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PERFORMANCE ANALYSIS OF PLATE HEAT EXCHANGER USING NANOFLUID

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ABSTRACT

Nanofluids are fluids that include nanoparticles, which are particles that are only a few nanometers in size. Nanoparticle suspensions in conventional fluids make up these fluids. Since pioneering researchers discovered their peculiar thermal behaviour, nanofluids have been the subject of considerable research all around the world. As a passive heat transfer technique, nanofluids have been used to increase heat transmission in a range of heat transfer applications. It is ideally suited for application in heat transfer processes such as microelectronics, fuel cells, pharmaceutical operations, and hybrid-powered engines, as well as engine cooling/vehicle thermal management, residential refrigerator, chiller, heat exchanger, and boiler flue gas temperature reduction. This article discusses the use of nanofluids to increase heat transfer as well as potential applications for nanofluids. This paper provides an updated review of nanofluid heat transfer applications to develop future studies and research directions because the literature in this area is spread across a wide range of disciplines, including heat transfer, material science, physics, chemical engineering, and synthetic chemistry.

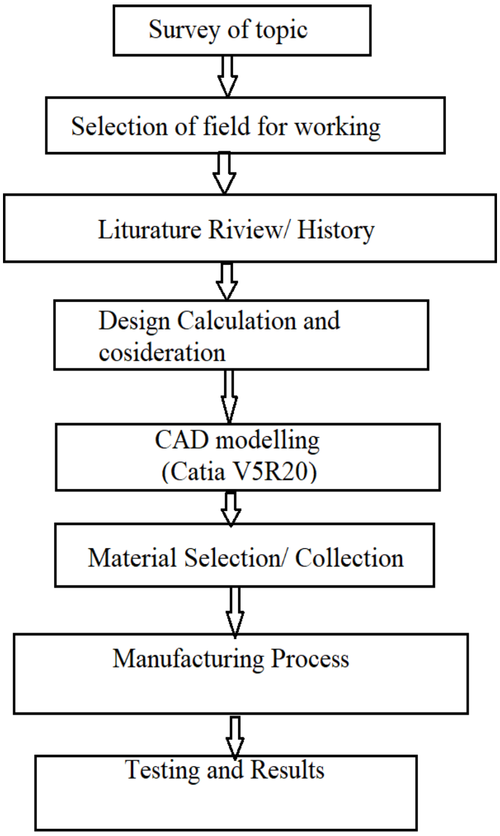
Keywords: Nanofluids, Nanoparticles, Enhancement Of Heat Transfer, Friction Factor.

I. INTRODUCTION

Nano-fluids have lately received a lot of interest due to their potential as high-performance heat transfer fluids in electronic cooling and automotive applications. Studies involving a considerable increase in heat flow and miniaturization can help enhance the performance of heat transfer equipment. Water, mineral oil, and ethylene glycol are utilized as heat transfer fluids in various industrial applications such as power generation, microelectronics, heating, cooling, and chemical processes. The weaker heat transfer capabilities of these common fluids, compared to most, hinder the effectiveness and compactness of heat exchangers. Nanofluids have lately received a lot of interest due to their potential as high-performance heat transfer fluids in electronic cooling and automotive applications. Studies involving a considerable increase in heat flow and miniaturization can help enhance the performance of heat transfer equipment. Water, mineral oil, and ethylene glycol are utilized as heat transfer fluids in various industrial applications such as power generation, microelectronics, heating, cooling, and chemical processes. The weaker heat transfer characteristics of these common fluids compared to most solids hinder the effectiveness and compactness of heat exchangers. Solid particles with thermal conductivities hundreds of times greater than these ordinary fluids are evident. Suspending ultrafine solid particles in a fluid to promote thermal conductivity is a novel way to improve thermal conductivity. Slurries may be made by mixing several sorts of particles (metallic, non-metallic, and polymeric) with fluids. Because the diameters of these suspended particles are millimeters or even micrometers, major difficulties such as blockage of flow channels, pipeline erosion, and an increase in pressure drop might arise. Furthermore, they frequently have rheological and stability issues. Especially

The particles tend to settle quickly. As a result, even though slurries have higher thermal conductivities, they are impractical. The heat exchanger's external surfaces are considered to be insulated, and all of the heat exchanger's walls are expected to be non-slip. The present work considers conjugate heat transfer, in which the solid domain is exposed to a conduction mechanism and the fluid domains to conduction and convection processes. The mirror pattern and thermal and flow properties are formed by the computational geometry of the microplate heat exchanger, which has a similar pattern and symmetry boundary. As a result, the computational geometry of the microplate heat exchanger is subjected to symmetry boundary requirements.

II. METHODOLOGY



Methodology Flow Chart

III. MODELING AND ANALYSIS

Figure 1: Experimental Set-Up

IV. PREPARATION OF NANOFLUID USING NANOPARTICLES

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Thermophysical properties of nanofluid

Using a Stabinger viscometer, the density and viscosity of nanofluid samples were evaluated at various concentrations and temperatures (Anton Paar, SVM3000). As illustrated in Figure 5, the dynamic viscosity reduces as the temperature rises because the cohesive forces between fluid molecules diminish (a). Due to an increase in shear resistance between the fluid layers, the viscosity rose with concentration. When density is tested at different temperatures, a similar pattern emerges. When a nanofluid is heated, the volume expands and the fluid molecules separate, resulting in a drop in density. Because more particles of the same density are crammed into a given volume, density rises with concentration. A thermal analyzer (Thermtest, THW-L2) with a 62 percent error rate was used to determine the thermal conductivity of nanofluid samples.

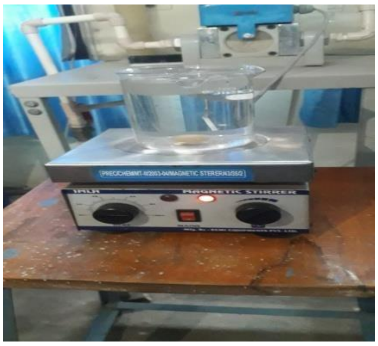

Figure 2: Sterreling Process

V. EXPERIMENTAL PROCEDURE

1. Aim

The current study should achieve the following objectives:

1. To use Nanoparticles to detect, assess, evaluate, interpret, and report on energy use.
2. To investigate the experimental analysis of the Plate type heat exchanger.
3. Research into the size and rating of Nanofluid Plate heat exchangers.
4. To reduce the amount of energy consumed by Nanoparticles in plate heat exchangers.

2. Plate type exchanger procedure:

- Connect the set up to the cooling water supply.
- Connect the heat exchanger's cooling water exit to the drain.
- Connect the cold water pipe line to the exchanger's cold water input.
- To circulate cold water, open the cold water input valve and regulate the flow rate.
- Connect the hot water pipeline to the exchanger's hot water input. • Allow hot water to run through the heat exchanger, and use the control valve and by-pass valve to modify the flow rate. • Record the temperatures and flow rates of hot and cold water in a steady-state (constant temperature). • Repeat the experiment with a different hot and cold water flow rate. • Repeat the experiment with different hot water temperatures.

The following readings of observation table have been taken by using an experimentalprocedure stated above:

Table 1: Observation table for an experiment on Plate type Heat Exchanger

Sr. No.	Hot Water Side			Cold Water Side		
	Flow rate, F_H (LPH)	Inlet TemperatureT1 (°C)	Outlet TemperatureT2 (°C)	Flow rate, F_C (LPH)	Inlet TemperatureT3 (°C)	Outlet TemperatureT4 (°C)
1.						

By using details of table Heat transfer rate, LMTD and overall heat transfer coefficient can becalculated from the following equations:

$$TH = (T1+T2)/2,\ (^\circ C)TC= (T3+T4)/2,\ (^\circ C)$$

The properties of both fluids like specific heats and densities at temperature TH and attemperature TC from data book.

Area of plates (Ap) = Numbers of Plates (N) × Length of the plate (L) × Width of Plate (B),(m2)

$$\Delta Ti = T1-T3,\ (^\circ C)\ \Delta TO = T2-T4,\ (^\circ C)$$

$$Q = M \times Cp\ (To - Ti)$$

$$\Delta Tm = \ln \Delta To - \Delta ti\ \Delta To\ \Delta TiU = Q\ A\ \Delta Tm.$$

For every reading,

- Temp of water entering the cooling section,T1 = tp - (tp - tr) ƞr
- Temp of water leaving the cooling section, T2Heat transfer, Q1 = mh × Cph × (T1 - T2)
- Temp of hot water entering the , T3
- Temp of hot water leaving the , T4
- Hot side heat transfer, Q2 = mh × Cph × (T4 - T3)
- Heat transfer area of the plate, AΔT1=T1-T4

$$\Delta T2=T2-T3$$

- The heat transfer of a chevron gasket-plate heat exchanger is analyzed using a logarithmic mean temperature difference. The chevron inclination angle ß relative to the flow direction will have a significant impact on heat transfer enhancement. With ß, heat transmission and friction factor increase..

1. LMTD =ΔT1 - ΔT2/[ln (ΔT1 / ΔT2)]
2. Total Heat Transfer, Q = (Q1 + Q2)/2, w
3. Overall Heat Transfer Coefficient, U = Q/(A×LMTD)

VI. COMPARING RESULTS OF NORMAL WATER WITH NANOFLUID

Table 2: Result Table

Sr. no.	Characteristics	Normal Water (H2O)	Aluminum Oxide(AL2O3)
1.	LMTD	27.95 °C	35.96°C
2.	Total Heat Transfer, Q	18782.72 W	21981.72 W
3.	Overall Heat Transfer Coefficient, U	0.92 w/m^2°C	0.98 w/m^2°C

VII. CONCLUSION

The current work presents a review of heat transfer enhancement using nanofluids by several writers who conducted experimental and computational studies on heat transfer enhancement using nanofluids. As a result of this examination, we need to grasp the principles of heat transfer and wall friction since they are critical for producing nanofluids for a variety of heat transfer applications, and we may conclude the following:

1. Nanofluids enhance the logarithmic temperature difference.
2. In cold water, the use of nanofluids enhances overall heat transmission.
3. Using Nanofluids improves the overall heat transfer coefficient.

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