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Experimental Investigation of Cooling Performance of Nano-Fluid Based Mini-Channel Heat Exchanger

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Abstract

Mini channel heat exchangers are largely used in several applications thus researchers are constantly working to find out the different ways to enhance the rate of heat transfer. Such activity is by no means completed. A simple product of nanotechnology nano-fluid, due to its extraordinary heat transfer performance it has become a topic of attractionMini-channel tubes are reasonable for little and light weight equipment's. Liquids are broadly utilized as warmth bearer along these lines to improve heat move rate warm conductivity of liquid ought to be expanded by certain methods, this can be best done by adding metallic particles to the liquid likewise called as nano-particles.Enhancement of cooling performance of mini-channel heat exchanger using titanium oxide nano-fluid is compared with water. The experiment is performed at different flow rates (24 LPH, 32 LPH, 40 LPH).

Keyword: *Coolant, Heat Sink, Magnetic Stirrer, Mini-channel, Nanofluid, Nanoparticles, Sonic Heater*

1.1 Introduction

A heat exchanger is a thermal device which is used in exchanging heat between two or more solutions, the fluids have a solid barrier between them to prevent it from mixing. They are used in industries like electronics industry, space industry, chemical industry, etc. Those particles which have a dimension of at least a side less than 100 nm is called a nanoparticle. Nanoparticles are currently used in many industries like electronic chip industry, optics, medical research etc. The most common thing used in today's advancing world is electronic chips. Starting from a small alarm clock to a truck, these chips play an important role. As these chips produce a lot of heat due to which there is a need of cooling agent or coolant. Hence the nanofluids were invented to cool down these systems and prevent it from any hazards. The nanoparticle, when blended with a fluid base, shows a phenomenal spike in the thermal conductivity of the nanofluid. Be that as it may, precisely evaluated single-stage heat move coefficients will decide two-stage heat move coefficients. The suspension of metallic particles in common liquid, for example, water ethylene glycol and so forth to make new class of designed liquids with improved warm conductivity is named as "Nano-liquid". Following are the properties generally possess by Nano-fluid:

ISSN: 0971-1260
Vol-22-Issue-16-August-2019

1.More heat transfer surface between particles and fluids hence providing high surface area.
2. High scattering stability with overwhelming Brownian movement of particles.

3. Diminish pumping power when contrasted with pureliquid to accomplish identical warmth move escalation.

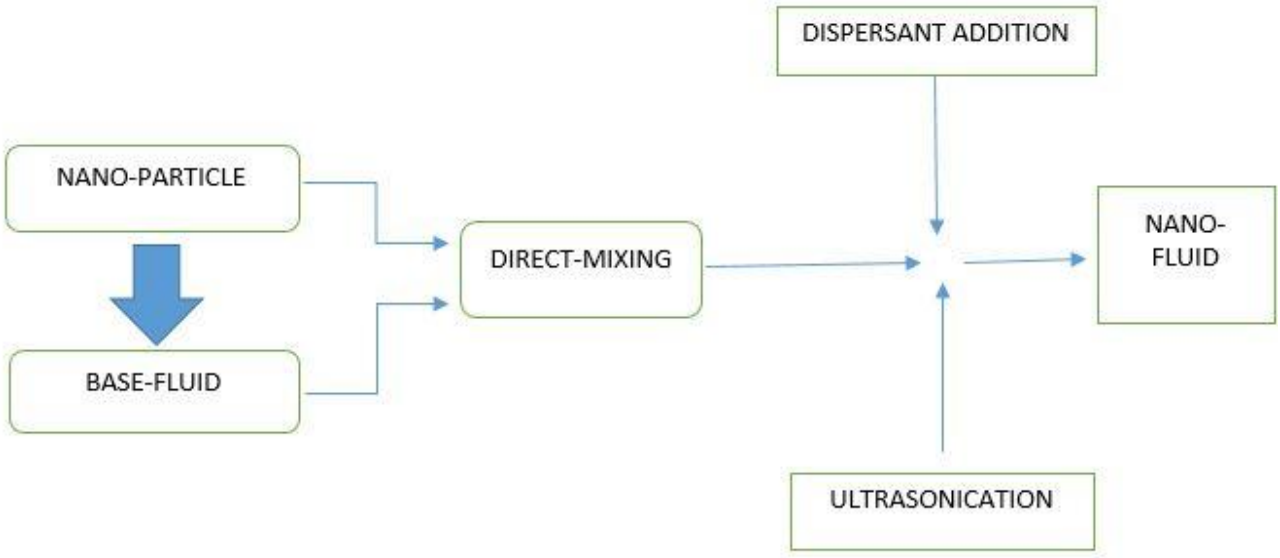

Fig. 1 Preparation of nano-fluid by Two-step method

1.2 Literature Review

Fezal et al. [1] examined on different nanofluids to evaluate the capability of planning a solar collector heat exchanger that can deliver wanted yield temperature. As per his outcomes, Copper Oxide (CuO), Titanium Oxide (TiO_2) and Alumina (Al_2O_3) are giving best yield. While, in the practical perspective nanofluids (CuO and Al_2O_3) are best choices for heat move. Chaji et al. [2] explored tentatively the impacts of TiO_2 and H_2O nanofluid as a working liquid at a little sun powered level plate gatherers. They directed trial by utilizing TiO_2 and H_2O nanofluid and 15.7% improvement found in effectiveness of sun based authority. Polvongsri and Kiatsiriroat [3] utilized silver nano liquid in a level plate sun based gatherer. Their exploratory outcomes demonstrated that silver nano liquid improve the warm presentation of level plate sun oriented gatherer, while the upgrade is more at gulf temperature. Jabari Moghadam et al. [4] tentatively observed the impact of CuO and water nano liquid, on the warm conduct of a level plate sun based gatherer. In their examination 0.4% volume portion of nanoparticles were utilized in the water working liquid, while the mass stream rate was in the scope of 1–3 kg for each min. Meibodi et al. [5] tentatively indicated that the effectiveness of level plate sunlight based gatherer with SiO_2/ethylene glycol (EG)- H_2O nano liquid, improve with the mass stream rate. Yousefi et al. [6] explored the impact of Al_2O_3- H_2O working liquid on the warm qualities of a level plate sun powered gatherer. As per their investigations, the gatherer productivity upgrades

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Vol-22-Issue-16-August-2019

by 28.3%, when utilizing 0.2% volume grouping of Al_2O_3nanofluid as contrasted and water as working liquid. Taylor et al. [7] found tentatively that by utilizing nano-liquid of Al_2O_3- H_2O (0.01 % vol. conc.) framework execution is upgraded by 10.12 %.

1.3 Experimental Setup and Methodology

The dimensions of plate is (120 mm × 55 mm) in which square channel of (2.5 mm × 2.5 mm) were cut satisfying the criteria of mini-channel heat exchanger (3 mm≥ D_h> 20 µm). The material of the plate chosen is aluminum because for equal thermal conductivity weight of aluminum is half that of copper and it is relatively less expensive. Setup include pump, four way valve, arduino, mini-channel plate and U-tube manometer, Storage tank.

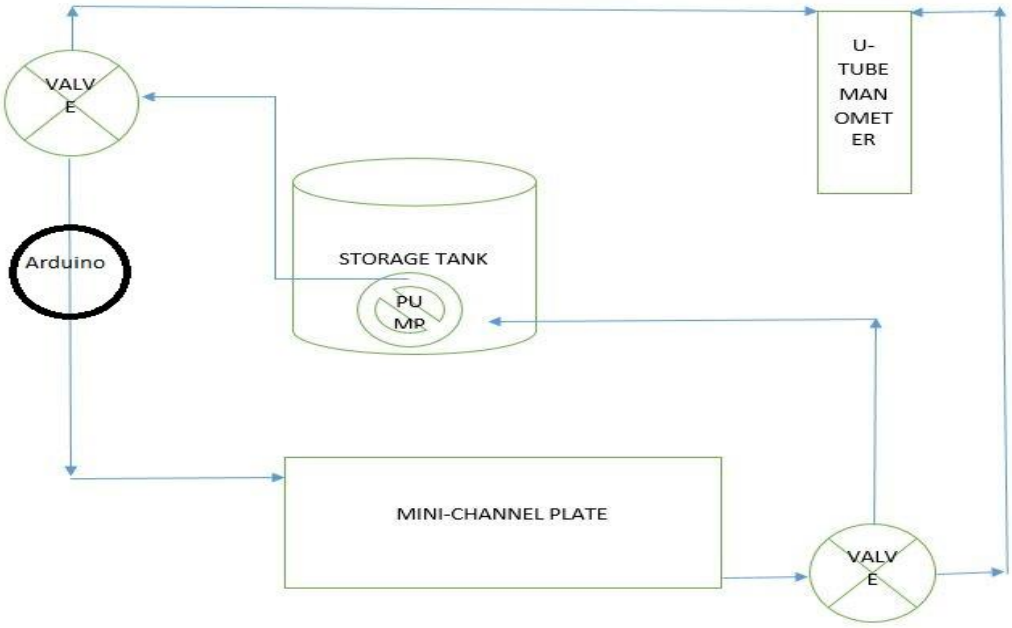

Fig. 2 Schematic diagram of experimental setup

A reservoir in which fluid is stored and pump is installed so as to flow the fluid and reduce agglomeration in case of nano-fluid. The fluid flows through the pipe passing through arduino, which gives the flow rate in LPH. After arduino it enters in four way valve where the flow is diverted in two directions namely U-tube manometer and Mini-channel plate. Mini-channel plate is heated by using heating element to 60˚C. Now fluids exit from the other section taking heat from mini-channel plate and passes through four way valve and is again diverted in two directions namely U-tube manometer and storage tank. Pressure difference is measured between the inlet and outlet of the mini-channel plate using U-tube manometer.

Working fluid (5 liters) from storage container is made to flow through the channel of aluminium plate which is completely sealed by tempered glass. The flow is controlled by ball valve and then it passes through flow sensor after that passes through four way valve in which one connection

ISSN: 0971-1260
Vol-22-Issue-16-August-2019

goes to aluminum plate and another to U-tube manometer to measure the pressure difference across the plate. Experiment performed with 24 LPH, 32 LPH and 40 LPH. Temperatures at inlet and outlet are measured by digital thermometer and flow rate measured by flow sensor

1.4 Results and Discussion

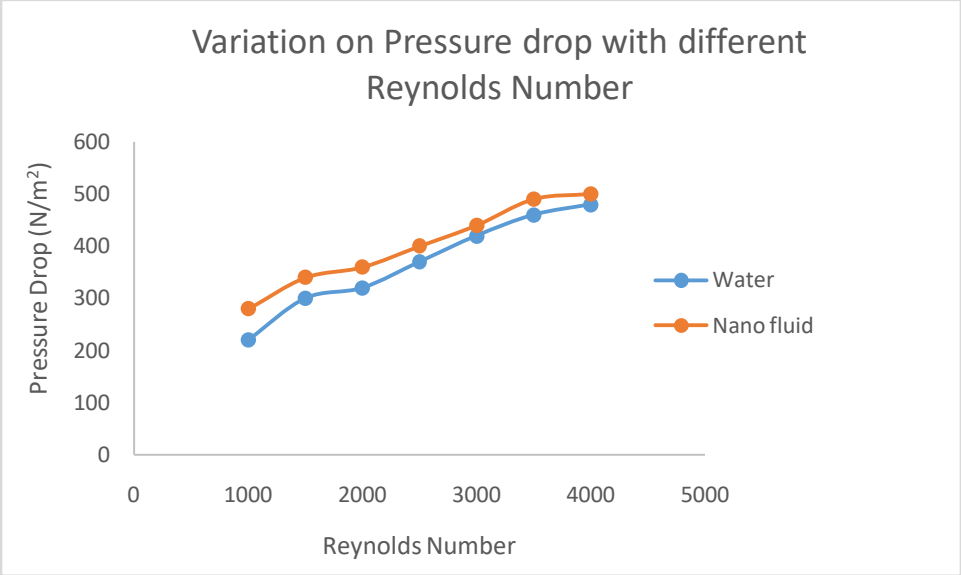

Fig. 3 Variation on pressure drop with different Reynolds Number

From experimental investigation it has been seen that pressure drop is more in the nanofluid as compared to water because density of nanofluid is more than the water. Also it has been seen that pressure drop increases with increases in Reynolds number because of flow velocity.

ISSN: 0971-1260
Vol-22-Issue-16-August-2019

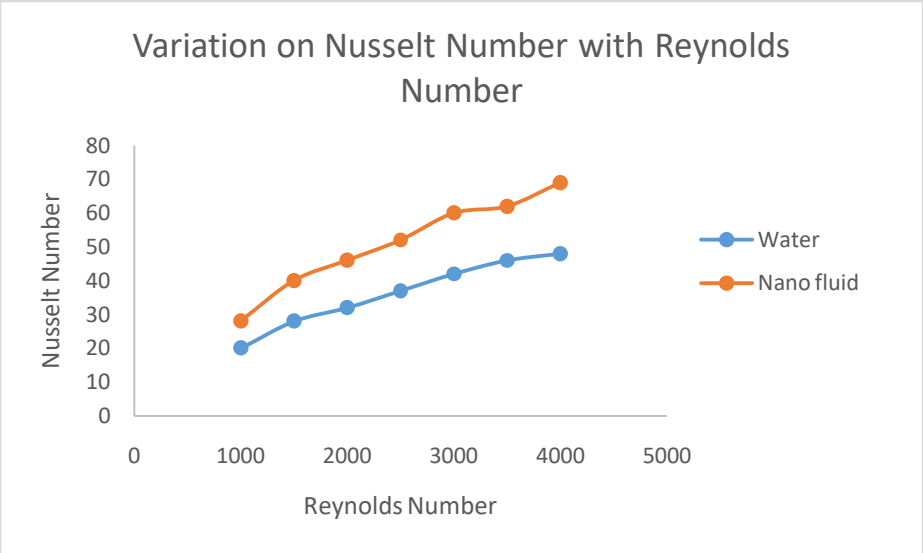

Fig. 4 Variation on Nusselt Number with different Reynolds Number

From experimental investigation it has observed thatNusselt number increases with increases in Reynolds number because thermal conductivity of nano particle is high. In this experiment aluminum nanao particle are used. Also seen Nusselt number is more as compared with water. It shows rate of heat transfer enhanced when nanofluid are being used as compared to water.

1.5 Conclusions

In this experiment, we have seen that there is valuable enhancement in the rate of heat transfer when nanofluids are being used. We have aslo seen that thermal conductivities of fluids that contain suspended solid metalic particles are expected to be significantly increased than conventional fluid.mA significant improvement in the heat transfer coefficient was achieved using the nanofluid compared to the distilled water. It has been seen that pressure drop increases with increases in Reynolds number because of flow velocity.

References

[1] M. Faizal, et al., Energy: economic and environmental analysis of metal oxides nanofluid for flat-plate solar collector, Energy Convers. Manage. 76 (2013) 162–168.

[2] HosseinChaji, et al., Experimental study on thermal efficiency of flat plate solar collector using TiO_2 and water nanofluid, Modern Appl. Sci. 7 (10) (2013) 60.

ISSN: 0971-1260
Vol-22-Issue-16-August-2019

[3] SarawutPolvongsri, KiatsiriroatTanongkiat, Enhancement of flat-plate solar collector thermal performance with silver nano-fluid, Second TSME International Conference on Mechanical Engineering, Krabi, Thailand, 2011

[4] Ali Jabari Moghadam, et al., Effects of CuO/water nanofluid on the efficiency of a flat-plate solar collector, Exp. Therm. Fluid Sci. 58 (2014) 9–14.

[5] Saleh SalavatiMeibodi, et al., Experimental investigation on the thermal efficiency and performance characteristics of a flat plate solar collector using SiO2/EG–water nanofluids, Int. Commun. Heat Mass Transf. 65 (2015) 71–75

[6] Yousefi, Tooraj, et al., An experimental investigation on the effect of pH variation of MWCNT–H2O nanofluid on the efficiency of a flat-plate solar collector, Sol. Energy 86 (2) (2012) 771–779.

[7] Taylor RA, Phelan PE, Otanicar TP, Walker CA, Nguyen M, Trimble S, Prasher R. Applicability of nanofluids in high flux solar collectors. Journal of Renewable and Sustain Energy.2011; 3: 023104.