(IJITR) INTERNATIONAL JOURNAL OF INNOVATIVE TECHNOLOGY AND RESEARCH
Volume No.5, Issue No.4, June – July 2017, 7016-7020.

CFD Analysis Of Periodic Flow Heat Exchanger Using Nanofluids

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Abstract: **Many heat transfer applications such as steam generators in a boiler or air cooling coil of an air conditioner, can be modelled in a bank of tubes containing a fluid flowing at one temperature that is immersed in a second fluid in a cross flow at different temperature. CFD analysis is a useful tool for understanding flow and heat transfer principles as well as for modelling these types of geometries. Both the fluids considered in the present study are CuO Nano fluid, and SiO_2 and flow is classified as laminar and steady with The tube spacing or arrangement with 30 and 60 degree angle are studied to determine the maximum heat transfer fluid Both the nanofluids are simulated with both the angle arrangement to extract pressure velocity and temperature distribution the analysis is the compared with the common fluid Water to determine the performance of the arrangement.**

Keywords: **Plate Heat Exchanger; Ceramic; Nanofluids SiO_2; CuO;**

I. INTRODUCTION

Generally, in any kind of heat exchanger the commonly used flowing fluid is water. But now here we are using Nano fluid (CUO). A Nano fluid is a fluid containing nanometer-sized particles, called nanoparticles. These fluids are engineered colloidal suspensions of nanoparticles in a base fluid. The nanoparticles used in Nano fluids are typically made of metals, oxides, carbides, or carbon nanotubes. Common base fluids include water, ethylene glycol and oil.

Nano fluids have novel properties that make them potentially useful in many applications in heat transfer including microelectronics, fuel cells, pharmaceutical processes, and hybrid –powered engines, engine cooling/vehicle thermal management, domestic refrigerator, chillier, heat exchangers in grinding, machining and in boiler flue gas Temperature reduction. They exhibit enhanced thermal conductivity and the convective heat transfer coefficient compared to the base fluid. Knowledge of the rheological behaviour of Nano fluids is found to be very critical in deciding their suitability for convective heat transfer.

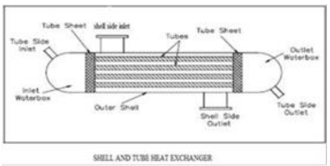

Figure 1: Heat transfer for heat exchanger.

Heat Exchanger Tubes

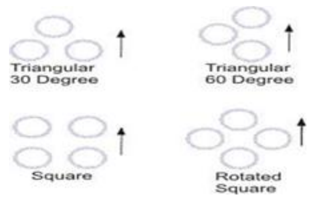

Figure 2: Common tube layouts for exchangers.

The tubes are the basic components of the shell and Tube heat exchanger, providing the heat transfer surface between on fluid flowing inside the tube and the other fluid flowing across outside of the tubes. The tubes may be seamless or welded and most commonly made of copper or steel alloys. Other alloys for specific applications the tubes are available in a variety of metals which includes admiralty, Mountz metal, brass, 70-30 copper nickel, aluminium bronze, aluminium. They are available in a number of different wall thicknesses. Tubes in heat exchangers.

Working of Nano fluid

A nanofluid is a fluid containing nanometer-sized particles, called nanoparticles. These fluids are engineered colloidal suspensions of nanoparticles in a base fluid. The nanoparticles used in nanofluids are typically made of metals, oxides, carbides, or carbon nanotubes. Common base fluids include water, ethylene glycol and oil.

II. METHODOLOGY

Step 1

Create Periodic Zones

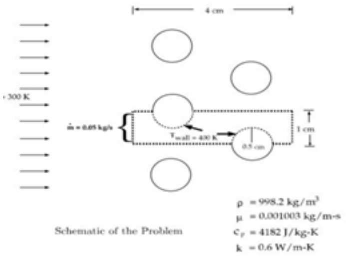

Figure 3: Geometry

III. MESHING

ANSYS Meshing is a general-purpose, intelligent, automated high-performance product. It produces the most appropriate mesh for accurate, efficient multi physics solutions. A mesh well suited for a specific analysis can be generated with a single mouse click for all parts in a model. Full controls over the options used to generate the mesh are available for the expert user who wants to fine-tune it. The power of parallel processing is automatically used to reduce the time you have to wait for mesh generation.

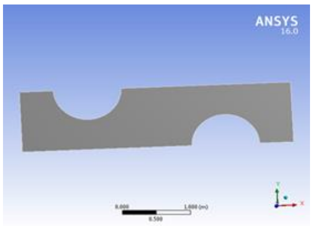

Figure 4: Meshing

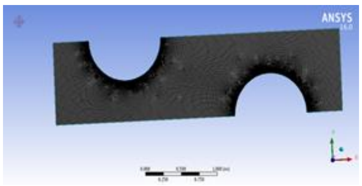

Figure 5: Meshing

IV. RESULTS

1. RESULTS OF THE PERIODIC HEAT TRANSFER USING SIO2 AS A WORKING FLUID WITH 30 DEGREE

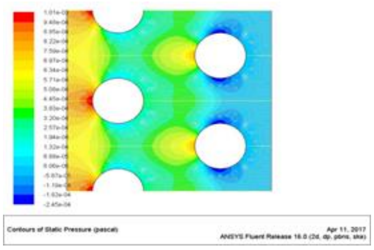

Figure 6: Static Pressure Of periodic heat transfer with SIO2

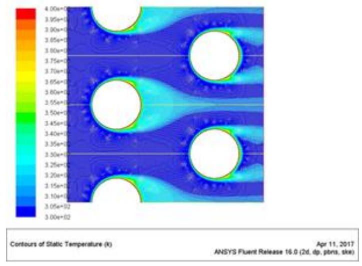

Figure 7: Static Temperature of the periodic heat transfer using SIO2

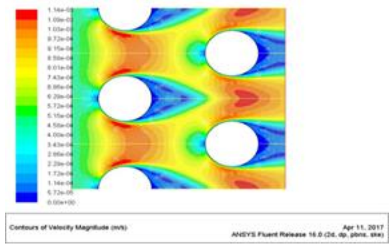

Figure 8: Velocity of the periodic heat transfer using SIO2

2. RESULTS OF THE PERIODIC HEAT TRANSFER USING CuO AS WORKING FLUID WITH 30 DEGREE

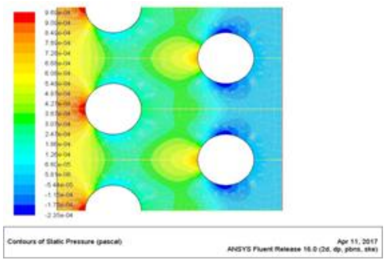

Figure 9: Static Pressure Of periodic heat transfer with CUO

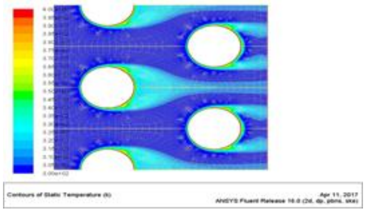

Figure 10: Static Temperature Of periodic heat transfer with CUO

V. PLOTS COMPARISIONS

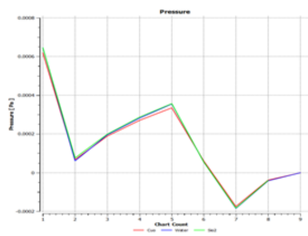

Figure 11: Pressure Comparison between water, CuO and SiO_2

The above Graph represents the Comparison of

Pressure Distribution in periodic heat transfer in 30 degree arrangement with water , CUO and SIO2 , In the plot X-axis represents the chart count and y-axis represents the Pressure in Pascal Chart count is the term obtained from the 2d line drawn from the inlet and outlet it represents the equally spaced points on the total length of the line , From the curves we can say the pressure is gradually decreasing up to the Cylinder wall area and it is increasing at the outlet with the similar behaviour in all three fluids due to the closer arrangement of cylinders

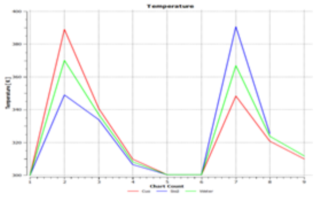

Figure 12: Temperature Distribution Comparison between water, CuO and SiO_2

The above Graph represents the Comparison of Temperature (k) Distribution in periodic heat transfer in 30 degree arrangement with Water, CUO and SIO2 , In the plot X-axis represents the chart count and y-axis represents the Temperature in Kelvin Chart count is the term obtained from the 2d line drawn from the inlet and outlet it represents the equally spaced points on the total length of the line ,

The obtain curves suggests that in all the three fluids Sio2 has more heat transfer because of the Divided arrangement and the uniform cooling will decide the high thermal conductive fluid

Figure 13: Velocity Distribution along the line of water, CuO and SiO_2

The above Graph represents the Comparison of Velocity (m/s) Distribution in periodic heat transfer in 30 degree arrangement with Water , CuO and SiO2 , In the plot X-axis represents the chart count and y-axis represents the Velocity in meter per second Chart count is the term obtained from the 2d line drawn from the inlet and outlet it represents the equally spaced points on the total length of the line ,

From the curve the Velocity of the water is much higher compared with the other nano fluids because of the lower density we can observe the hikes in the curve has formed near the cylinder region because of periodicity all fluids respond or react similarly unless they have any changes in the physical properties

3. RESULTS OF THE PERIODIC HEAT TRANSFER USING CUO NANOFLUID WITH 60 DEGREES

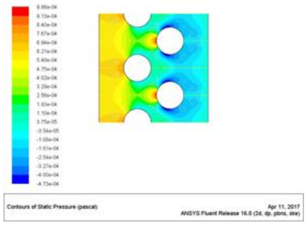

Figure 14: Static Pressure Of periodic heat transfer with CuO with construction angle of 60 degrees

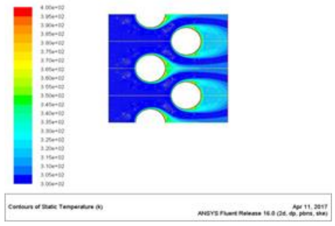

Figure 15: Static Temperature Of periodic heat transfer with CuO with construction angle of 60 degrees

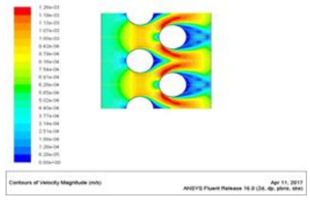

Figure 16: Velocity Magnitude Of periodic heat transfer with CuO with construction angle of 60 degrees

4. RESULTS OF THE PERIODIC HEAT TRANSFER USING SiO_2 NANOFLUID WITH 60 DEGREES

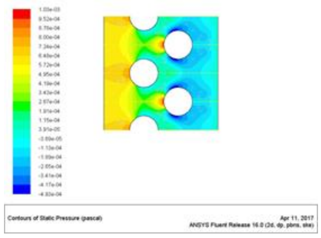

Figure 17: Static Pressure Of periodic heat transfer with SiO2 with construction angle of 60 degrees

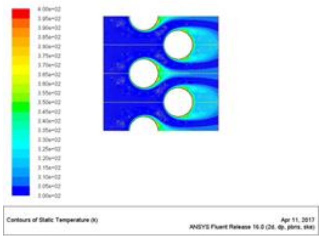

Figure 18: Static Pressure Of periodic heat transfer with SiO2with construction angle of 60 degrees

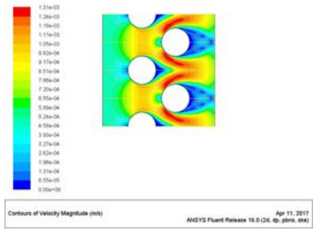

Figure 19: Velocity magnitude of periodic heat transfer with SiO2 with construction angle of 60 degrees

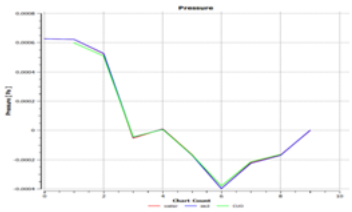

Figure 20: Pressure Distribution along the line of water, CuO and SiO_2

The above Graph represents the Comparison of Pressure Distribution in periodic heat transfer with water , CUO and SIO2 , In the plot X-axis represents the chart count and y-axis represents the Pressure in Pascal Chart count is the term obtained from the 2d line drawn from the inlet and outlet it represents the equally spaced points on the total length of the line , From the curves we can say the pressure is gradually decreasing up to the Cylinder wall area and it is increasing at the outlet with the similar behaviour in all three fluids due to the closer arrangement of cylinders

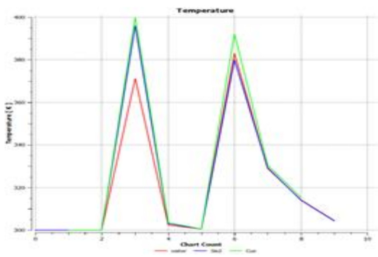

Figure 21: Temperature Distribution along the axis Of three Fluids

The above Graph represents the Comparison of Temperature (k)Distribution in periodic heat transfer with Water , CUO and SIO2 , In the plot X-axis represents the chart count and y-axis represents the Temperature in Kelvin Chart count is the term obtained from the 2d line drawn from the inlet and outlet it represents the equally spaced points on the total length of the line ,

The obtain curves suggests that in all the three fluids Sio2 has more heat transfer because of the closure arrangement and the rapidly subjected cooling will vary the difference vastly

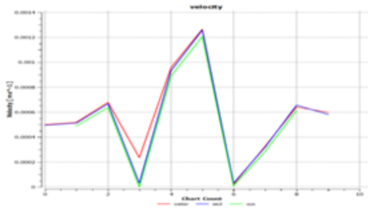

Figure 22: Velocity Distribution along the length of the three fluids

The above Graph represents the Comparison of Velocity (m/s) Distribution in periodic heat transfer with Water , CUO and SIO2 , In the plot X-axis represents the chart count and y-axis represents the Velocity in meter per second Chart count is the term obtained from the 2d line drawn from the inlet and outlet it represents the equally spaced points on the total length of the line ,

From the curve the Velocity of the water is much higher compared with the other nanofluids because of the lower density we can observe the hikes in the curve has formed near the cylinder region because of periodicity all fluids respond or react similarly unless they have any changes in the physical properties

VI. CONCLUSION

Mode and mesh creation n CFD is one of the most important phases of simulation. The model and mesh density determine the accuracy and flexibility of the simulations. Too dense a mesh will unnecessarily increase the solution time; too coarse a mesh will reach to a divergent solution quickly. But will not show an accurate flow profile. An optimal mesh is denser in areas where there are no flow profile changes.

•A two- dimensional numerical solution of flow and heat transfer in a bank of tubes which is used in industrial applications has been carried out.

•Analysis for 60 and 30 degree models were performed to extract the heat transfer from the cylinders it is observed that the nanofluids taken sio2 and CuO has performed better in transferring heat when compared to the graph

•Further improvements of heat transfer and fluid flow modelling can be possible by modelling three dimensional models and changing the working fluid.

•It was observed that Heat transfer rate is more for Nano fluids when compared to water.

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