A Review on Heat Transfer Enhancement Using Passive Techniques

Prof. Pushparaj Singh[1], Avanish Kumar[2]
[1]*Rewa Institute of Technology, Professor, Department of Mechanical Engg. REWA, MP*
[2]*Rewa Institute of Technology, M.Tech Scholar, Department of Mechanical Engg. REWA, MP*

***Abstract*- A double pipe heat exchanger, in its simplest form is just one pipe inside another larger pipe. One fluid flows through the inside pipe and the other flows through the annulus between the two pipes. The wall of the inner pipe is the heat transfer surface. The pipes are usually doubled, in order to make the overall unit more compact. In this work the review on various researches have been done for the enhancement of heat transfer in double pipe heat exchanger and the analysis of the survey is shown in this research. It can observed that the extended surface play an important role in the enhancement of heat transfer. In this work the extended surface added in the inner tube and the model will be generated in the CFD, the model will be meshed and the results analysed in the Post CFD.**

Index Terms- Extended surface, Heat transfer, CFD, Nusselt number, Reynolds number, mesh

1. INTRODUCTION

In double pipe heat exchanger design, an important factor is the type of flow pattern in the heat exchanger. A double pipe heat exchanger will typically be either counter flow or parallel flow. Cross flow just doesn't work for a double pipe heat exchanger. The flow pattern and the required heat exchange duty allow calculation of the log mean temperature difference. That together with an estimated overall heat transfer coefficient allows calculation of the required heat transfer surface area. Then pipe sizes, pipe lengths and number of bends can be determined.

The term 'hairpin heat exchanger' is also used for a heat exchanger. A hairpin heat exchanger may have only one inside pipe, or it may have multiple inside tubes, but it will always have the doubling back feature. Some heat exchanger manufacturers advertise the availability of finned tubes in a hairpin or double pipe heat exchanger. These would always be longitudinal fins, rather than the more common radial fins used in a cross flow finned tube heat exchanger.

A primary advantage of a hairpin or double pipe heat exchanger is that it can be operated in a true counter flow pattern, which is the most efficient flow pattern. That is, it will give the highest overall heat transfer coefficient for the double pipe heat exchanger design. Also, hairpin and double pipe heat exchangers can handle high pressures and temperatures well. When they are operating in true counter flow, they can operate with a temperature cross, that is, where the cold side outlet temperature is higher than the hot side outlet temperature.

1.1 Passive Techniques: Active, passive and compound techniques are used for the enhancement of heat transfer. Nowadays, there have been a large number of attempts to reduce size and cost of heat exchangers, in reducing size and cost of a heat exchanger are basically the heat transfer coefficient and pressure drop. The performance of heat exchangers is essential for reducing size of the system and to make the system more compact and the performance depends on the rate of heat transfer. The high rate of heat transfer is desirable because, it reduces the fuel consumption. A wide range of experimental, theoretical and numerical studies has been performed on the effect of different parameters like Reynolds number, Nusselt number, Concentration of nanofluids and size of nano particle.

2. LITERATURE REVIEW

A broad review of research in the field of heat exchanger spatially on double pipe heat exchanger is shown below:

Qianmei Fu, Jing Ding et.al, 2019 In this study the effect of structure ratio of heat exchanger and the entrance velocity of S-CO2 on heat transfer and flow resistance are investigated numerically.

Xue Chen, Chuang Sun et.al 2019 A numerical investigation is performed to analyze the high-temperature heat transfer behavior in a double-pipe heat exchanger filled with open-cell porous foam. The Forchheimer-extended Darcy equation and the local thermal non equilibrium model are utilized to simulate the flow and thermal transport inside the foam regions, considering the coupling effects between the inner and annular spaces. The effect of solid wall thickness is incorporated in the modelling process, following the continuity conditions of temperature and heat flux at the porous-solid interface.

A.M. Ali, El-Maghlany, 2018 Three dimensional, steady sate and incompressible CFD model was constructed for investigation of the effect of rotation and eccentricity on the heat transfer rate. A double pipe heat exchanger which was used for this study consists of an inner pipe and an outer pipe of diameter 50 mm and 150 mm respectively with a length of 2000 mm.

Mohammad Hussein Bahmani, 2017 heat transfer and turbulent flow of water/alumina nanofluid in a parallel as well as counter flow double pipe heat exchanger have been investigated. The governing equations have been solved using an in-house FORTRAN code, based on finite volume method. Single-phase and standard k-e models have been used for nanofluid and turbulent modeling, respectively. The internal fluid has been considered as hot fluid (nanofluid) and the external fluid, cold fluid (base fluid). The effects of nanoparticles volume fraction, flow direction and Reynolds number on base fluid, nanofluid and wall temperatures, thermal efficiency, Nusselt number and convection heat transfer coefficient have been studied. The results indicated that increasing the nanoparticles volume fraction or Reynolds number causes enhancement of Nusselt number and convection heat transfer coefficient.

Mohamad Omidi, Farhadi, 2017 Growing need to develop and improve the effectiveness of heat exchangers has led to a broad range of investigations for increasing heat transfer rate along with decreasing the size and cost of the industrial apparatus accordingly. One of these many apparatus which are used in different industries is double pipe heat exchanger.

M. Sheikholeslami, D.D. Ganji, 2016 Effect of typical and perforated conical ring turbulators on hydrothermal behavior of air to water double pipe heat exchanger is investigated. Two arrays (Direct conical ring (DCR) array and Reverse conical ring (RCR) array) are considered. Experimental analysis is examined for different values of open area ratio (0–0.0833), Reynolds number (6000–12,000), conical angle (0°–30°) and pitch ratio (1.83–5.83). Correlations for friction factor, Nusselt number and thermal performance factor are presented.

Hamed Sadighi Dizaji, Samad Jafarmadar et.al 2015 Heat transfer, pressure drop and effectiveness in a double pipe heat exchanger made of corrugated outer and inner tubes have been experimentally investigated in this paper. Both of the inner and outer tubes were corrugated by means of a special machine. New various arrangements of convex and concave corrugated tube were investigated. Heat transfer coefficient was determined using Wilson plots.

H.J. Xu, Z.G. Qu 2014 The self-coupling heat transfer in a counter-flow double-pipe heat exchanger filled with metallic foams is numerically investigated. The Forchheimer extended Darcy equation with a quadratic term is adopted for the momentum equation, whereas the local thermal non-equilibrium model is applied for establishing energy equations with thermal dispersion.

N. Targui, H. Kahalerras 2013 A numerical investigations is carried out to analyze the effect of porous baffles and flow pulsation on a double pipe heat exchanger performance. The hot fluid flows in the inner cylinder, whereas the cold fluid circulates in the annular gap. The Darcy–Brinkman–Forchheimer model is adopted to describe the flow in the porous regions and the finite volume method is used to solve the governing equations with the appropriate boundary conditions.

3. RESEARCH OBJECTIVES

The objective of the present study is to enhancement of heat transfer in the double pipe heat exchanger. In this study the extended surfaces have been added in the inner tube.

The objectives of the present study are as follows:

To generate the geometry model and analyze it.

To study and evaluate the effects of flow conditions and flow configurations on the rate of heat transfer through thin walled tubes. To determine the overall heat transfer coefficient for the double pipe heat exchanger for counter flow.

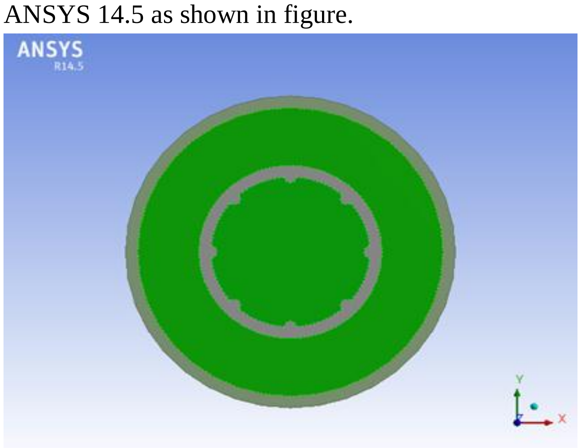
4. METHODOLOGY

CFD can be used to determine the performance of a component at the design stage, or it can be used to analyze difficulties with an existing component and lead to its improved design. The geometry of the region of interest is then defined. If the geometry already exists in CAD, it can be imported directly. The mesh is then created. After importing the mesh into the pre-processor, other elements of the simulation including the boundary conditions (inlets, outlets, and so on) and fluid properties are defined. The flow solver is run to produce a file of results that contains the variation of velocity, pressure and any other variables throughout the region of interest. The results can be visualized and can provide the engineer an understanding of the behavior of the fluid throughout the region of interest. This can lead to design modifications that can be tested by changing the geometry of the CFD model and seeing the effect.
The process of performing a single CFD simulation is split into four components:

- Creating the Geometry/Mesh
- Defining the Physics of the Model
- Solving the CFD Problem
- Visualizing the Results in the Postprocessor

5. CONCLUSION

The geometrical model of double pipe heat exchanger has generated in the design modular by using ANSYS 14.5 as shown in figure.



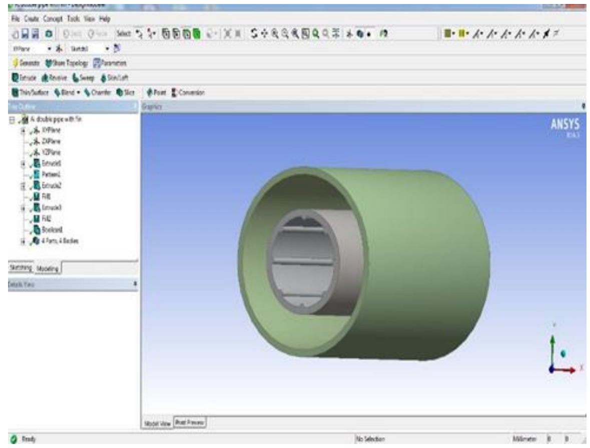


Figure 1 Geometry of double pipe heat exchanger with fin

The design model will mesh in the ICEM CFD and the meshed model will be imported to Fluent. The desired boundary condition will be applied and model will be analysed and the result will be compared on the basis of previous study.

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