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Comparison Analysis Between Cuo And Sio_2 Nan fluids Heat Transfer In Phe

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Abstract:- In the present study, the effects of nano fluids used in the plate heat exchanger has been experimentally studied. In the first stage temperature of the nano fluids has been measured and compared with enhancement with base fluid (water) and in second stage heat transfer performance of plate heat exchanger has investigated using CuO and SiO_2 (0.1 v/v and 0.2v/v) nano fluids. The experimental study has been conducted by change in different parameters such as the Flow Rate, inlet & outlet temperatures' and nano fluid concentrations. Heat transfer performance of plate heat exchanger has been compared with water. From the results it has been observed that performance of heat exchanger has been enhanced with increasing the Overall Heat Transfer Coefficient and Nusselt Number with different flow rate with different particles concentrations. In the results it has been shown that CuO nano fluids have best performance as compared to SiO_2 and water.

Keywords:- Heat Exchanger, Nano fluids, PHE **(**Plate Heat Exchanger), Heat Transfer Coefficient, SiO_2 Nanoparticals, CuO nano particles.

I. INTRODUCTION

1.1 Plate Heat Exchanger [PHE]

A plate heat exchanger is a one of the most useable type of heat exchanger in which metal plates are used to transfer heat between two fluids [1]. Plate type heat exchangers are very important components of power industry and process today. Due to their ease of clearing uses of the plate type heat exchangers was limited to hygienic industries such as pharmaceuticals, food processing and dairy industries primarily [2].

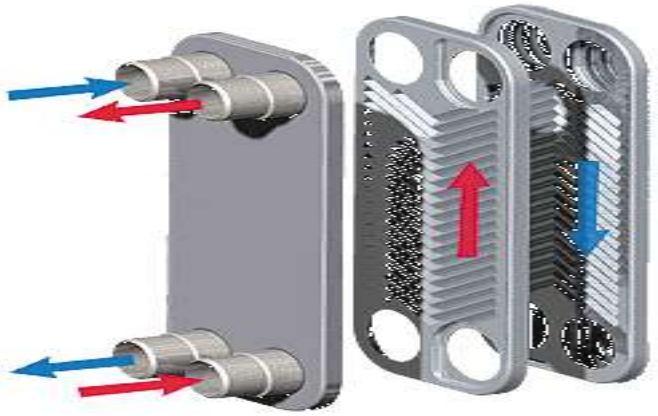


Fig. – 1.2 Plate Heat Exchanger

1.2 Classification of Plate Heat Exchanger:
1.Gasket plate heat exchangers (plate and frame heat exchangers)
2.Brazed plate heat exchangers
3.Welded plate heat exchangers
1.Gasket plate heat exchangers (plate and frame heat exchangers) -

Each plate is made by stamping or embossing a corrugated (or wavy) surface pattern on sheet metal. On one side of each plate, special grooves are provided along the periphery of the plate and around the ports for a gasket, as indicated by the dark lines in Fig. 1.2. Typical plate geometries (corrugated patterns) are shown in Fig. 1.4, and over 60 different patterns have been developed worldwide. Alternate plates are assembled such that the corrugations on successive plates contact or cross each there to provide mechanical support to the plate pack through a large number of contact points. The resulting low passages are narrow, highly interrupted, and tortuous, and enhance the heat transfer rate and decrease fouling resistance by increasing the shear stress, producing secondary flow, and increasing the level of turbulence. The corrugations also improve the rigidity of the plates and form the desired plate spacing. Plates are designated as hard or soft, depending on whether they generate a high or low intensity of turbulence

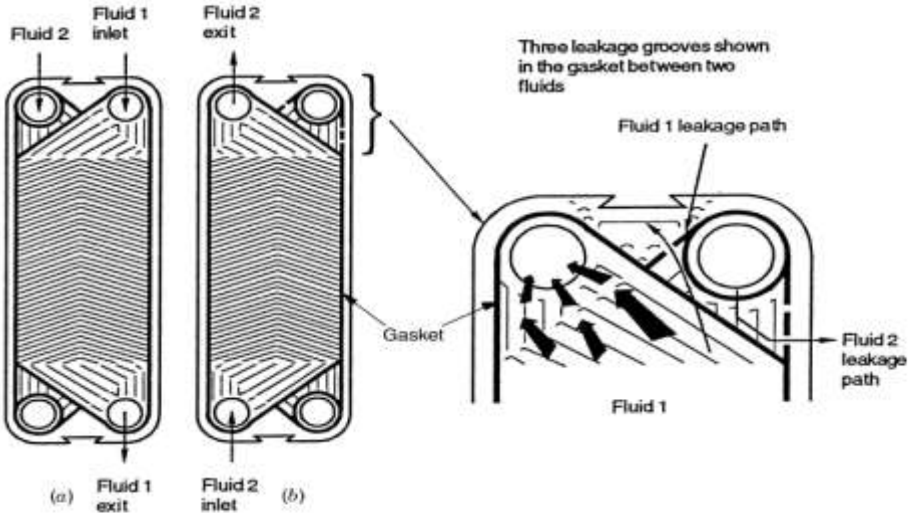


Figure - 1.3 Plate showing gaskets around the ports (Shah and Focke, 1988)

Brazed Plate Heat Exchange (BPHEs) -

A brazed plate heat exchanger is a compact PHE for high-temperature and high-pressure duties, and it does not have gaskets, tightening bolts, frame, or carrying and guide bars. It consists simply of stainless steel plates and two end plates, all generally copper brazed, but nickel brazed for ammonia units. The plate size is generally limited to $0.3m^2$. Such a unit can be mounted directly on piping without brackets and foundations. Since this exchanger cannot be opened, applications are limited to negligible fouling cases. The applications include water-cooled evaporators and condensers in the refrigeration industry, and process water heating and heat recovery. BPHEs were developed with experience and expertise from a wide range in many different climates.

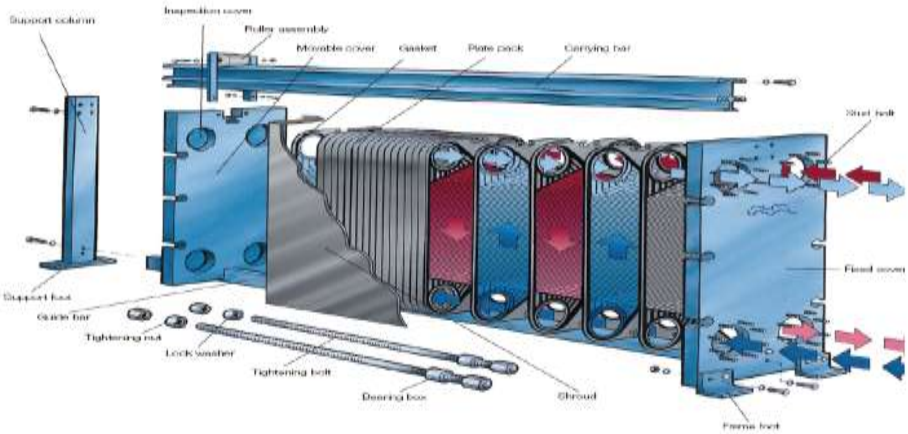


Figure - 1.4 Brazed Plate Exchanger

We aim to maximize the performance and at the same time minimize the amount of material used. This has environmental benefits, keeps costs down and reduces exposure.

Advantages and Limitations -

1. They can easily be taken apart into their individual components for cleaning, inspection, and maintenance.
2.The heat transfer surface area can readily be changed or rearranged for a different task or for anticipated changing loads, through the flexibility of plate size, corrugation patterns, and pass arrangements.
3.High shear rates and shear stresses, secondary flow, high turbulence, and mixing due to plate corrugation patterns reduce fouling to about 10 to 25% of that of a shell-and-tube exchanger, and enhance heat transfer.

4.Very high heat transfer coefficients are achieved due to the breakup and reattachment of boundary layers, swirl or vortex flow generation, and small hydraulic diameter flow passages. 5.Because of high heat transfer coefficients, reduced fouling, the absence of bypass and leakage streams, and pure counter low arrangements, the surface area required for a plate exchanger is one-half to one-third that of a shell-and tube exchanger for a given heat duty, thus reducing the cost, overall volume, and space requirement for the exchanger.
6.Also, the gross weight of a plate exchanger is about one sixth that of an equivalent shell-and-tube exchanger.
7.Leakage from one fluid to the other cannot take place unless a plate develops a hole.
8. The gasket is between the plates, any leakage from the gaskets is to the outside of the exchanger.
9.The residence time (time to travel from the inlet to the outlet of the exchanger) for different fluid particles or flow paths on a given side are approximately the same.
10.This parity is desirable for uniformity of heat treatment in applications such as sterilizing, pasteurizing, and cooking.

II. RESEARCH OBJECTIVE

The experimental set up has been constructed is to check heat transfer rate. Nanofluids are used since they exhibit the property of high heat transfer rate. The main components of the set up are water tank, pump, heat exchanger, flow meter, and manometer. There will be increase of the mass velocity of fluid which results in the increase of pressure drop across the test section. Pressure drop increases with nano fluids. Therefore, the choice of flow rate is important factor. SiO_2 and CuO nano particles (Nano shells) are being used

a) To Prepare the Nano fluids SiO_2 and CuO with base fluid water.
b) The effect of Heat Transfer Coefficient with Nusselt Number on plate heat exchanger.
c) Comparison of overall Heat Transfer Coefficient with water and Nano fluids.

III. EQUIPMENT USED

Experimental set up include:

1) Main storage tank with heat source
2) Flow meter
3) Magnetic pump
4) Thermocouples
5) U-tube manometer
6) Plate type heat exchanger
7) Control and display unit

Water storage tank -

Storage tank used for PHE has a capacity of 6L and in the storage tank the steel is used as a material. The storage tank will contain nano-fluid mixed with water in different ratios.

Nanofluids -

Copper Oxide and Silicon Oxide are the nanoparticals having size of CuO and SiO2 is 20 nm. The Nano fluids are prepared by two stepped method. 0.1 and 0.2 concentration are made by mixture 3 and 6 gms of each nano particles in separate 100ml of distilled water. Sodium Dodecyl sulphaste is used a sufrfant to avoid any settlement of nano particles in the fluid mixture. The nano particles are stirred with water for 20 minutes then sonicated for 90-100 minutes.

IV. EXPERIMENTAL ANALYSIS

In the experimental setup the brazed type plate heat exchanger is used, display panel unit including PID controller, Thermocouples, magnetic pump, Rota meter of maximum of 3 lpm flow rate. The plate heat exchanger consists of a bundle of corrugated metal plates with portholes. The plate pack is assembled between a fix frame plate and a movable pressure plate and compressed by tightening bolts. The plates are fitted with a gasket which seals the interpolate channel. The plate and the pressure plate are suspended from an upper carrying bar and located by a lower guiding bar, both of which are fixed to a support column.

Fig.-1.5 Photographic view of the set up

Product	**Special as schematic diagram**
Hot water tank	**6 liter capacity, made up of steel**
Cold Water Bucket	**10 Liter capacity, made up of plastic**
Pump	**Magnetic pump (capacity 15 LPM) , Submersed pump (clod fluid)**
Manometer	**U – tube manometer for checking pressure drop across the test section**
Temperature sensor	**RTD PT-100 type (Quantity-4 Nos.)**
Heat exchanger	**Brazed type plate heat exchanger**
Flow meter	**Rota meter with range of .5 LPM – 5 LPM**
Control panel	**Digital temperature controller with on/off switch (0-199 c)**
PID controller	**Maintain the selected temperature and cut the heating supply if exceeded selected temperature**

Table – 1.1 Technical Data of Experimental Set- Up

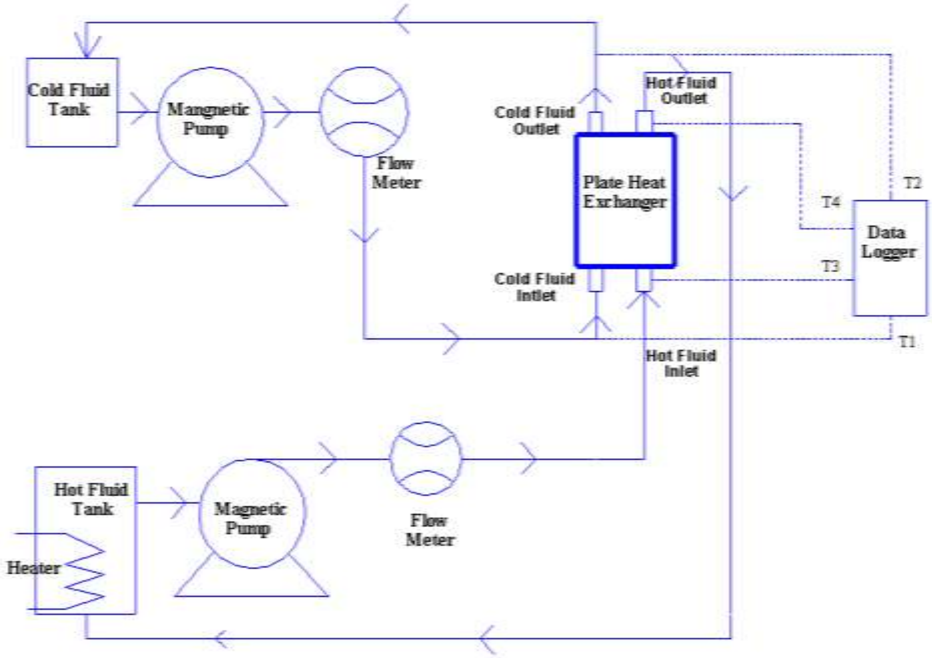


Fig. – 1.6 Line Diagram of PHE

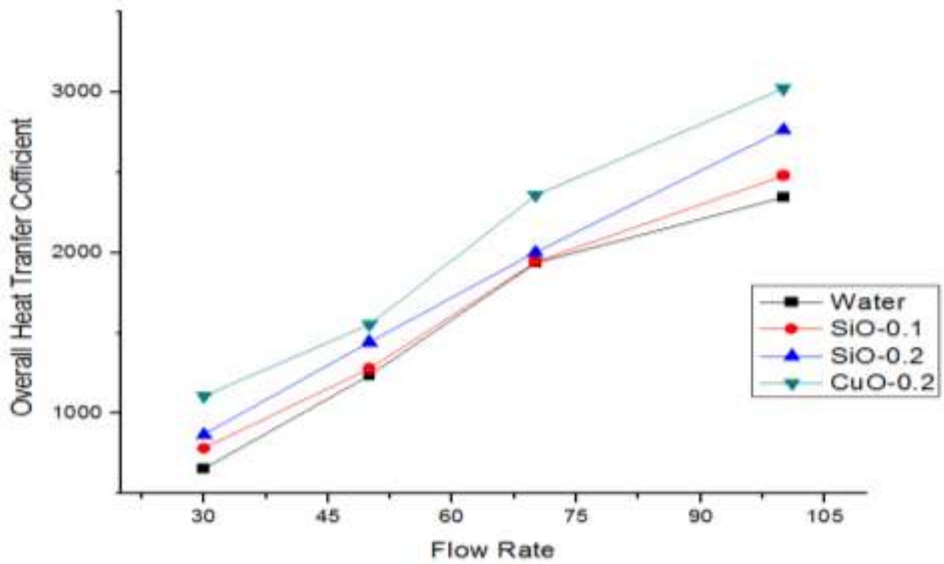
V. RESULT AND DISCUSSION

Experiments are also performed with distilled water before with SiO2/water and CuO/water nano fluid at different concentrations. In this chapter we will discuss all the parameters and results calculated for overall heat transfer coefficient.

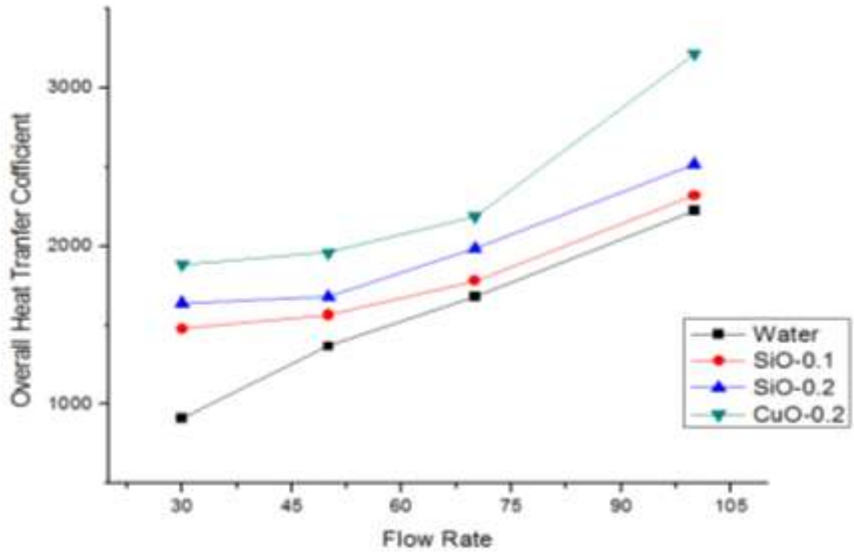
Comparison of experimental results -

Different fluids are compared for overall heat transfer coefficient at all temperatures (40°C, 45°C, 50°C, 55°C and 60°C). From the experimental study it was shown that CuO/water (.2 conc.) nano fluid has the highest 56 %, 40 %, 30% overall heat transfer coefficient from water. SiO_2/water nano fluid at both concentrations has low heat transfer coefficient than CuO (.2) at all temperature. In SiO_2/water (at .1 and .2 conc.) nano fluid heat transfer coefficient is less as compared with CuO/water (.2 conc.).

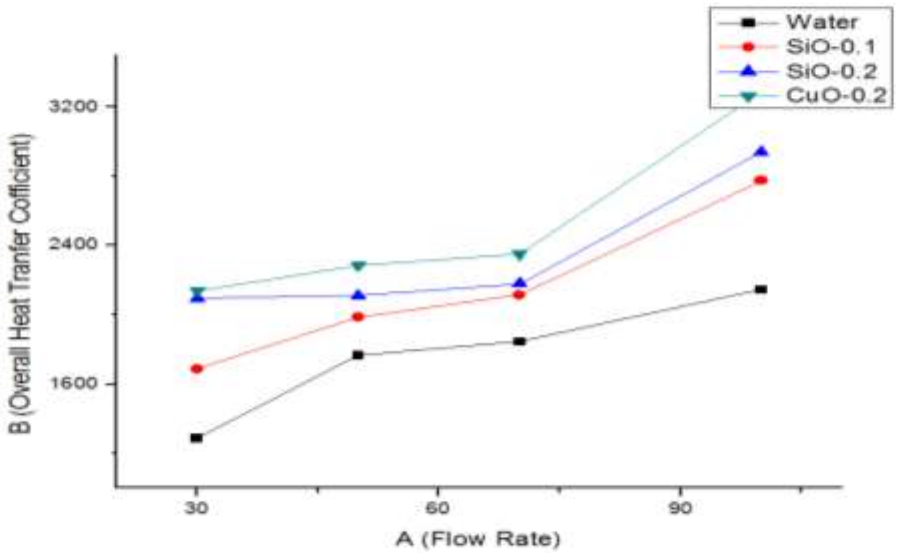
1. Variation of the Overall heat transfer coefficient with Flow rate



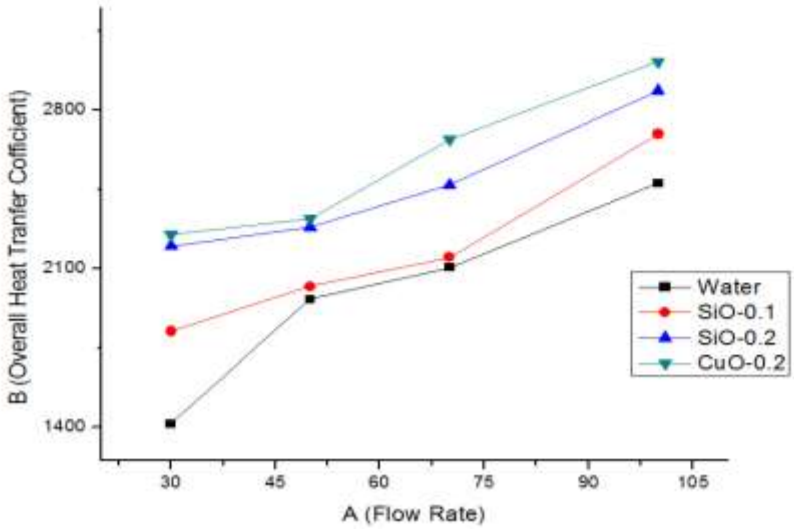
Graph – 4.1 Variation of Overall Heat Transfer Coefficient (h) with Flow Rate at 40°C



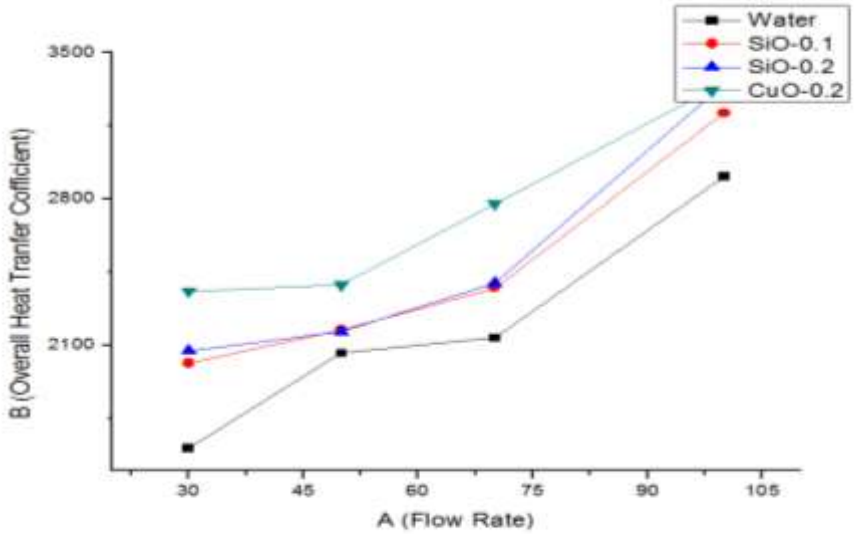
Graph. - 4.2 over all Heat transfer coefficient (h) with Flow Rate at 45°C



Graph - 4.3 Over all Heat transfer coefficient (h) with Flow Rate at 50°C



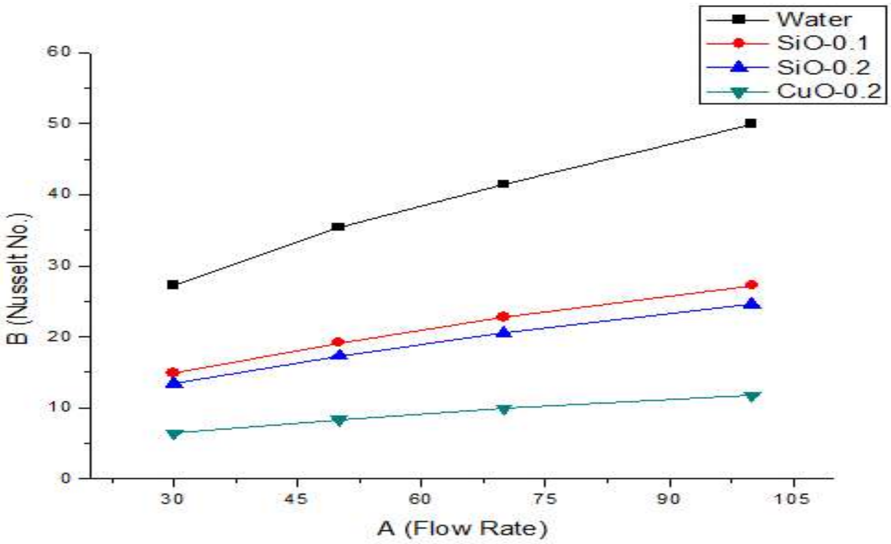
Graph - 4.4 over all Heat transfer coefficient (h) with Flow Rate at 55°C



Graph – 4.5. Over all Heat transfer coefficient (h) with Flow Rate at 60°C

2. Variation of Nusselt number (Nu) with Flow Rate

Results are compared for distilled water, SiO_2/water (.1 and .2 conc.) nano fluid and CuO/water (0.2 concentration) nano fluid. From the study it was concluded that with the increase of Flow Rate and Nusselt number (Nu) also increases. Nusselt number increases as the temperature increases. Nusselt number in case of water is lower than in case of nano fluid. The Nusselt number in case of SiO_2/water (.2 conc.) is more than water but lower than CuO/water nano fluid at all temperatures. Water has the lowest Nusselt number value in all. The comparisons of Nusselt number with Flow rate at all temperatures for all fluids are shown in the following figures.



Graph - 4.6 Variation of Nusselt number (Nu) with Flow Rate

VI. CONCLUSIONS

In present work experimentation was carried out to calculate the overall heat transfer coefficient and heat transfer characteristics on plate heat exchangers using nano fluid. 0.1% and 0.2% concentration of nano fluid are prepared. CuO/water and SiO2/water nano fluid are prepared using two-step method. From the study the following conclusions are drawn:

Heat transfer coefficient in case of CuO/water nano fluid is more than SiO_2/water nano fluid followed by distilled water. Heat transfer coefficient increases with volume concentration and is more than in case of 0.2% conc. than in 0.1% conc. for each nano fluid.

1. The overall heat transfer coefficient for CuO/water 0.2% conc. and 0.1% conc. is increased by 56% and 40% respectively. In case of SiO_2/water nano fluid for 0.2% conc. and 0.1% conc. It is increased by 30% and 26% respectively.

2. In case of CuO/water 0.2% conc. heat transfer coefficient is increased by 70%. In case of SiO_2/water nano fluid heat transfer coefficient for 0.2% conc. and 0.1% conc. is increased.

VII. FUTURE SCOPE

The ideas that we thought would be interesting for future work are as follows:

1. Study can be performed using different positioning of plate heat exchanger.
2. The studies can be performed using metallic nano-powders like ZnO, FeO_2, CeO etc.
3. Different kind of insertions can be used in concentric pipe heat exchangers.

REFERENCES

[1]. R. K. Shah and D. R Sekulib, Heat exchangers, University of Kentucky Deepali Gaikwad, Kundlik Mali Vol. 3, Issue 7, July 2014 ISSN: 2319-8753

[2]. S. Choi. Enhancing thermal conductivity of fluid with nano particles in: D.A. Siginer, H.P. Wang (Eds.) Developments and application of Non-Newtonian flows. Vol. 231/MD 66, ASMEFED, 1995, pp. 99-105

[3]. Maxwell J.C A treatise on electrical and magnetism, 2nd ed. Vol. 1, Clarendon Press, Oxford, UK, 1881

[4]. Hamilton, R. L., and Crosser, O. K., Thermal Conductivity of Heterogeneous Two Component Systems, Industrial and Engineering Chemistry Fundamentals, vol. 1, no. 3, pp. 187–191, 1962.

[5]. Wasp, E. J., Kenny, J. P., and Gandhi, R. L., Solid-Liquid Flow Slurry Pipeline Transportation, Series on Bulk Materials Handling, Trans. Tech. Publications, 1:4, Clausthal, Germany, 1977

[6]. Sarit Kumar Das, Stephen U. S. Choi, Hrishikesh E. Patel Heat Transfer in Nanofluids— A Review Heat Transfer Engineering, 27(10):3–19, 2006

[7]. Sayantan Mukherjee, Somjit Paria, Preparation and Stability of Nanofluids-A Review, ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 9, Issue 2 (Sep. - Oct. 2013), PP 63-69

[8]. H. Akoh, Y.Tsukasaki, S.Yatsuya, and A.Tasaki, ―Magnetic properties of ferromagnetic ultrafine particlesprepared by vacuum evaporation on running oil substrate.‖ Journal of Crystal Growth, 45, 495–500, 1978.

[9]. J.A.Eastman, U.S.Choi, S.Li, L.J.Thompson, S.Lee, ―Enhanced thermal conductivity through the development of nanofluids‖ , Materials Research Society Symposium-Proceedings, Materials research Society, Pittsburgh, PA, USA, Boston, MA, USA, vol.457:pp.3-11, 1997.

[10]. C–H. Lo, T-T. Tsung, L-C. Chen, C.-H. Su and H.-M.Lin, ―Fabrication of Copper Oxide Nanofluid Using Submerged Arc Nanoparticles Synthesis System (SANSS)‖ .Journal of Nanoparticles Research 7: 313–320, 2005.

[11]. C.G Granqvist and R.A Buhrman (1976). Ultra fine metal particles. J.Appl. Physics, Volume 47.pp.2200.

[12]. J.M Romano, J.C Parker and Q.B Ford (1997). Application opportunities for nanoparticles made from condensation of physical vapors. Adv. Powder methal. Partic, Mater, volume 2. pp. 12-13

[13]. J. A. Eastman, S. U. S. Choi, S. Li, W. Yu, and L. J. Thompson, ―Anomalously increased effective thermal conductivities of ethylene glycol-based nanofluids containing copper nanoparticles,‖ Applied Physics Letters, vol. 78, no. 6, pp. 718–720, 200.

[14]. Xiang-Qi Wang and Arun S. Mujumdar1 (2008) a review on nanofluids - part ii: Experiments and applications Vol. 25, No. 04, pp. 631 - 648, October - December, 2008.

[15]. F.S. Javadi , S. Sadeghipour , R. Saidur , G. BoroumandJazi , B. Rahmati , M.M. Elias , M.R. Sohel vol.no.44(2013)

[16]. Sandeep kumar et.al. int. journal of engineering research and applications ISSN : 2248, vol.4 (2014)

[17]. A.G. Kanaris, A.A. Mouza, S.V. Paras International Journal of Thermal Sciences 48 (2009) 1184–1195

[18]. Jogi Nikhil G., Assist. Prof. Lawankar Shailendra M. International Journal of Emerging Technology and Advanced Engineering [ISSN 2250-2459, Volume 2, Issue 10, Oct 2012]

[19]. B. Sreedhara Rao1, Varun S, Surywanshi G D, Prof. R C Sastry International Journal of Scientific Engineering and Technology (ISSN : 2277-1581) Volume No.3 Issue No.7, pp : 902-905

[20]. Jyoti K Javanjal and Madan Parande Journal of Chemical, Biological and Physical Sciences Vol. 3, No. 4; 2806-2817.

[21]. M.A. Khairul , M.A. Alim, I.M. Mahbubul , R. Saidur , A. Hepbasli , A. Hossain International Communications in Heat and Mass Transfer 50 (2014) 8–14

[22]. Shive Dayal Pandey, V.K. Nema Experimental Thermal and Fluid Science 38 (2012) 248–256.

[23]. Kanjirakat Anoop, Jonathan Cox, Reza Sadr International Communications in Heat and Mass Transfer 49 (2013) 5–9.

[24]. Y. Xuan and Q. Li, "Investigation on Convective Heat Transfer and Flow Features of Nanofluids,"

ASME J Heat Transfer, no. 125, pp. 151–155, 2003.
[25]. Q. Li and Y. Xuan, "Convective Heat Transfer and Flow Characteristics of Cu-Water Nano fluid" Science in China Series E, vol. 45, no. 4, pp. 408–416, 2002.
[26]. Y. Yang, Z.G. Zhang, E.A. Grulke, W.B. Anderson, and G. Wu, "Heat Transfer Properties of Nano particle-in-Fluid Dispersions (Nano fluids) in Laminar Flow," International Journal Heat Mass Transfer, vol. 48, no. 6, pp. 1107–1116, 2005.
[27]. D. Wen and Y. Ding, "Experimental Investigation into Convective Heat Transfer of Nanofluids at the Entrance Region under Laminar Flow Conditions," International Journal Heat Mass Transfer, vol. 47, pp. 5181– 5188, 2004.
[28]. S. U.S. Choi, "Enhancing thermal conductivity of fluids with nanoparticles," in Developments and Applications of Non-Newtonian Flows, D.A. Singer and H.P. Wang, Eds. New York, 1995, pp. 99-105.
[29]. Q. Li, Y. Xuan, J. Jiang, and J.W. Xu, "Experimental Investigation on Flow and Convective Heat Transfer Feature of a Nanofluid for Aerospace Thermal Management," Journal of Astronautics, vol. 26, pp. 391 - 394, 2005.
[30]. S.Z. Heris, S.G. Etemad, and Nasr Esfahany M., "Experimental investigation of oxide nanofluids laminar flow convective heat transfer," International Communications in Heat and Mass Transfer, vol. 33, no. 4, pp. 529–535, 2006.
[31]. Sarit K. Das, Stephen U.S. Choi, Wenhua Yu, and T. Pradeep , Nano fluids: Science and Technology. Hoboken, New Jersey: John Wiley & Sons, Inc., 2008.
[32]. D. Faulkner, D.R. Rector, J.J. Davison, and She, "Enhanced Heat Transfer through the Use of Nanofluids in Forced Convection," in Proceedings of ASME Heat Transfer Division, 2004, pp. 219 - 224.
[33]. W.Y. Lai, B. Duculescu, P.E. Phelan, and R.S. Prasher, "Convective heat transfer with nanofluids in a single 1.02-mm tube," in Proceedings of ASME International Mechanical Engineering Congress and Exposition (IMECE 2006), 2006.