A Review on CFD Study on Forced Convection Flow of Nano fluid in Triangular Corrugated Channel

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Abstract- **Heat transfer is a science that studies the energy transfer between two bodies due to temperature difference. In theory, thermal energy is related to the kinetics energy of molecules on a microscopic scale. When material's temperature increases, the thermal agitation of its constituent molecules will increase. The performance of heat exchangers especially for single phase flows can be enhanced by many augmentation techniques. One of the most popular methods used is a passive heat transfer technique. Researchers have been quite active in the search of novel ways on heat transfer augmentation techniques using various types of passive techniques to increase heat transfer performances of heat exchanger. Computational Fluid Dynamics (CFD) simulations of heat transfer and friction factor analysis in a turbulent flow in triangular corrugated channels with Al2O3-water nanofluid is presented in this paper. Simulations are carried out at Reynolds number range of 10000-30000, with nanoparticle volume fractions 0-6% and constant heat flux condition.**

INTRODUCTION

The plates provide each of the fluids with large heat transfer area because each of the plates has a very large surface area. As a result a plate type heat exchanger compared to a similarly sized of shell and tube heat exchanger, is capable of transferring much more heat because of the larger area of the plates provides over tubes. Due to the high heat transfer efficiency, plate type heat exchangers are usually very small when compared to a shell and tube type heat exchanger but with the same heat transfer capacity. Recently efforts are being made in India towards the development of small plate fin heat exchangers for cryogenic and aerospace applications. A plate fin heat exchanger is a form of compact heat exchanger consisting of a block of alternating layers of corrugated *fins* and flat separators known as parting sheets. A schematic view of such an Heat exchanger is given in Fig. 1.1. The corrugations serve both as secondary heat transfer surface and as mechanical support against the internal pressure between layers. Streams exchange heat by flowing along the passages by the corrugations between the parting sheets. The edges of the corrugated layers are sealed by side-bars. Corrugations and side-bars are brazed to the parting sheets on both sides to form rigid pressure-containing voids. The first and the last sheets, called *cap sheets*, are usually of thicker material than the parting sheets to support the excess pressure over the ambient and to give protection against physical damage. Each stream enters the block from its own header via ports in the side-bars of appropriate layers and leaves in a similar fashion. The header tanks are welded to the side-bars and parting sheets across the full stack of layers.

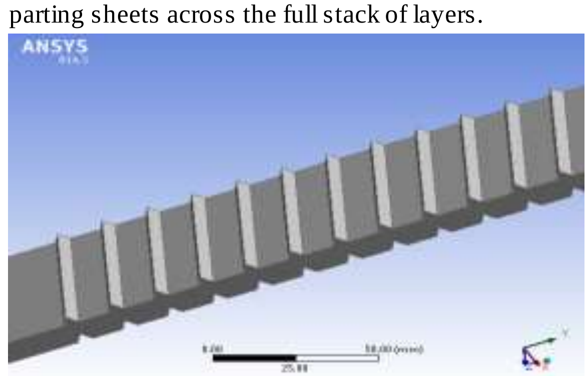

Figure 1.1: Plate fin heat exchanger

LITERATURE REVIEW

Mohammed and Abed (2008) numerically studied laminar forced convection heat transfer and fluid flow characteristic in a corrugated channel. Temperature of the channel walls was maintained constant which was higher than fluid temperature. Effect of wavy angle and Reynolds number were studied on fluid flow and heat transfer. The range of the Reynold`s number was carried out for the solution was found out to be 500 to 2500, wavy angles range was from 0° to 60° and Prandtl number was 0.7. It was found that the optimum values of the heat transfer enhancement and pressure drop were 3.6 and 1.11 times higher than those from the plane channel at wavy angle λ = 40°, respectively Marjanet.al (2008) has made an experimental study over corrugated plate heat exchanger by using multi-walled carbon nanotubes (MWCNT). To investigate friction loss, heat transfer coefficient by convection, Nusselt number, pumping power and pressure drop in a counter flow corrugated plate heat exchanger different water-based nano-fluids such as Gum Arabic-treated multi-walled carbon nanotubes (MWCNT-GA), functionalized MWCNT with cysteine (FMWCNT-Cys) and silver (FMWCNT-Ag) were employed as coolants. From the experimentation it was found that by increasing Pecelet number, Reynolds number, or fraction of nonmaterial improve marks in the characteristics heat transfer of the nanofluid increased. In all investigated cases, it has been found that power consumption and heat transfer rate is less for water compared to nanofluids. Besides that it has been also found that for a specific pumping power, heat removal in nanofluids is higher as compared to water. Therefore, performance of the heat exchanger can be enhanced by choosing MWCNT water as the working.

Kumar et.al (2010) has made an attempt to investigate the performance and effectiveness of corrugated plate heat exchanger. Experiment was conducted on three channels 1-1 passes of corrugated plate heat exchanger. Hot fluid was made to flow at the middle channel while the cold fluid flow at top and bottom channel in counter and in parallel flow. Plate had a sinusoidal shape at an angle of 30° corrugation angle. Temperature of hot fluid was in the range of 50°C to 70°C whereas temperature of the cold fluid was in the range if 30°C to 40°C inlet. It was found that the effectiveness of counter flow heat exchanger is 48% higher than the parallel flow. As well as exergy loss was also calculated and found 33% less in counter flow arrangement as compared to the parallel flow arrangement.

Khan and Kumar (2009) described performance and exergy of corrugated plate heat exchanger in parallel or in counter flow. Plate had sinusoidal wavy surface with corrugation angle of 45°C. Heat exchanger contained 3 Channels. Hot fluid flow at the middle channel which was cooled by water through outer channels. Hot water temperature was in the range of 40°C to 60°C. Reynolds number was in the range of 900< Re>1300 for hot and cold fluid. After performing experiment performance or effectiveness of corrugated plate heat exchanger for counter flow was found out to be 44.5% more as compared to parallel flow arrangement. As well as exergy loss in counter flow is 7.2% less as compared to parallel flow .

Raoet.al (2009) in their investigation used corrugated plate heat exchanger with corrugation angle 30°, 40°, 50°. Water was taken as heating medium while Glycerol was taken as test fluid. The inlet and outlet temperature of hot fluid and test fluid was measured by means of four thermocouples. From the experimental investigation it was found that 50° corrugation angle heat transfer increased. It is also found that 60% Glycerol had high rate of heat transfer as compared to the 50%, 60% and water. Hence in investigation it has been found that with the increase of corrugation angle as well as with the increase of viscosity of fluid heat transfer rate increases.

CONCLUSION

The CFD model of triangular corrugated heat exchanger will be design on ANSYS 14.5. The design model of ANSYS will be meshed on the ICEM CFD. The meshed model will be analysed and the results will be discussed in the further research work.

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