# Overview of impact of Nanofluids on performance of shell and tube heat exchanger

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**ABSTRACT**

Heat exchangers are important devices for thermal systems in many industrial fields. In order to improve efficiency of commonly used shell and tube heat exchangers, nanofluids are used as coolants due to unique characteristics. This paper reviews and summarizes rescent investigations conducted on use of nanofluids in shell and tube heat exchangers with different concentrations with base fluids. Challenges and opportunities for future research are presented and discussed.

The Shell and Tube Heat Exchangers are the most commonly used in for industrial application due to its numerous beneficial application. Device is used for transferring of internal thermal energy between the two or more fluids/ gases at different temperature levels. In heat exchangers the fluids are segregated by the heat transfer surface and ideally they do not mix with each other. Nanofluids are nanoparticles suspended in base fluids. E.g. CuO in water with size of nanoparticles in the range 1-100 nm. Due to thermophysical properties coefficient of heat transfer with nanofluids is more than that of base fluids.

***Keywords-Shell and tube heat exchanger, CuO nanofluid , Thermo-physical properties , Heat transfer , Enhancement***

## 1. INTRODUCTION

A heat exchanger is equipment which transfers the energy from a hot fluid to a cold fluid, with maximum rate and minimum investment and running costs. It is a device used for affecti ng the process of heat exchange between two fluids that are at different temperatures. Heat exchangers are useful in many engineering process like those in refrigerating and air conditioning systems, power systems, food processing systems, chemical reactors and space or aeronautical applications.[1]In heat exchangers the temperature of each fluid changes as it passes through the exchangers, and hence the temperature of the dividing wall between the fluids also changes along the length of the heat exchanger. Heat exchangers are designed to deliver certain heat transfer rate for a certain specified conditions of flow rates and temperature. To get substantial heat transfer area from a double pipe exchanger, it must be long. The result is a high pressure drop, increased pumping costs, and large amounts of metal. This means we need a more compact arrangement that still simulates counter current flow. The Shell and Tube exchangers are used when a process requires large amounts of fluid to be heated or cooled and are suited for higher-pressure applications.[2]

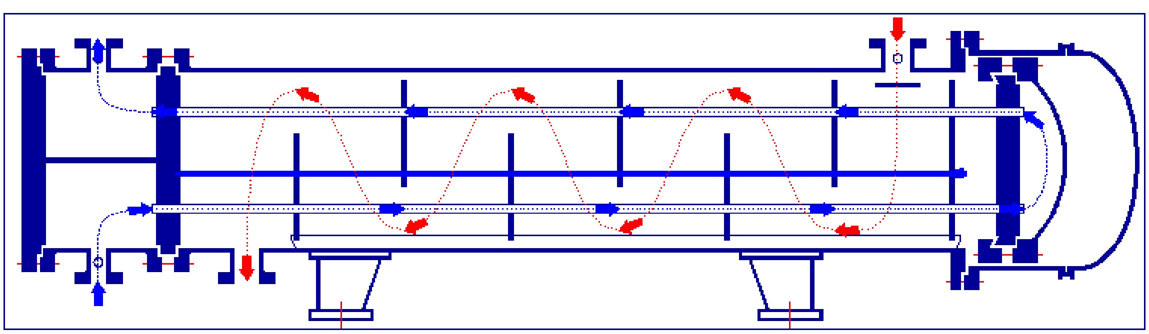

Fig No. 1. Experimental setup[3]

Shell and tube exchangers come in two pass and four pass models standards, and multi-pass custom models. Shell and Tube heat exchangers use baffles on the shell side fluid to accomplished mixing or turbulence. Without the use of baffles, the fluid can become stagnant in certain parts of the shell. A comprehensive treatment of heat exchanger design would involve many factors besides the heat transfer design would involve many factors besides the heat transfer analysis like size, weight, structural length, pressure drop and cost is beyond our scope.The amount of heat transfer was limited by the heat transfer fluids used. In order to maximize the heat transfer characteristics traditional fluids like oils and ethylene glycol are used further to increase and/or enhance the thermal conductivity of traditional fluids, the solid particles are suspended into the base fluids in heat exchangers.[4]

The thermal conductivity of ethylene glycol can be improved by addition of solid particles with thermal conductivity much higher than that of ethylene glycol. However to ensure ease of pumping of dispersion without phase separation and prevention of wall ero- sion by particles, very fine particles must be used. Nanofluids are stable, colloidal dispersions of nanoparticles such as metals, metal oxides, metal carbides and carbon allotropes in common coolants such as water, ethylene glycol, ethylene glycol–water mixture, propylene glycol, propylene glycol–water mixture and oil. Nanofluids possess higher thermal conductivity than the corresponding base fluid[5] The thermal conductivity of nanofluids depends on the morphology of nanomaterial, state of aggregation/dispersion, nanoparticle concentration, temperature and ratio of nanoparticle to base fluid thermal con- ductivity. Viscosity is also influenced by addition of nanoparticles with nanofluid viscosity generally higher than that of viscosity of base fluid . Thermal conductivity ratio and relative viscosity are used to compare the thermal conductivity and viscosity of nanofluids with those of the base fluid . Nanofluids with higher thermal conductivity ratio and lower relative viscosity are desirable. Hence development of such nanofluids using ethylene glycol as the base fluid can provide better heat transfer performance than pure ethylene glycol.[6]

## 2. LITERATURE SURVEY

[a] Farajollahi B., S.G.H, Etemad, M. H.et.al Performed an experimental analysis to study heat transfer of Nano fluids in a shell and tube heat exchanger. The Nano fluids used were TiO2/water and Al2O3/water under turbulent flow conditions the effect of Peclet number were investigated. This results Nano particle addition to the base fluids enhances the heat transfer coefficient.[7]

[b] Spiga G., M. Spigaet.al have determined the thermal balance equations in order to transient distribution of temperature in the core wall and both the unmixed gasses. The aim is the development of quite general exact analytical solution for transient two dimensional temperature distribution for wall and both gasses in cross flow heat exchanger with neither gas mixed.[8]

[c] Prashant S.et.al carried out an experimental study in which he compared the performance of Nano fluid based on direct absorption of solar thermal system (DASC) with that of a conventional one. The results obtained revealed that the efficiency increased of an order of 4-6% on using CuO when compared to water. Furthermore, the CuO Nano fluid with 0.005% volume fraction possess 2 –2.5 % of efficiency improvement than 0.05% volume fraction.[9]

[d]Taylor.R.A, Phelan.P.E, Otanicar.T.P, Walker.C.A , Nguyen. M, Trimble. S, Prasher.et.al ivestigated on applicability of Nano fluids in high flux solar collectors. Experiments on a laboratory-scale Nano fluid dish receiver suggest that up to 10% increase inefficiency is possible-relative to a conventional fluid- if operating conditions are chosen carefully for 0.125% volume fraction of graphite.[10]

[e] Varma.et.al an experimental study has been carried out on the flow and convective heat transfer characteristics of water based Al2O3 Nano fluids flowing through a circular tube of 1.812 mm inner diameter with the constant heat flux in fully developed laminar regime. Water- based Al2O3 Nano fluids with various volume fractions ranging from 0.01% to0.3% are manufactured by the two-step method, the heat transfer coefficient of water-based Al2O3 Nano fluids was increased by 8% at 0.3 to l% under the fixed Reynolds number compared with that of pure water and the enhancement of the heat transfer coefficient is larger than that of the effective thermal Conductivity at the same volume concentration.[11]

## 3. MATERIALS AND METHOD

The experimental set up consists of one shell that is fabricated from steel pipe with nominal IPS diameter up to 12 in. Shells are fabricated by rolling steel plate. It is apparent that higher heat transfer coefficient results when a liquid is maintained at a state of turbulence. Two baffle plates are inculcated to the tube bundle. Condenser tubes are made up of brass. The brass having a high thermal conductivity has the capacity to transfer more heat from the hot fluid in shell to the cold fluid in tubes. There are two u-tubes that are kept with square pitch. The tube sheets inserted at ends of the tubes in order to avoid the instability of tubes in the shell and to provide support to withstand pressures.A separate partition has been created with a non-conducting material in between the cold fluid inlet and cold fluid outlet sections in order to avoid the mixing of fluids. The various working fluids used in this experiment are water, pure ethylene glycol, and 50% of ethylene glycol, 25%ethylene glycol, 1% volume fraction of Sic and 2% volume fraction of Sic with water as base fluid. The working fluid silicon carbide Nano fluid is used with the advantages of having low density with high thermal conductivity among the ceramic compounds. It is comparatively cheap and commercially available. The colour of nanoparticles is grey and black. With the cheap potential availability the black coloured 100nm sized have been used for the preparation of Nano fluid. The thermal conductivity of the Nano fluid increases when compared with the base fluid. The Nano fluids are prepared by two-step method by the ultra sonicator and the stirrer breakdown the aggregates of the nanoparticles. The suspension and addition of surfactants help in adjusting the PH value of Nano fluids. The adjustment of Nano fluids prevented the reaggregation of nanoparticles and improved the stability of Nano fluids. The Nano fluid is prepared by stirring for 8 hours and the settlement of the particles is avoid for five hours. Always the hot fluid water is kept used in the shell with a temperature of331K. On the other side the tube side various working fluid sare varied and those are water, pure ethylene glycol, 50%,25%volume concentrations of ethylene glycol and 1%,2% volume concentrations of Sic with water as base fluid are allowed at a temperature of 300K.[12]

## 4.RESULT AND CONCLUSION

Most of the experimental and numerical examinations have shown that nanofluids present an enhanced heat transfer rate in comparison with conventional fluids, and it augments significantly by increasing concentration and Reynolds number. The advantages of applying nanofluids in heat exchangers can vary considerably depending not only on thermophysical properties butalso on the geometrical parameters of the heat exchanging equip- ment and the working conditions. Research studies conducted on double-pipe heat exchangers aredependent on type of nanofluids used and consequently, the drawn conclusions cannot be generalized for all nanofluids. The obtained results significantly depend on the several parameters such as the nanoparticle type, morphology shape, surfactants, preparation techniques and plans considered for simulation or mea- suring the variables. Therefore, neglecting the effect of different parameters can decrease accuracy and consequently, different parameters should be taken into account. Finally, it should be mentioned that with further advancement in heat exchangers and also producing better nanofluids, this technology will find substantial applications in many thermal engineering fields, especially those in which there is a crucial need for decreasing the energy consumption. Combining heat exchangers and nanofluids could cause a vital breakthrough in developing heat exchange equipment.

## ACKNOWLEDGEMENT

I would like to express my gratitude and sincere thanks to all those who helped us in the completion of Project Stage 1. We are grateful to Prof. N.P.Sherje (HOD, Mechanical Engg. Dept) for his contribution and immense help in completion of the Project Stage 1.I'm grateful to our project Coordinator, Prof. M.M.Kulkarni whose help, stimulating suggestions and encouragement, helped us to coordinate our project especially in writing this report.

I wish to express my sincere thanks to my project guide Prof.B.S.Patil for his valuable guidance and encouragement throughout the course of the Project work. His inspirations and immense cooperation in analyzing the documents and data helped to complete our project successfully in time.

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