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Thermo-hydraulic Performance of Shell and Tube Heat Exchanger by Enhancing Thermo-physical Properties Using Nano-fluid – A Review

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ABSTRACT- A heat exchanger is an equipment which transfer heat energy from a hot fluid to a cold fluid .Our main objective is to transfer heat at greater possible rate. Shell and tube heat exchangers are widely used in various fields like boilers, condensers, etc. They provide more surface area for heat transfer between two fluids in comparison with other type of heat exchanger. For the purpose of increasing heat transfer with least power required for pumping, fluids like Nano fluids which is comprises of nanoparticle and base fluids have become the major area of research now-a-days. This report givesan outline of the proposed work and literature review of some of the important articles published in various journals and gives the effect of the heat transfer characteristics in shell and tube heat exchangers using Nano fluids. Some of the published articles include experimental work to explore heat transfer behavior of γ-Al_2O_3Nano fluid in a shell and tube heat exchanger. This paper reviews on the experimental and analytical studies of the significant incensement in effectiveness of the shell and tube type heat exchanger with the use of nanoparticle which is used along with the base fluid.

I. INTRODUCTION

Heat exchangers play very important role in the field of energy conservation by taking heat from the fluid at higher temperature and use this considerable amount of heat for heating the other heat input system. Heat transfer rate can either be increased by increasing area of heat transfer or by increasing the thermal conductivity of fluids or temperature difference between cold and hot fluids. Increasing the heat transfer area is not possible everywhere because of space restrictions. Increasing the temperature difference is also restricted, because upper limit doesn't cross the metallurgical condition and lower limit is atmospheric condition. Therefore our main motive is to increase thermo-physical properties of cooling fluid.

The scientific aspects is concentrating both on improving the equipment design and on enhancing the thermal potential of the working fluid. A considerable amount of reduction in energy consumption could be made possible by improving the performance of heat exchanger systems.

Heat transfer rate in a heat exchanger are dependent on the thermo-physical properties of the fluids participating in the heat exchanger, the material of the heat exchanger and also the areas of the surfaces which is taking place in the process.

Nano fluids are the newly discovered fluid which is used for various industrial and automotive applications because of their magnificent thermalperformance. Nano fluids consists of suspensions of nanoparticles with at least one of their principal dimensions smaller than 100nm.The Nano fluids, in comparison to base fluids like water/oil, possess enhanced thermo-physical properties such as thermal conductivity and convective heat transfer coefficient. Due to small and very large specific surface area of the Nano particles, Nano fluids have superior properties like thermal conductivity, stability, lesser clogging in flow passage, homogeneity etc. Hence, Nano fluids have a wide range of potential applications like electronics industries, automotive field, and nuclear applications where improved heat transfer or efficient heat transfer is required. Hence in the past few years, many experimental investigations on the thermal conductivity of Nano fluids have been reported which showed that Nano fluids shows relatively higher thermal conductivities than their base fluids even when the concentrations of suspended nanoparticles are very low and the Nano fluid thermal conductivity increase significantly with Nano particle volume concentration.

II. LITERATURE REVIEW

The heat transfer by shell and tube type heat exchanger system with the use of Nano fluids has been the subject of many theoretical and experimental analysis.By having a review on previous research paper published by many authors we can have an idea on how the heat exchanger is behaving and what does the effect on their

performance of heat exchanger while Nano fluids are used**.**

Firstly I studied the paper published by Etmad and Farajollahi(2010**). Etemad and Farajollahi[2010]** studied on behavior of Nano fluid in a shell and tube heat exchanger. The objective of this paper is an experimental system was designed and constructed to investigate heat transfer behavior of γ-Al_2O_3Nano fluid in a shell and tube heat exchanger. They measured the heat transfer characteristics under the turbulent flow condition. The addition of nanoparticles to the base fluid causes the significant improvement of heat transfer characteristics and results in larger heat transfer coefficient than that of the basefluid. From the researched paper of Etmad and farajollahi[2010], we can conclude that another Nano fluid other than the Al2O3 may enhanced the heat transfer characteristics of the base fluid. The nanoparticle which we will use in order to synthesis of Nano fluid is Titanium oxide (TiO2). Another research paper which Istudied is paper published by khoddamrezaee.**Khoddamrezaee et al. [2010]** investigated heat transfer characteristics of an Al2O3/ethylene glycol Nano fluid and ethylene glycol fluid in a cross rectangular arrangement of tubes in a shell and tubes heat exchanger. The variables like stagnation point, separation point, and heat transfer coefficient and shear stress for Nano fluid and pure fluid were determined and compared. From the results they concluded that by using of Nano fluids, the stagnation and separation points of flow were delayed and the heat transfer coefficient and shear stress increased.

After studying the paper **khoddamrezaee et al.[2010**], we can conclude that even the shear stress increases the heat transfer area is also increases, thisresearched we can use to improve the heat transfer area of shell and tube heat exchanger.

After studying above two paper I have studied the paper published by lotfi et al**. Lotfi et al.[2012]** conducted an experimental investigation on heat transfer enhancement of multi-walled carbon nanotube (MWNT)/water Nano fluid) in a horizontal shell and tube heat exchanger. The test section of the heat exchanger has 14 tubes with 7mm inside diameter and length 580mm. The coolant flows in shell with 101mm diameter. The carbon Nanotubes were prepared by the use of catalytic chemical vapor deposition (CCVD) method over Co–Mo/Mg On a catalyst. From the results it is found that the presence of multi-walled Nanotubes enhanced the heat transfer rate the heat exchanger.

After studying the above three papers I have studied the paper published by Arunachalam and Raja[2012]**Arunachalam and Raja, [2012]** studied heat transfer character of Alumina/water Nano fluid in a shell and tube heat exchanger with the aid of coil insert. They studied behavior of Peclet no, or Alumina/water Nano fluid concentration on the heat transfer and pumping power. The concentration of Nanoparticle was taken as 0.5, 1 and 1.5 (in percent) was prepared and made solution with base fluid water. An increase in the concentration of the nanoparticles in the base fluid caused a significant enhancement in the all over heat transfer coefficient compared with water, they used wire coil insert raises the all over heat-transfer-coefficient for the give Peclet number and it was raised by 12.6, 20 25 (all in percent) for Alumina/water Nano fluid when the percentage of volume concentrations was 0.5, 1, 1.5 at Pe of three thousand, compared to those of distilled water. There was similar rise of thirteen percent in the pumping work for wire coil insert, when compared to that of the pumping power find with distilled water

From this paper we can conclude that by the use of Nano fluid the heat transfer can be enhanced by the use of Nano fluid.

Leong et al. [2012] investigated the application of Nano fluids as working fluids for a biomass heating plant with shell and tube heat recovery exchangers. The results showed that the overall and convective heat transfer coefficient improved with the application of Nano fluids compared to ethylene glycol or water based fluids.

Albadr et al. [2013] experimentally studied horizontal shell and tube heat exchanger for forced convective heat transfer and flow characteristics of a counter flow under turbulent flow conditions for water as base fluid and different volume concentrations of Al2O3 Nano fluid. They found that nanoparticles dissolved in distilled water increases both thermal conductivity and viscosity of the Nano fluid. Friction factor increases with the increase in volume concentration of nanoparticles. Particle volume concentration of 2% the use of Aluminum oxide Nano fluid gives significantly higher heat transfer characteristics.

SanthoshCibi, et al., [2013] studied on convective of heat transfer increment with graphite Nano fluids by the use of Shell and tube heat exchanger. They mainly focus during their research study the graphite Nano fluids performed great in Shell and tube heat exchanger for laminar flow. They used Graphite Nano powders for the experiment and stirrer with the base water by varying its concentration in the range of 0.025, 0.05, and 0.075 (in percent) by volume. During the experiment they observed that when the

concentration of the graphite was rises with different concentrations, the heat-transfer-co-efficient rises gradually with the concentrations. They also concluded that the performance of graphite on K(thermal conductivity) value of Nano fluids was much better than heat transfer-coefficient of Nano fluids, and also with graphite rise concentration and flow performance of the coldest fluid.

Kirubadurai and Ramesh [2014] studied on heat-transfer behavior of Shell-Tube heat exchanger using Silicon Nitride- Water Nano fluid. They did the work on new Nano fluid system which they emerge by silicon nitride to amalgamate Nano fluid for shell-tube heat exchanger. During the study the results showed that the Nano fluid provides better thermal properties. They also concluded that the most of these parameter of heat-transfer was not taken for study in past time, hence they performed on it and it require the simultaneously study ofNano fluid for heat transfer provides valuable information for the optimization of heat-transfer improvement. And they find the efficiency raises up to eleven percent with nanoparticles with water.

Tiwari[2015]studied on "thermal Performance of Shell and Tube Heat Exchanger using Nano fluids, in this paper, an attempt is made to experimentally investigate the thermal performance of a shell and tube heat exchanger using Nano fluids. The cold water based Nano fluids flow in tube side and water as hot fluid flows on shell side. Use of nanoparticles in water based Nano fluid as coolant in shell and tube heat exchanger improves the effectiveness by a considerable amount, while the convective and overall heat transfer coefficient increases even further with the addition of 3% Al_2O_3nanoparticles in water based fluid.

III. PROPOSED WORK HAS TO BE DONE

After studying the above researched paper we can conclude that we can improve the performance of the heat exchanger in an efficient manner with the use of Nano fluid.The nanoparticle which we will use in the proposed work is titanium oxide.Investigation of different researchers from previous work on heat transfer enhancement of Shell and Tube heat exchangers by using different Nano fluid has been reviewed and proposed work has been decided based on that.

1. Nano fluid is best cooling fluid for heat transfer when compared with other fluid.
2. Various Nano Fluids have different thermo physical property depending on types of Nano particles used.
3. Nanofluids are more efficient as compare to other base fluids i.e in this project we use nanofluid (TiO_2, 18 nm, up to 0.2%vol. concentration) in Shell and Tube heat exchanger and planned to compare its performance with the base fluid.

IV. FUTURE SCOPE

Many operating and design parameter have been covered in this research. However there are many other issue that may be investigated. Recommended future studies as follows,

1. Use of nanofluid in place of base fluid (water) to achieve higher effectiveness.
2. If uses in power plant it reduces the pump work for the same amount of heat transfer with the base fluid (water).
3. Use of nanofluids, minimum global warming potential and eco-friendly.
4. It will reduce size of heat exchanger for the same amount of heat transfer with the base fluid (water).
5. There is always chance of development of some new experimental or new numerical methods which can give the new scope in this field.

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