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# Enhancement Of Heat Transfer Rate Using Mgo Nanofluid In Heat Exchanger

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**Abstract -** *Energy conservation, conversion, and recovery are vital thinking among people due to environmental issues. The effectively way to save energy of materials and facilities in which heat exchanger plays a significant role. Mostly in industries uses heat exchangers for enchantment of heat transfer. The common used heat transfer fluids are water, ethylene glycol and propylene glycol as base fluids in heat exchanger. Dispersion of Nano particles in a base fluid shows solution in problems such as high pressure loss, erosion of material. The thermal conductivity of the base fluid increase by adding Nano particle which in turn increase the heat transfer rate. In this paper heat exchanger performance is analyzed by adding Magnesium oxide with base fluid (a mixture of Distilled water and propylene glycol). The thermal property i.e. overall heat transfer coefficient of heat exchanger is calculated and compared with base fluid. Experiments were conducted for various volume concentration 0.1%,0.3% and 0.5% and observed that the addition of manganese oxide nanoparticles enhances the thermal performance. The maximum enhancement in the convective heat transfer is observed at 0.5% volume concentration.*

***Key Words*: Heat transfer rate, Shell and tube heat exchanger, Manganese oxide nano particle, Nusslet Number**

## 1.INTRODUCTION

Power saving practices and concept of miniaturization of the heat transfer systems motivate many investigators to focus on enhancing the performance of Heat exchanger equipment. The thermal conductivity Enhanced in Traditional heat transfer fluid like Water, refrigerants, engine oil, glycols etc compare to metal and also with the metal oxides in the fluid medium Traditional fluids affecting the thermal conductivity due to the size of solid particles. The application of nanoparticles as additives to liquids is more noticeable and currently a large number of researchers are devoted to this subject. Nano particle with size less than 100nm & volume concentration of 0-5% which are stable with very less particle settling, erosion, clogging. Tranditonal fluids with nanoparticles suspended in them are called nanofluids .Nanofluids have interesting properties such as large specific surface area, higher thermal conductivity, lesser erosion and longer term stability, thus making them potentially important as heat transfer fluids in heat exchangers, nuclear reactors, electronic cooling, fuel cells, pharmaceutical processes, food industry

### 1.1 Shell And Tube Exchanger

Heat Exchanger is a device which heat transfer take place two to fluids in solid surface. These heat exchanger uses at many applications like power plants, air conditioning, chemical process etc, gives higher thermal efficiency in the system. In shell and tube exchanger which provide a large ratio of heat transfer area to volume and weight. The main role of shell and tube heat exchanger is to transfer of heat at large rate. The estimation of the minimum heat transfer area required for a given heat as it governs the overall cost of heat exchanger is the primary objective of any heat exchanger design. The baffles are used in shell and tube exchanger to improve mixing which forces from shell side going in a zigzag manner which improves the heat transfer and avoiding vibration of the tubes. In the shell and tube heat exchanger ,the thermal capability of base fluid must be increase to enhance the thermal efficiency .Adding a little amount of high thermal conductivity nano particles in base fluid improving the thermal conductivity. The Heat transfer enhancement depends on type, size, concentration of nano particles in a base fluid .

For preparing Manganese oxide nanofliuds two step method is used. The mixture is composed of MgO (manganese ) nano particle is dispersed in the Propylene glycol in the corresponding volume concentration of 0.1%,0.3%,0.5% are prepared .The nano particle was slowly added to the base fluid in process of stirring. After stirring the Nano fluid, Ultrasonic sonicator (Oscar 179electronics) whose frequency ranges up to 100 HZ is used to sonicate the solution continuously for approximately 30 min per sample in order to break down agglomeration of the nanoparticles

$$\text{Volume fraction} = \frac{V_n}{V_n + V_b} = \frac{M_n/\rho_n}{M_n/\rho_n + M_b/\rho_f}$$

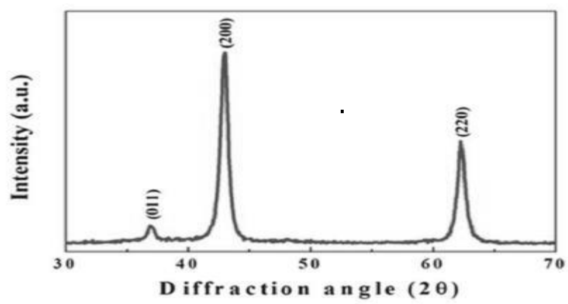



**Fig X-ray diffraction patterns of MgO**

**Nano fluid through heat transfer**

1. The performance of Fe-CNT magnetic nanofluids in various flow through shell and tube heat exchanger were experimentally studied at the heat flux with voltages 80, 120 and 150 V. Fe-CNT nanofluids used for enhanced heat transfer coefficient compared to the Conventional fluids . Higher enhancement results from the use of higher weight concentrations. For each flow regime various flows i.e. laminar, transient and turbulent .By using nanofluids convective heat transfer coefficient enhances in higher heat flux. Increasing the Reynolds number and temperature with the average heat transfer coefficient of Fe2O3-CNT magnetic nanofluids enhances.

2. In split flow heat exchanger water, distilled water and a combination of ethylene glycol and distilled water is analysed with various parameters such as mass flow rate, heat transfer rate, overall heat transfer coefficient and effectiveness with constant temperature.T he heat transfer characteristics is enhanced for a combination of ethylene glycol and distilled water as a conventional fluid .Thermal properties such as overall heat transfer coefficient and effectiveness of the heat exchanger were calculated and compared conventional fluids .

3.By the results the enhancement of heat transfer adding of the Al2O3 nanoparticles presence in the convectional fluid. In investigation is to determine the effect of different concentration of Al2O3 nanoparticle mixed in water as conventional fluid on heat transfer rate of single pipe heat exchanger both parallel and counter flow. Volume concentrations of Al2O3 nanofluid compared are 0.05 % and 0.1 %. Conclusion in the study is that overall heat transfer coefficient increases by increasing the concentration of nanoparticles in nanofluid .The results from the experimentt should be noted that enhancement of heat transfer highly depends on particle type, particle size, base fluid, boundary condition.

4. heat transfer rate results for nanofluids with the aid of a wire coil insert which comparatively that the heat transfer rate of nanofluids increase .Peclet number when compared to that of the results increase . Nanoparticles in the base fluid and wire coil insert showing increase in the performance of heat transfer. A higher heat transfer coefficient being obtained when compared to conventional fluid. For volume concentration percentages of 0.5, 1 and 1.5 of Alumina nanofluids increased the Overall heat transfer coefficients by 17%, 29.4% and 33.5% for respectively for wire coil insert at Pe = 3000 compared to that of distilled

5. At 2% and 4% vol. concentration Al2O3 nano fluids are into the heat exchanger and the experimental calculations are estimated. It is noticed that nanofluids higher performance than that of conventional fluid. At 4% of volume concentration Al2O3 showed better performance than that of Al2O3 and conventional fluid showed better performance than of Al2O3 with 2% of volume concentration and water. LMTD and overall heat transfer coefficient, Reynolds number, Nusslet number was also increased. Heat transfer coefficient improved by 23% as compared to conventional fluid.

6. In this study the shell and tube heat exchanger has given virtues large ratios of heat transfer area to volume and weight. By using copper oxide nano fluids in shell and tube heat exchanger they have been achieved increase in various thermo properties such as overall heat transfer coefficient, pressure drop, effectiveness, heat transfer coefficients at volumetric concentration of 0.023% copper oxide nano fluid Mass Flow rate of hot water is maintained around 15-18 lpm where as volume fraction of copper oxide nano fluid is varied from 10-30.

*7.* The heat exchanger basic depends up on effectiveness., In the shell and tube heat exchanger can be increasing in terms of enengy effectiveness from 31% to 44% Metal oxide nanoparticles ZnO, CuO, Fe3O4, TiO2, and Al2O3, with conventional fluid at the volume concentration of 0.03. ZnO-W nanofluid comparatively high energy effectiveness, than the Al2O3-W which is lowest effectiveness The Energy effectiveness strongly depends on the specific heat of the conventional fluids. The highest heat transfer coefficient was found for Al2O3 nanofluid, as depends on both thermal conductivity and specific heat of the nano fluid.

8. In this shell and tube heat exchanger has highest overall heat transfer coefficient with the increase of mass flow rate at helical 25° followed by helical 50°.In the Side ,overall heat transfer coefficient with the adding of nanoparticles of the type of heat exchanger. Heat transfer rate using of 25° helical baffles heat exchanger is improved significantly compared to 50° helical exchanger.

**2. EXPERIMENTAL SETUP**

The setup consists of an inner tube and an outer shell. The inner tube is made of copper .The outer shell is made of stainless steel .Dgital temperature sensors are used to measure the inlet and outlet temperature of the hot and cold water. Flow control valve is used to control the flow of fluids. One pumps are immersed in water tanks to pump the hot fluid in to the tube and cold fluid in to the shell.

Shell is the outermost part of the heat exchanger in which the cold fluid carrying nanoparticles flows and it consists of an inner port and an outer port. The cold fluid enters the input port and receives heat from the hot fluid and exits via the outer port. The inner port and outer port and it is fitted in the centre part of the shell. The material of the shell is stainless steel. The inner tube rests inside the shell and it gives heat to the cold fluid. The hot fluid from the water tank enters in to the tube and exits via the exit port. The inlet and outlet temperatures are recorded by the digital temperature sensor by means of a probe attached at the inlet and outlet ports.. The material of the inner tube is copper.

**Data reduction**

The properties of the nanofluid are determined from the models taken from literature

Thermal conductivity of nanofliuds

$$\frac{k_{nf}}{k_{bf}} = 1+0.0838\ Ø^{0.3372}$$

Density

$$\rho_{nf} = (1-Ø)\rho_f + Ø\rho_p$$

Viscosity

$$\mu_{nf} = \mu_{bf}\,(1-Ø)^{-2.5}$$

Specific heat

$$C_{pf} = \frac{(1-Ø)\rho_f\ C_p + Ø_f C_p}{\rho_{nf}}$$

Shell and side calculation: To calculate the shell side heat transfer coefficient ,variables need to be calculated below,

Shell side cross flow area $A_s$

$$A_s = (D_i - N_{TC} d_O)B$$

$$N_{TC} = \frac{Di}{Pt}$$

$D_i$= shell diameter and $P_t$ = tube pitch

$$D_e = \frac{4\left(p_t^2 - \frac{\pi}{4} d_0^2\right)}{\pi d_0}$$

Base fluid Reynolds number is expressed by the following

$$Re = \left(\frac{m_s}{A_c}\right)\frac{D_e}{\mu_g}$$

Prandtl number is calculated in terms $C_p$ and $k_s$

$$Pr = \frac{C_p}{k_s}\mu$$

The heat transfer coefficient of base fluid

$$h_{fg} = \frac{0.36k}{D_e}\ Re_{fg}^{0.55} Pr_{fg}^{\frac{1}{3}}$$

Tube side calculations: To calculate the tube side heat transfer coefficient were determined, as follows:

Tube side flow area $A_t$

$$A_t = \frac{\pi}{4}\ d_i^2 N_t$$

Where $N_{t,p}$= $N_T$

Reynolds and Prandtl numbers of the tube side flow can be determined as

$$Re = \left(\frac{m_f}{A_o}\right)\frac{d_i}{\mu_f}$$

$$Pr = \frac{C_p}{k_f}\mu_f$$

The Nusselt number was calculated using the turbulent flow inside the tube.

$$Nu = 0.024\ Re_f^{0.8} Pr_f^{0.4}$$

The tube side heat transfer coefficient, has been calculated

$$h = \frac{Nu_f k_f}{d_i}$$

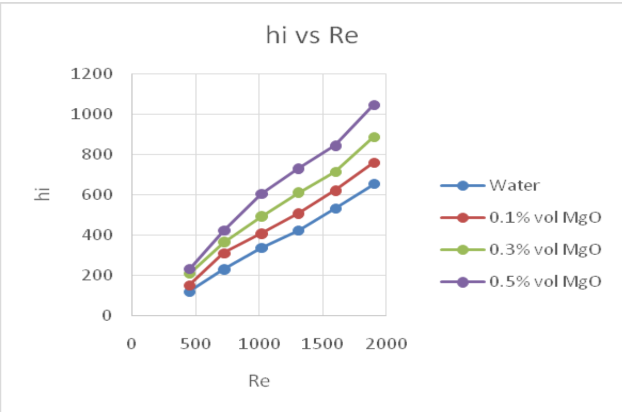
Overall heat transfer coefficient:

Overall Heat transfer coefficient (Uo) were determined

$$\frac{1}{U_o} = \frac{1}{h_{fg}} + d_{to}\frac{ln\left(\frac{d_{to}}{d_{ti}}\right)}{2k_w} + \frac{1}{h_{nf}}\frac{d_{to}}{d_{ti}}$$

## 3. RESULTS & DISCUSSIONS

By the graph the variation of different volume concentration of nano fluids are compared with base fluid. The Heat transfer coefficient nano fluids are compared with Nusslet number of different concentration of nano fluid is observed that at each concentration increasing Reynold numbers increasing the heat transfer coefficient increases. The highest heat transfer coefficient is observed at 0.5% and in case of Reynold number also increase at 0.5% .

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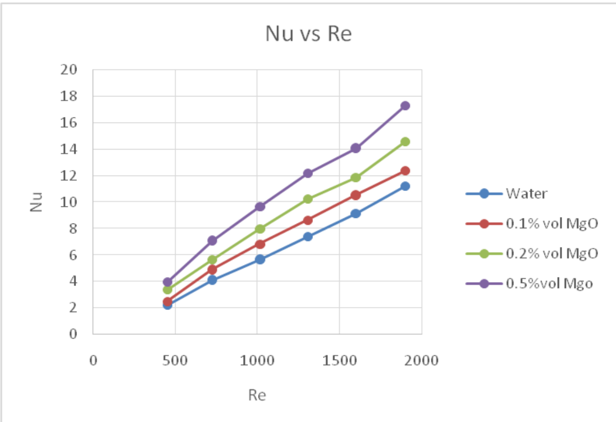


## 4. CONCLUSIONS

1. It is observed that the heat transfer rate of nano fluids is higher than that of conventional fluids. Hence, by using nanofluid as a working fluid in heat exchangers it can enhance the heat transfer capacity. In this experiment, were done by using conventional fluid i.e., water as a working fluid and determining LMTD, overall heat transfer coefficient, inside heat transfer coefficient, Reynold number and nusselt numbers were calculated and compared with nano fluid . Nanofluids at 0.1% ,0.3%and 0.5% vol. concentration MgO were used into the heat exchanger and the determining LMTD, overall heat transfer coefficient, inside heat transfer coefficient, Reynold number and nusselt numbers experimental calculations are estimated .It is observed that higher concentration can be used for better enhancement of overall heat transfer coefficient.

2. It is observed by using nanofluids shown higher performance than compared to water and heat transfer coefficient is increased by 15% as of water with increased with increasing in volume concentration of nano particles.

3. Experiments showed increase in Reynolds number, Nusslet number and Overall heat transfer with the higher volume concentration.

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