Heat Transfer Phenomenon of Fluids in Corrugated Plate Heat Exchangers

D.Anjibabu, Shaik Nayeem

Abstract: ***Heat transfer is great attention in every Industrial application. While designing the heat exchanger two important factors are must be considered one is the least amount of pumping power (minimum Pressure drop) and most efficient heat transfer for given conditions. The configuration of heat Exchangers is extent effects on the above two factors. The corrugated heat exchanger comes under special type of heat exchangers .This type heat exchanger recover more heat than the other type of heat Exchangers because of they are arranged to form a package due to this is compact form of heat having less weight, and less space and providing high heat transfer coefficients than the other types. The heat transfer coefficient and friction factor of water,water+sio$_2$ are determined for flow under corrugated heat exchanger at corrugation angles of30°,40°,50°.Experiments are under taken laminar flow region at bulk temperature of 60° c. The experimental results shows that enhance in Reynolds number causes increase in heat transfer coefficient and 50°corrugated angle gives optimum result due to high turbulence created at low velocities.***

Keywords: ***Corrugated heat exchanger, heat transfer coefficient, Reynolds number, nano particles***.

I. INTRODUCTION:

For Energy saving many types of heat exchangers are now available. Heat exchangers can be used many applications relating high heat transfer performance. Corrugated plate heat exchanger are belongs to this category. They are capable of recovering heat efficiently even at low temperature difference mainly because of high turbulence created at low velocity. The corrugated plate heat Exchanger process may unique characteristics of great Significance to Industrial applications. These type of heat exchanger can with stand up to 250^0 and pressure range of 2MPA and made of variety of materials like stainless steel, nickel&nickelalloys, copper and titanium etc depending upon the operations temperature and pressures.The nano particles mixed in conventional fluids may leads to considerable increasing heat transfer coefficient. The nano particle consists of good physical and chemical properties it include high heat transfer rate, better mechanical permanence and higher thermal conductivity because of wide surface area and scaled nano size. The- better heat transfer obtained at minimum spacing .The experiment conducted at three different spacing at 6-mm, 9mm, 12mm .For this purpose 20 parallel plates are arranged with total heat transfer of 1.1629m^2 [1].

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The heat transfer performance of the corrugated plate heat exchanger is done by using the Buckingham Pi -theorem. The experimental results are contrast with the correlation to recognize flow characteristics and geometry parameters which affect the heat transfer rate [2].Increase in channel spacing and its phase shift angle in corrugated heat exchanger will cause the increase in friction factor. Results are compared with the parallel plates the mean heat transfer coefficient and pressure drop increases from 2.6 to 3.2 and 1.9 to 2.6[3]. CFD code is used for measurement of heat transfer performance of a cross corrugated heat exchanger. Network of resistance method is used for to find out the longitudinal heat conduction effect. This method widely used for heat exchangers design [4].For the experimental purpose two different size of nanoparticles are consider that is 36nm and 47nm .Experimental results shows that the addition of nanoparticles into conventional fluids has produced a considerable enhancement of the heat transfer coefficient that clearly indicates increases with the nanoparticle concentration. Heat transfer coefficient is higher for 36nm [5]. Heat exchanger consists of ARMFIELDFT-43 with flat plate arrangement. The estimated results are compared with those obtained from usual method of single pass arrangements [6]. The rate of heat transfer in corrugated plate heat exchangers is higher as compared smooth tube under at turbulent fluid flow region of Reynolds number 5500 to 60000 by water is used as a working fluid. Heat transfer rate increases due to the increase in heat capacity ratio, flow arrangement, number of channels used and relationship between the heat transfer performances [7]. Theoretical results are compare with experimental results. By changing geometric parameters like aspect ratio, hydraulic diameters are used for calculation of convective coefficients this results are compare with experimental ones [8]. Under constant temperature range the convective heat transfer coefficient and friction factor of TiO_2/ water and SiO_2/water nanofluids are determined at turbulent flow filed of Reynolds number ranging from 5000 to 25000 and for volume concentrations ratio up to 3.0% [9]. They development of three different type sections that are offset fin, wavy fin and non-uniformity characteristics of the inlet fluid flow. For experimental purpose air is used as a working fluid. Better results obtained for wavy fin characteristics [10]. The angular cut wavy tape inserts with wave ratio and different inlet velocity. By using angular wavy tape leads increase in heat transfer as compared to no angular cut wavy tape. This type particularly useful in solar preheaters and heat exchangers [11]. Commercial code fluent is used for flow visualization. Secondary flows inside wavy duct causes pressure drop will be in more in those that of the smooth circular duct and the Reynolds number increases with the average mass transfer [12-13].

II. THE EXPERIMENTAL SETUP:

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1. Corrugated plate heat exchanger
2. Storage tanks for test fluid and hot fluid
3. Rota meters
4. Digital temperature indicator
5. Pumps
6. Manometer

The dimensions of the Plate Heat Exchanger are-

S.no	factor	Value
1.	Developed length of the Corrugated Plate	41cm
2.	Each plate Length L	30cm
3.	Each plate Width W	10cm
4.	Plate spacing	0.5cm
5.	External Height	1.5cm
6.	Pitch	4.4cm
7.	Corrugation angle	40°

The testing section consists of three channels. Two outer channels in which hot water at constant temperature is following through these outer channels. Testing fluid cold fluid is following through the middle channel.

III.EXPERIMENTAL PROCEDURE:

The experiments are conducted at the corrugated Plate Heat Exchanger having 0.5 cm spacing.The corrugation angles used are 30°,40°and50°.The experiments are carried out with the following fluids as test fluids-

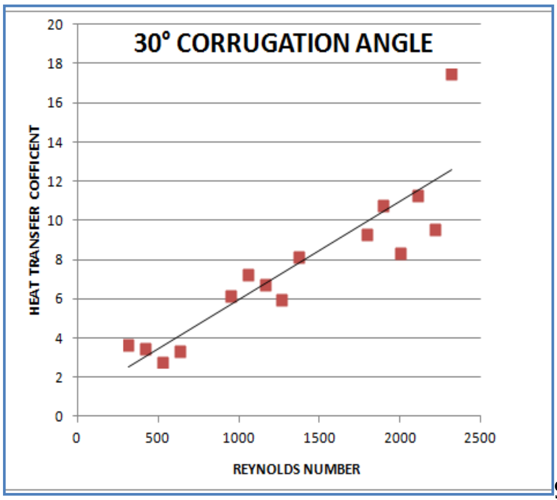
1.Water (0.737cp at 35°c)

2.Silicondioxide nanofluid(sio_2)+water(0.737cp at 35°c)

The experiment was conducted at constant hot water temperature at 60°c has been used for heating the tested fliud.For measureing the temperatures of inlet and outlet of the fliud as well as the temperature on the heat exchanger plate 6 different places are calculated by means of thermocouples welded at different places and and these tempertures are read through digital temperature indicator.These can be used for heat transfer analysis.The testing fluid is pumped into bottom channel through calibrated rotameter from 1 to 6 litres per minite. The centre plate is constits of 6 thermocouples, along the length and width of the plate, to determine the wall temperatures and four more thermocouples are insert into bulk fluid to find out the temperatures the inlet and outlet temperatures.For the calculation of heat transfer coefficent(h) by using the energy balance equation with logathermic mean temperature diffrence (LMTD).The viscosity measured by means of redwood viscometer and specific gravity by means of hydrometer.the digital temperature indicator measure the tempertaure having a accuracy of ±0.1°C.

IV.RESULTS AND DISCUSSIONS

The heat transfer coefficient and friction factor with water/sio_2 are determined for flow under corrugated heat exchanger at corrugation angles of 30°,40°,50°.Experiments are under taken laminar flow region at bulk temperature of 60°c .It is observed from investigation results both nusselt number and heat transfer coefficient increases with corrugation angle for particular fluid this is due to the high turbulence of fluid created at higher corrugation angle. The adding nano particles in conventional fluid will be leads considerable enhance in heat transfer coefficient and reduce the pressure drop as compare to conventional fluids up to 4% particle volume concentration beyond there will be decreases due to the reasons of obstruction, attrition of pipe line linked with high pumping power requirements.



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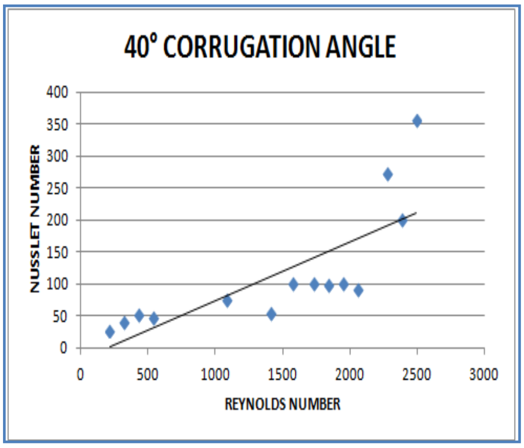

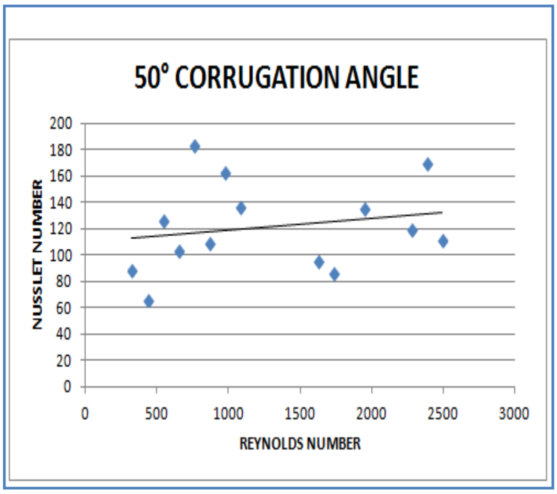

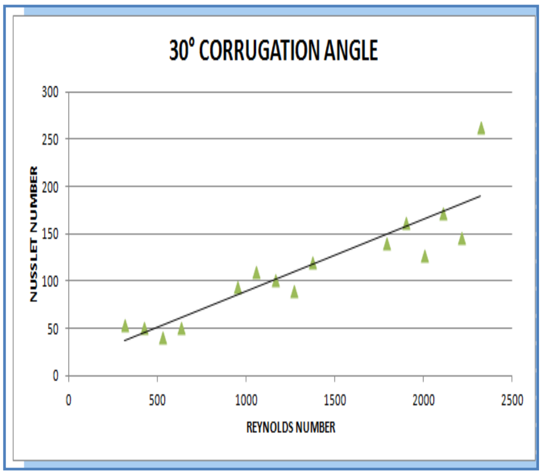

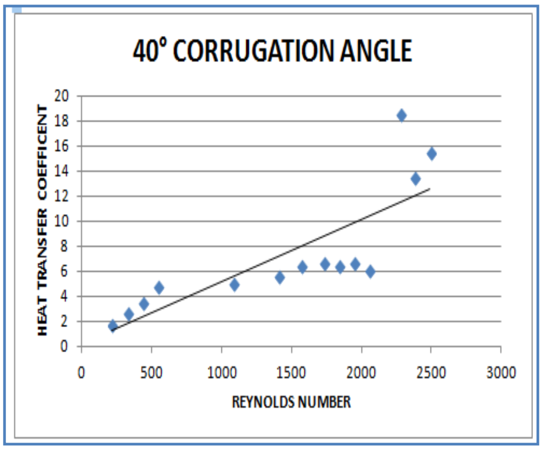

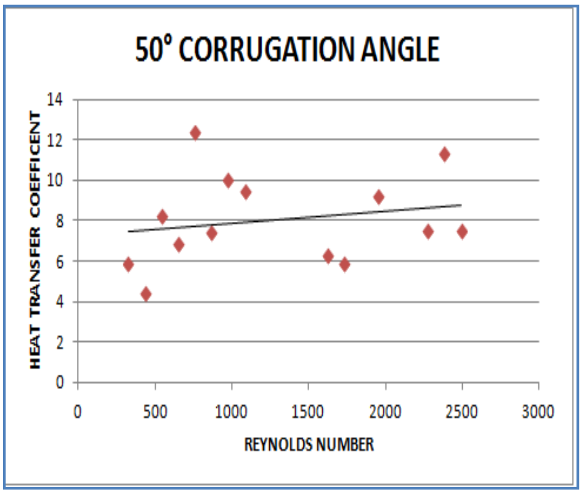

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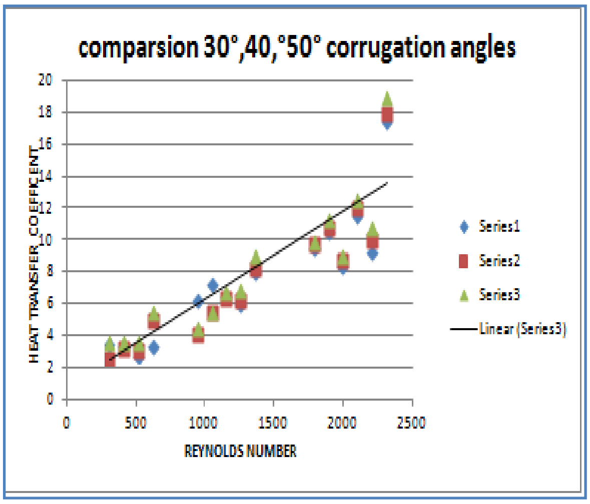

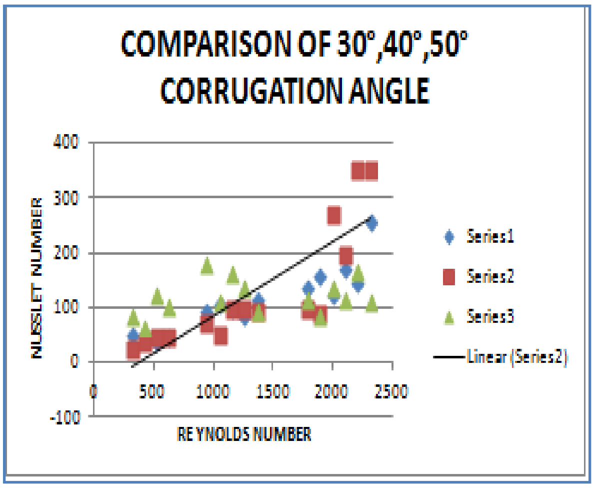

V.CONCLUSIONS

The shape of heat exchanger greatly effect on heat transfer rate. The development of corrugated heat exchangers due the they offer high rate of heat transfer even at low temperature differences due high turbulence created at low velocity. In this experiment we tested corrugation angles of 30°,40°,50°.the optimum heat transfer observed at 50° corrugation angle. Due to the shape pressure drop will be less as compared to flat plate heat exchangers.

***Scope for future work*:**

The present investigations the heat transfer description of water and sio_2 with fixed spacing in the corrugated plate heat exchanger are under taken.

It is recommended to further examine the heat transfer characteristics of different nano particles at different concentration and along with variable spacing and different corrugation angles.

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