IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 2, Issue 3, May 2022
Impact Factor: 6.252

Analysis of Nano-Fluid and Water Using CFD for Heat Exchanger

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Abstract: *Heat exchangers are a device used to transfer heat between two or more fluids. Cold water is commonly used in heat exchangers. But the heat transfer rate of the heat exchangers using water is less. Our aim is to improve the heat transfer rate. So, instead of cold water, we are using Nano fluid along with water. Nano fluids have improved thermal properties and heat transfer rate. Nano fluid contains metallic or non-metallic nano powder with a size of 100 nm in base fluid. We designed a CATIA model and imported the geometry in ANSYS software. After importing, we completed meshing process. Next, in setup, we selected material for shell and tube. Then we selected Nano fluid as the heat transferring medium. We provided boundary conditions to the heat exchanger. This gave us the result. From the result, we calculated the efficiencies of heat exchanger using water, aluminium oxide and copper oxide respectively. By comparing, we observed that the efficiency of copper oxide is greater than aluminium oxide and the efficiency of aluminium oxide is greater than cold water. Thus, we conclude that Nano fluids increase the efficiency of heat exchanger.*

Keywords: Nano fluid, CFD, ANSYS, Heat Exchanger, Mass Flow Rate, Efficiency

I. INTRODUCTION

Researchers have proven that Nanofluids have a great thermal conductivity and proper stability. Many surveys have been carried out in the field of Nanofluids, and some of investigators have reviewed the studies conducted in this area in different fields such as applying Nanofluids in boiling heat transfer, convective heat transfer and friction factor correlations of Nano fluids, particle migration in Nanofluids, magnetic Nano fluids, entropy generation in Nanofluids, mass transfer in Nanofluids, and so forth. Employing Nanofluids can be one of the most interesting techniques for heat transfer enhancement in heat exchangers. Several researchers have use Nanofluids for this purpose. A heat exchanger is a device which is use to transfer heat between two or more fluids. In other words, heat exchangers may be used in both cooling and heating processes. The fluids were separated by a solid wall to prevent mixing or they may be in direct contact. They are widely used in space heating, refrigeration, power stations, air conditioning, chemical plants, petrochemical plants, petroleum refineries, natural-gas processing. The classic example of a heat exchanger device is found in an internal combustion engine in which a circulating fluid known as engine coolant flows through radiator coils and airflows across the coils, it cools the coolant and heats the incoming air. Another example is the heat sink; it's a passive heat exchanger device that transfers the heat generated by an electronic or a mechanical device to a fluid medium, often air or a liquid coolant. The results display that Al2O3-water gave better heat transfer performance than water alone. Nanofluids with 40 nm- Al2O3 gives better heat transfer performance as compared to 100 nm- Al2O3 nanofluids [7]. Nanofluids containing smaller diameter particles at low particle volume concentration would yield better heat transfer than water by at least 16.7% [7].

II. LITERATURE SURVEY

Kunal Koushal Dew, Pankaj Shrivastava., [1] calculated the different results of nano fluids on heat exchangers. This is done with the help of 3 different nano fluids that is Aluminium oxide (Al2O3), Ferric oxide (Fe2O3) and Copper oxide (CuO). The effects of different percentages of nano fluids were studied. In order to achieve this, the percentage of nano fluids considered is 0.25 and 0.5%. The results clearly show that copper oxide nano fluids have more thermal heat transfer rate than aluminium oxide and ferric oxide.

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Yogesh Sharma, Neeraj Yadav., [2] worked on parametric analysis of Al203 of size 20-30 nm and CuO of size 30-50 nanometer to improve the properties of shell and tube heat exchanger. An experiment was done on the forced convective heat transfer and flow characteristics of the nano-fluid flowing in a horizontal shell and tube heat exchanger under turbulent flow conditions. The results stated that nano fluids have higher heat transfer rate than base fluids at same mass flow rate and temperature difference.

M.T. Naik, G. Ranga Janardhana., [3] researched on glycol based fluids exhibiting anti-freezing characteristics at sub-zero temperatures and hence widely used in heat exchangers in cold regions. CuO nanoparticles of size around 50 nm are mixed in the base fluid of propylene glycol-water (60:40 by volume) mixture, in the range of 0.025, 0.1, 0.4, 0.8 and 1.2% volume fraction and CuO nanofluids were prepared. The heat transfer rate of nanofluids for different particle volume concentration is studied at different temperatures of nanofluids. Results obtained display that thermal conductivity of nanofluids increases with increase in temperature and particle volume concentration of nanofluids.

III. Work Objectives

1. To design and heat exchanger which is suitable for the experiment.
2. To decide between metal-based nanofluids from all the nanofluids according to cost and availability.
3. To prepare a suitable CATIA model based on the experimental setup.
4. To note down the temperatures of the inlet and outlet using CFD diagrams from the analysis.
5. After making experiment analysis testing suitable results and conclusions were stated with the data.

IV. Analysis

4.1 Geometry

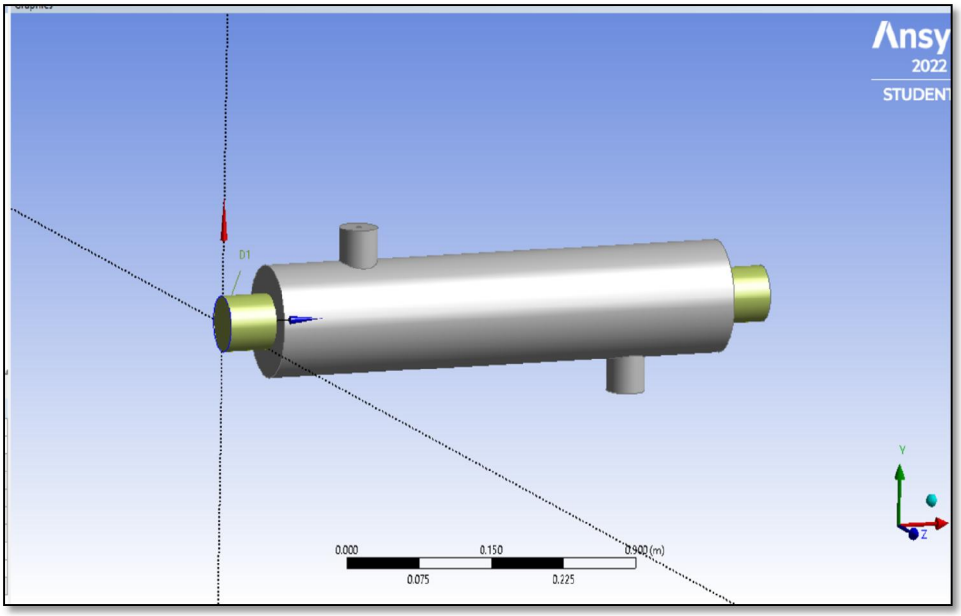

Figure 1: CATIA Design

We designed a single tube heat exchanger using CATIA software. In CATIA, we created two separate shell and tube designs and assembled them. After that we imported that CATIA design in ANSYS geometry.

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4.2 Meshing (2D/ 3D Mesh)

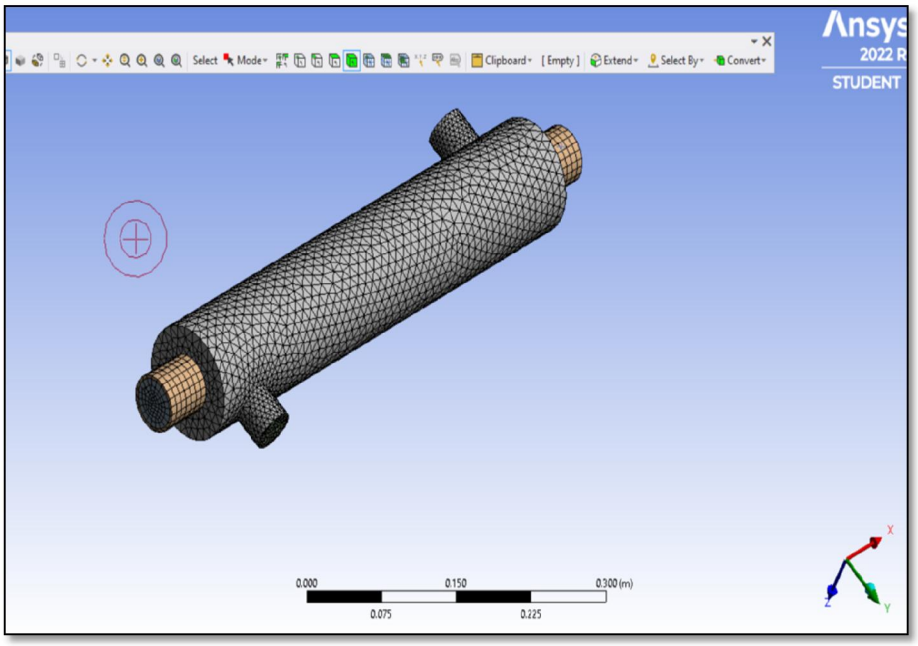
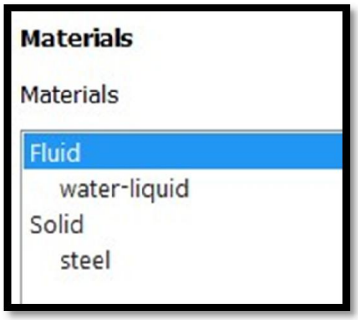


Figure 2: Meshing

ANSYS Meshing is a general-purpose, intelligent, automated high-performance product. It produces the most suitable mesh for accurate, efficient Multiphasic solutions. A mesh well suited for a specific analysis can be generated with a single mouse click for all parts in a model. The above CAD model is imported in ANSYS meshing to mesh the design.

- **Material Selection** – Here, we applied material to the heat exchanger and nano fluids. Stainless steel was selected for shell and tube of heat exchanger and aluminium oxide and copper oxide for nano fluids. This process was carried out in setup option.
- **Boundary condition**: We set the inlet temperature of hot water which flows through the tube and the inlet temperature of nano fluid flowing over the tube and inside the shell of heat exchanger



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V. RESULT

The below figure shows the change in temperature of the hot water passing through the tube. The nano fluid used here is copper oxide. The varying colours help us to study to the change in temperatures using the colour scale.

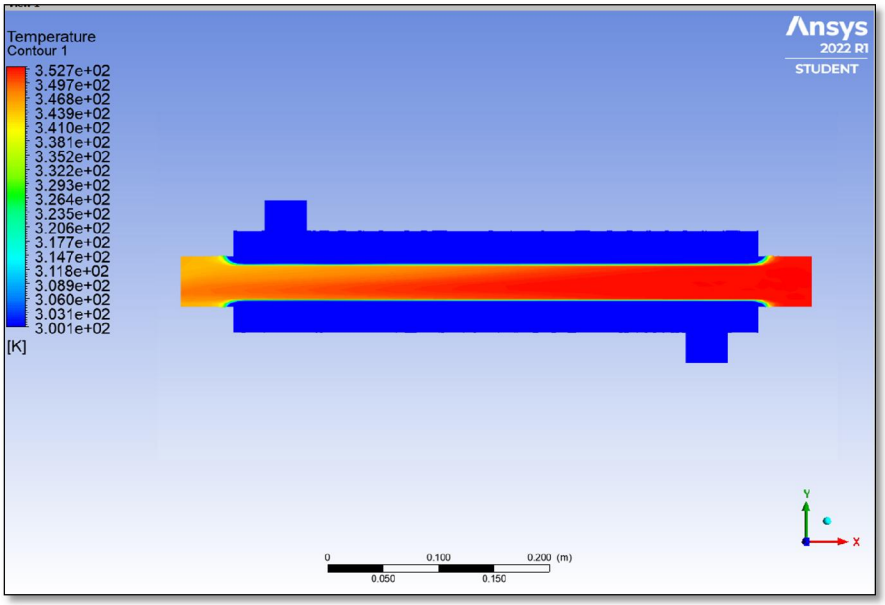

Figure 3: CuO Analysis with Hot water.

The below figure shows the change in temperature of the hot water passing through the tube. The nano fluid used here is aluminium oxide. The varying colours help us to study to the change in temperatures using the colour scale.

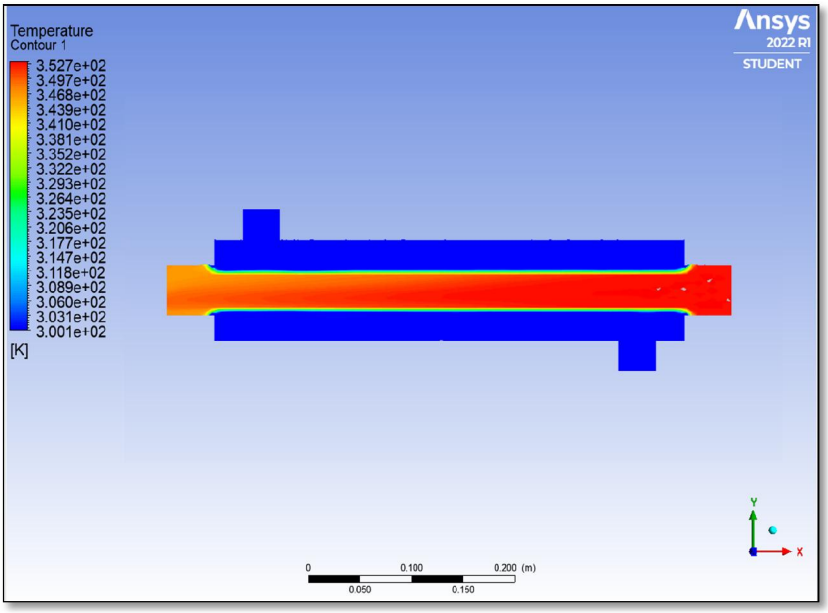

Figure 4: Al2O3 Analysis with Hot Water

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The below figure shows how nano fluid flows through the shell and the flow of hot water through the tube.

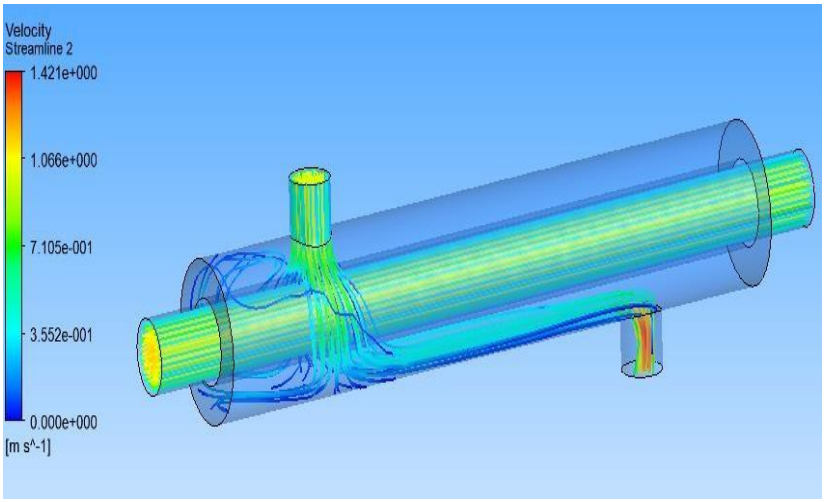

Figure 5: Streamline flow

VI. CONCLUSION

In this experiment existing CFD simulations have been performed to output data such as temperature and wall heat transfer coefficient. This simulation is a great way attempted to conduct a parametric analysis to understand and identify the optimal level of about pointed out variables. Computational fluid dynamics in Ansys which are in the present investigation existing muffler CFD simulation has been performed to determine found to be a better alternative for inconvenient, high cost and time-consuming experimental methodology is utilized in this analysis. The shell side of a small shell-and-tube heat exchanger is meshed in the software during modelled with sufficient detail to efficient the flow and temperature fields values. From this CFD simulation result, for tube wall and inlet temperatures, heat transfer coefficient, and heat transfer rate values are obtained. It is observed from calculation that using nano fluid as cold-water efficiency is increased compared with water only.

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