{c2})$

$= 0.277 \times 4.18 \times (27.3 - 25.6)$

= 1.9733KJ

Q = UAθ_m

$$\theta_m = \frac{\theta_1 - \theta_2}{\text{In}(\frac{\theta_1}{\theta_2})}$$

$\theta_1 = (T_{h1} - T_{c2})$

= (67.1-27.3)

$\theta_1 = 39.8°C$

$\theta_2 = (T_{h2} - T_{c1})$

= (50.6-25.6)

= 25°C

$$\theta_m = \frac{39.8 - 25}{\text{In}(\frac{39.8}{25})}$$

$\theta_m = 31.82°C$

A $= \pi \times D \times L$

$= \pi \times 0.0125 \times 1$

A = 0.03926 m^2

U_{opr} **=1555.83 W/m^2K**

For cooling water:-

Calculation For R_{ec}*:*

$D_h = D_i - d_o$

$= 25.4 - 13.5$

=11.9mm

$\dot{m}_w$=1000 lph (0.277 m/s)

$\dot{m}_w = \rho \times A \times V_w$

$0.277 = 1000 \times \frac{\pi}{4} \times (0.0254^2 - 0.0135^2) \times V_w$

V_w=0.7622 m/s

$V_w = \frac{R_e \times \mu}{\rho \times d}$

$0.7622 = \frac{R_e \times 0.8908 \times 10^{-3}}{1000 \times 0.0119}$

$R_e = 10208.77$

Energy Losses:

For 100 lph

Pressure drop

$\Delta p = \rho\, g\, h_L$

=13600×9.81× (275/760)

= 48.27 Kpa

Energy loss

ΔE = Q ΔP

$= (100\times10^{-3}/3600)\times48.27\times10^3$

= 1.3408 J

VIII. FUTURE SCOPE

The designed experimental set up can be used to study heat transfer increase by the nanofluid water suspension. Different types of nanofluid like Alumina,TiO_2, Cuo,Silver,Gold with different volume concentrations can be studied. The change in pressure drop with respect to change in fluid flow rate & type of fluid can also be measured with this set up.Feasibility study of Nanofluid for heat exchange application can be understand by experimentation on the set up. Possible application of nanofluid as a heat exchange fluid in different heat exchangers, throttle systems, oil coolers,etc

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