Review Paper on Application of Nano Particle to Enhance Heat Transfer

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***Abstract-* In the present study, new cooling techniques are being explored for the dissipation of heat fluxes. Many recent studies on heat transfer with Nano fluids have focused on the advantages of single-phase enhancement of heat transfer. The convective heat transfer, friction factor, pressure drop and effectiveness of different volume concentrations of CNT Nano fluid flow in an outer tube of double pipe heat exchanger has been estimated experimentally and turbulent flow conditions. Also the relation between Re and Nu has been developed based on experimental data. The experimental outcomes are flow rate and temperature of hot and cold fluid respectively. The test and study of design data of double pipe heat exchanger and study of experimental data from that simulation work will be done.**

***Index Terms-* Double pipe heat exchanger, MWCNT/water, Nano fluid, CuO.**

INTRODUCTION

Nano particles are relatively advance class material which is used in conventional heat exchanger and enhancing the fluid characteristics. Nanoparticle of size 1-100mm, when suspended along with conventional base fluid is called nanofluid. As solids are better thermal conductivity and heat capacity than fluid, therefore nanoparticles are dilute suspended into conventional base fluid to increase effectiveness of heat exchanger, which is creating a new scope in nano technology. According to new scientific research, nanoparticle suspended base fluid has shown remarkable improvement in its characteristics. Nanoparticles are divided basically two types- (a) Metal- Oxide and (b) Non-Metal Oxide. Nano Particle possessed heat exchanger has effective increase in heat transfer as compared to conventional heat exchanger due to following reasons Choi (1995) a) Due to increase in surface area between nanoparticle and base fluid. c) Brownian motion of nanoparticles make it more stable in high dispersion. d) Remarkable increase in heat transfer causes reduction in pumping power as compare to conventional system to achieve same amount of heat transfer. e) By changing the concentration of addition of nanoparticle with base fluid can adjust heat transfer as well as surface wet ability. Sabareesh, (2012) performed an experiment on refrigerant R12 based vapour compression refrigeration system. In this experiment nanofluid (small concentration TiO2) was used. According to this experiment nanoparticle suspended refrigerant increase viscosity of refrigerant, but frictional coefficient decreased as increase in volume concentration of nanoparticles. The rate of heat transfer increased by 3.6% with increase in volume fraction of 0.01%. There was a significant increase in COP followed by decrease in compressor work by 11%. Thus it is cleared that by using nanoparticle dispersed refrigerant the performance of vapour compression system increased. An experiment to monitor the behavior of TiO2 nanoparticle suspended refrigerant R141b during nucleate pool boiling shows reduced the rate of boiling heat transfer by dispersing TiO2 nano particle increased from 0.03% to 0.05%(vol.). At higher heat flux rate the boiling heat transfer coefficient decreased at an increased volume concentration. Eastman, (1996), Liu (2006), Hwang (2006), Yu (2009), and Mintsa (2009), noticed significant increase of nanofluids thermal conductivity compared to conventional fluid.

Improvement of convective heat transfer was investigated by Zeinali Heris (2007), Kim, Jung (2009), and Sharma (2009).

PREPARATION OF NANOFLUID

The amount of nanoparticle required to prepare the nanofluid with different volume concentrations can be calculated from equation

$$\%\ \text{Volume Concentration} = \left[\frac{\frac{\text{Wnanopaticle}}{\text{Pnanoparticle}}}{\frac{\text{Wnanopaticle}}{\text{Pnanopaticle}} + \frac{\text{Wwater}}{\text{Pwater}}}\right] X\ 100$$

To get uniform dispersion of nanoparticles in water, the prepared nanofluids were sonicated for 3 hrs using ultrasonic sonicator. Sonication is the act of applying sound energy for proper mixing of any sample, for various proportion. Ultra sonic frequencies (>30 kHz) are usually used, this process also known as ultrasonication. Then the nanofluid was stirred using magnetic stirrer for 1 hr after preparing the nanofluid. No sedimentation was observed for several hours.

EXPERIMENTAL SETUP

The experimental set up as shown in the Figure could be used to transfer heat from nano fluid in a heat exchanger to water stored in a separate tank and make temperature calibrations for the same by employing four thermocouples. Also, Rotameter are installed in the pipes carrying nanofluid and hot water to check respective flowing rates. The complete system will be very dynamic and easy to use. It consists of two flow loops, a heating unit to heat the water and temperature measurement system. The two flow loops carries heated water and the other cooling nanofluid. Each flow loop includes a pump with a Rotameter, a reservoir and a by-pass valve to maintain the required flow rate. Thermocouples are inserted on the heat exchanger to measure the bulk temperatures of inlet and outlet fluid streams. The pumps are used with maximum delivery rate of 1000 LPH.

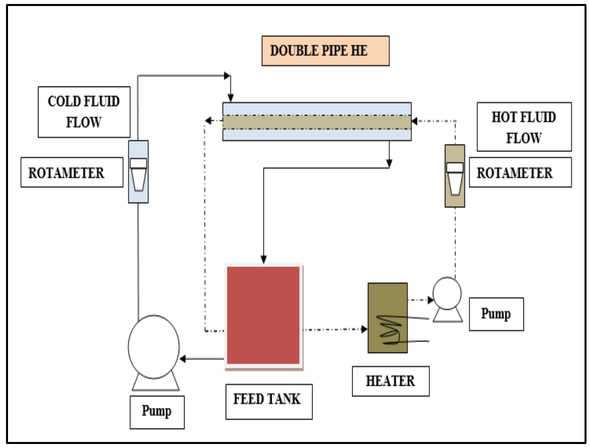

Figure 1 Line diagram Experimental setup

RESULT AND DISCUSSIONS

The results of experimental study by using nanofluid in different concentration have been discussed as below

I) PHYSICAL PROPERTIES

The density we consider the density of the particles as constant in the range of temperature used, and we take in account the variation of the density of the water in accordance with the temperature. We neglect the presence of surfactant and the relation used is the following

$\rho_{NF} = \phi\ \rho_{CNT} + (1-\phi)\rho_W$

The heat capacity the specific heat of the nanofluids was obtained from the equation given by Xuan and Roetzel which assumes thermal equilibrium between the base fluid and the nanoparticles. The equation is

$$C_{PNF} = \frac{\phi(\rho\ C_P)_{CNT} + (1-\phi)(\rho\ C_P)_W}{\rho_{NF}}$$

Thermal conductivity enhancement of thermal conductivity is the striking feature of nanofluids, hence, in this work, thermal conductivity of nanofluids was exprimentally measured by KD2 Decagon device and other thermo-physical properties were estimated using correlations introduced

$$K_{NF} = \frac{K_P + (N-1)K_f + (N-1)(K_P - K_f)\emptyset}{K_P + (N-1)K_f - (K_P - K_f)\emptyset} K_f$$

II) CALCULATION OF COVECTIVE HEAT TRANSFER

Heat Transfer from hot water (Qh):

Qh = Mh. Cph.(Thi- Tho)

Heat Transfer rate to cold water (Qc):

Qc = Mc Cpc (Tco-Tci)

L.M.T.D: $\Delta Tm = \Delta Ti - \Delta To / \ln(\Delta Ti / \Delta To)$

Overall Heat transfer Based on Internal Area of Tube Ui :

$Q = Ui\ Ai\ (\Delta Tm)$

$Ai = \pi\ di\ L$ & $Ao = (\pi/4)(do2-di2)$

III) STABILITY EVALUATION METHODS FOR NANOFLUIDS

Sedimentation method

It is the most basic method for stability evaluation of Nano fluids. The stability of Nano fluids is indicated by the weight or the volume of sediment.

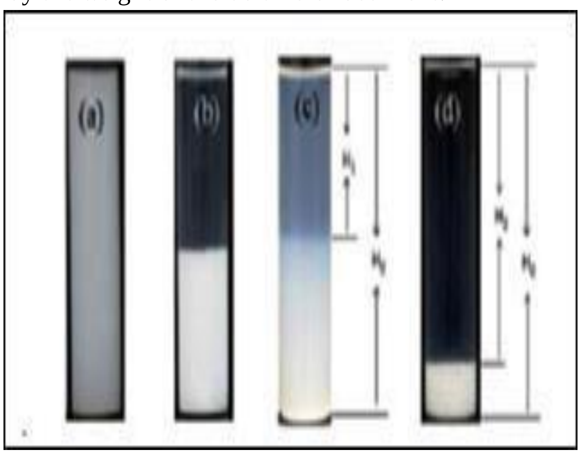

Figure 2 Nanofluid sediment

Spectral analysis method

Spectral analysis via UV- Vis spectrophotometer is a very useful method to evaluate the stability of nano fluids as it gives quantitative results corresponding to concentration of nano fluids.

CONCLUSION

In this paper, experimental and numerical investigation of different researchers from previous work on heat transfer enhancement of heat exchangers by using different nanofluid has been reviewed for wide range of Reynolds number and nanoparticle concentrations.

Two nanofluids (CuO) and carbon nanotubes (CNTs) dispersed in water are tested in the experimental process presented previously under a laminar out-flow mode. The experimental installation has been finalized and validated on water in order to value the thermal performances of the nanofluids at low temperature.

Complementary experimental studies on the thermal conductivity would permit to study the evolution of the number of Nusselt according to the number of Reynolds and finally the impact of the surfactant on the thermal characteristics of the nanofluids must be better dominated to analyse in a more precise way the thermal transfers. It's possible that in this low temperature, the surfactant loss these properties.

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