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HEAT TRANSFER IMPROVEMENT BY USING NANO FLUIDS IN SHELL AND TUBE HEAT EXCHANGER

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INTRODUCTION

Nowadays high prices of energy motivate industries to apply energy saving methods as much as possible in their facilities. Heat transfer enhancement techniques are one of the most important tools to save energy in different processes. Use of CFRF solid particles in conventional fluids, because of their higher thermal conductivity, has been considered for decades to enhance heat transfer. But in practice, problems like fouling, sedimentation and increased pressure drop reduce the interest of industries to this heat transfer technique In recent years, significant advances in Nano materials technology has made it possible to overcome these problems by producing desirable particles in Nanometer size ranges. Nanoparticle suspensions in fluids make a new innovative category of fluids, called Nano fluids

LITERATURE REVIEW

Das et al (2003) reported the thermal conductivity of Al2O3 and CuO Nanoparticles suspended in water as a function of temperature. The temperature oscillation technique was used in their study for measuring the thermal conductivity of Nano fluids at different temperatures ranging from 21oC to 51oC. **Duangthongsuk and Wong wises (2009**) investigated the thermal conductivity and dynamic viscosity of TiO2 Nanoparticles dispersed in water with volume concentrations of 0.2 - 2 % experimentally, for temperatures ranging from 15oC to 35oC. **Duangthongsuk and Wong wises (2008)** showed an enhancement of heat transfer at a lower concentration of TiO2-water (ij = 0.2 %) and claimed that the convective heat transfer coefficient also depends on the experimental measurement system and calibration. **Dubey and Verma(2006)** conducted a Performance Analysis of Shell & Tube Type Heat Exchanger under the Effect of Varied Operating Conditions and concluded that It may be said that the insulation is a good tool to increase the rate of heat transfer if used properly well below the level of critical thickness. Amongst the used materials the cotton wool and the tape have given the best values of effectiveness. Moreover the effectiveness of the heat exchanger also depends upon the value of turbulence provided. However it is also seen that there does not exists direct relation between the turbulence and effectiveness and effectiveness attains its peak at some intermediate value. The ambient conditions for which the heat exchanger was tested do not show any significant effect over the heat exchanger's performance. **Durgesh Bhatt, Priyanka(2002)** M Javhar conducted a Shell and Tube Heat Exchanger Performance Analysis It is observed that by changing the value of one variable the by keeping the rest variable as constant we can obtain the different results. Based on that result we can optimize the design of the shell and tube type heat exchanger. Higher the thermal conductivity of the tube metallurgy higher the heat transfer rate will be achieved.

Less is the baffle spacing , more is the shell side passes, higher the heat transfer but at the cost of the pressure drop.

List of equipment

There is quite a lot of equipment used in this research. The equipment with manufacturer name, model number, their purpose and their accuracy are listed at Table 5.1

Name **Precision analytical balance** **Microscope (FESEM)**	**Manufacturer**	**Model**	**Purpose**
Transmission Electron Microscope (TEM)	Zeiss	TEM LIBRA 120	To analyze the particle size, shape, and distribution
X-Ray Diffraction (XRD)	PAN alytical	Empyrean	determination of crystallinity of a compound
Scanning Electron Microscopy (SEM)	Phenom	Phenom Pro-X	To determine particle shape

Table 5.1: List of table equipment

Nano fluid preparation

The Nano particles in form of powder when dispersed in the base liquid, it is called Nano fluid. In order to improve the thermal conductivity of the Nano fluid, preparation of Nano fluid using Nano particles is important task. There are mainly two methods of producing Nano fluids.

1. Single step method and
2. Two step method.

These methods have been utilized using different types of chemical and physical techniques to make sure that the solid-liquid mixture is stable to avoid agglomeration, additional flow resistance, possible erosion and clogging, poor thermal conductivity, and poor heat transfer. It is observed in the literature that Nano fluids with oxide Nano particles and carbon Nano tubes are produced well by the two-step method, while it is not suitable for Nano fluids with metallic Nano particles.

HEAT EXCHANGER FABRICATION

Heat Exchanger is a device which provides a flow of thermal energy between two or more fluids at different temperatures. Heat exchangers are used in a wide variety of engineering applications like power generation, waste heat recovery, manufacturing industry, air-conditioning, refrigeration, space applications, petrochemical industries etc. Heat exchanger may be classified according to the following main criteria.

1. Recuperators and Regenerators.
2. Transfer process: Direct contact and Indirect contact.
3. Geometry of construction: tubes, plates and extended surfaces. 4. Heat transfer mechanisms: single phase and two phase.
5. Flow arrangements: parallel, counter and cross flows.

large ratio of heat transfer area to volume is provided by the shell and tube heat exchanger and weight and they can be easily cleaned. Great flexibility is always provided by the shell and tube heat exchangers to meet almost any service requirement. Shell and tube heat exchanger can be designed for high pressure relative to the environment and high pressure difference between the fluid streams.

Figure 7.1: fabrication model of heat exchanger

Components Required

- Heater
- Hose pipes-4
- Shell
- Helical Tube
- Enclosures-2
- Containers-4
- pump
- Digital Thermometers-3

Material selection:

Shell Material: Mild steel

It has good electrical conductivity and less brittle and flexibility. Steel cools as it is rolled, with a typical rolling finish temperature of around 750°C.

Tube material: Copper (Cu) Shape: Spiral type

Copper has good Thermal Conductivity and it is electrically conductive. It is corrosion resistance and has bio fouling resistance capability. It has good machinability and it can retender its mechanical and electrical properties at the cryogenic temperature. The thermal conductivity of copper is 385W/mK.

Dimensions

Dimensions of Helical tube:

1. Diameter of the inner tube di = 10mm
2. Diameter of the outer tube do= 12.7mm
3. Number of turns on the tube N= 17
4. Pitch of the spiral tube P= 10mm
5. Outside diameter of the coil D= 50mm

Dimensions of Outer shell:

6. Thickness of the shell t = 1.2mm
7. Diameter of the shell d = 84mm
8. Length of the shell L = 520mm
9. Area of the shell= π(r)2= π(42)2= 5541 mm^2
10. Circumference of the shell= 2πr = 2*π*42 = 263mm

Figure 8.2 Experimental setup

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Observations

S.NO.	Inlet temp.(cold) degree Celsius	Outlet temp.(cold) degree Celsius	Inlet temp.(hot) degree Celsius	Outlet temp.(hot) degree Celsius
1	**28**	**30.476**	**75**	**61**
2	**28**	**30.122**	**75**	**63**
3	**28**	**29.592**	**75**	**66**

Table 8.1 Reading Tabulation

Cold Water Flow Rate =2279.88 kg/h
Hot Water Flow Rate = 504 kg/h

OBSERVATION 1:

Heat Capacity Ratio	**0.1769**
NTU	**0.2164**
Effectiveness(€)	**0.1915**
Heat Transfer Rate(Q)	**1814.60 kcal/h**
Overall Heat Transfer Coefficient	**334.008 kcal/h.m^2. $^\circ$C**

Table 8.2

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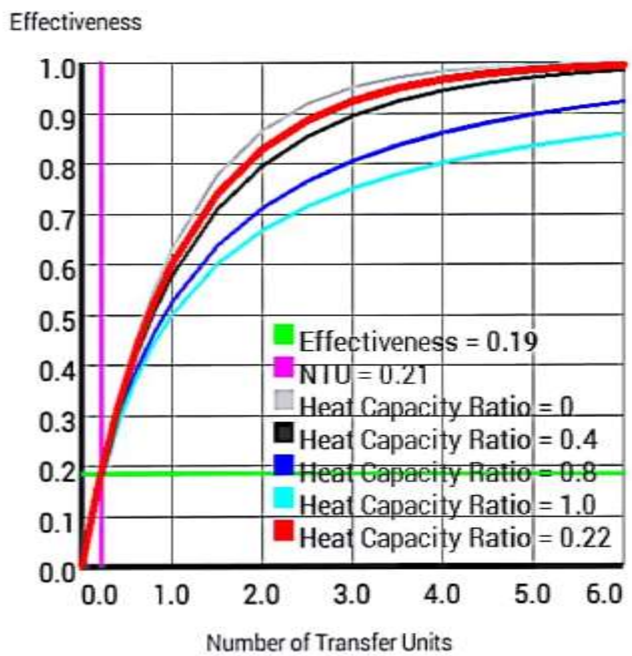

Figure 8.3 Effectiveness Vs NTU

OBSERVATION 2:

Heat Capacity Ratio	**0.1769**
NTU	**0.3020**
Effectiveness(Є)	**0.2553**
Heat Transfer Rate(Q)	**2419.20 kcal/h**
Overall Heat Transfer Coefficient	**466.188 kcal/h. m^2 . $^{\circ}$C**

Table 8.3

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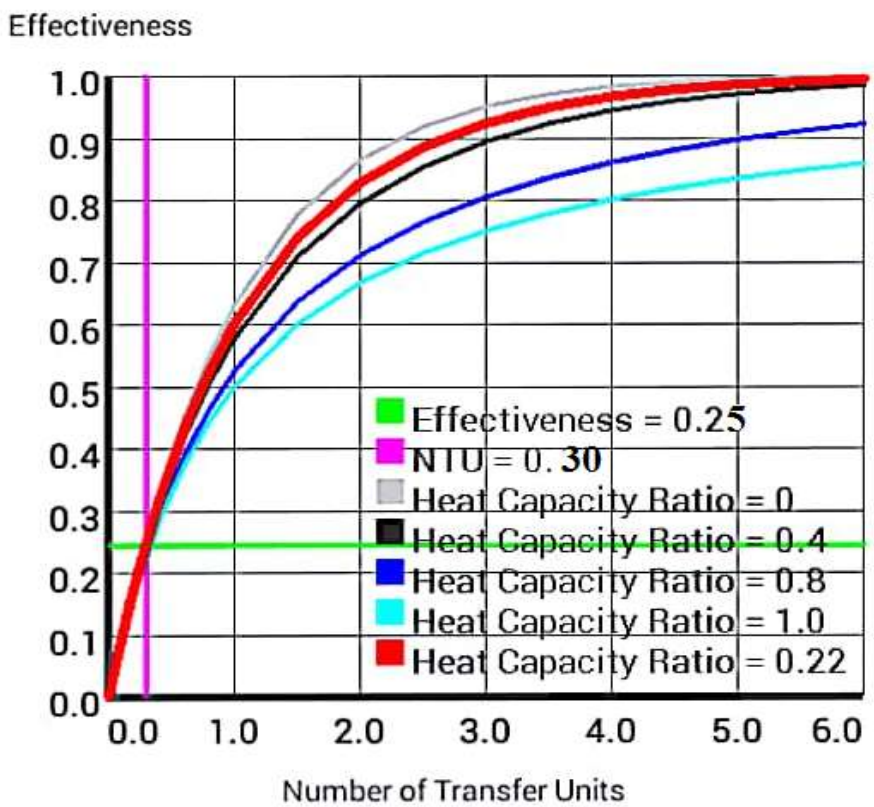

Figure 8.4 Effectivesness Vs NTU

OBSERVATION 3:

Heat Capacity Ratio	**0.1769**
NTU	**0.3639**
Effectiveness(€)	**0.2979**
Heat Transfer Rate(Q)	**2822.40 kcal/h**
Overall heat Transfer Coefficient	**561.693 kcal/h. m^2 . °C**

Table 8.4

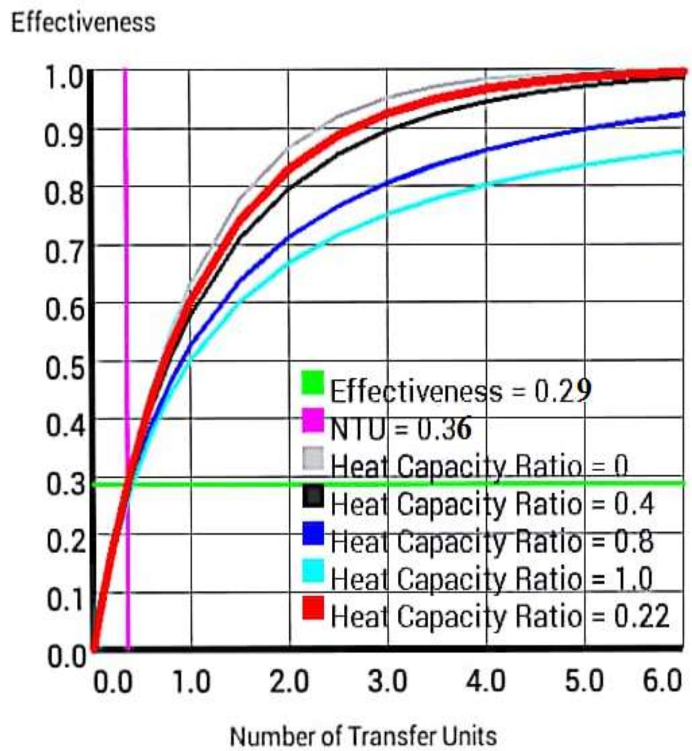

Figure 8.5 Effectiveness Vs NTU

CONCLUSION

Thus the experiment is conducted and the amount of heat transfer and the effectiveness of heat transfer is calculated. From our project we have shown that the spiral tube heat exchanger's effectiveness is more than the normal parallel flow heat exchanger.

After analyzing the results the net heat transfer increases with the addition of Nano particle i.e. 1% & 2% and shell side heat transfer coefficient also increases as in turn net heat transfer improves hence the objective is achieved.

Based on our project results we conclude that the heat transfer rate is increased by addition of Nano particle to the base fluid on different mass concentrations. The main objective of the project is to increase the effectiveness of heat exchanger by increasing the heat transfer rate this also be achieved by this project by adding Nano particle to the already used

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