Analysis of the Double Tube Heat Exchanger with Fins by Using Ansys Fluent: A Critical Review

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Abstract - A heat exchanger is a device used to transfer heat between a solid object and a fluid, or between two or more fluids. One of the most important industrial processes is heat transfer, carried out by heat exchangers in single and multiphase flow applications. Despite the existence of well-developed theoretical models for different heat transfer mechanisms, the expanding need for industrial applications requiring the design and optimization of heat exchangers has created a solid demand for experimental work and effort. We focused on heat transfer characteristics in surfaces with pin fins. Different fins shapes with various flow boundaries were studied, and thermal and hydraulic performances were investigated. The impact of parameters such as inlet boundary conditions, fin shapes, and duct cross-section characteristics on both flow and heat transfer was examined. Available experimental data and correlations in the literature have been used for models validation. For each case, a model based on current configuration was built and verified, and was then used for optimization and new design suggestions. All numerical modeling was performed using commercial CFD software. In this work performance of the heat exchanger with fins judged of the basis of the LMTD and over heat transfer coefficient using CFD technique .As expected manually it is very difficult that's why ANSYS Fluent 2021R1 used to analyze. Furthermore, compare and select the best model of the double pipe heat exchanger. At end of the work it is found heat transfer of the heat exchanger is increased after applying the fins.

Keywords: Heat Exchanger, CFD, ANSYS FLUENT, LMTD, FINS.

I. INTRODUCTION

New technologies are needed to fulfill the demand of high heat flow processes to enhance heat transfer requirement. Furthermore, there is growing interest in improving the efficiency of existing heat transfer processes. To enhancement heat transfer in the heat exchangers many active and passive techniques are used nowadays. Conventional heat transfer fluids such as water, air, lubricating oil, and ethylene glycol have very poor thermal conductivities compared with metal and metal oxides. Specific properties of conventional fluids can be improved by adding additives in liquid coolants to overcome this limitation. The heat transfer coefficient (heat transfer enhancement) can be improved via the addition of high thermal conductivity solid particles to the liquid coolant.

There may be several different flow patterns for a heat exchanger. Common types of heat exchangers are counterflow, parallel flow, and crossflow. The most effective flow method of the three is a counter flow heat exchanger.

A counterflow heat exchanger is a warm fluid that enters at one end of the heat exchanger, and the cold fluid exits at the same end of the flow path. Counterflow is the most popular type of fluid to the fluid heat exchanger since it is the most effective type.

The shell and tube heat exchanger is realized as the important equipment in waste heat recovery system. However, its volume is large and manufacturing costs is high because of the low heat transfer efficiency. It is necessary to improve heat transfer performance of heat exchanger by reducing the metal consumption and save operating cost.

Fiinned tube heat exchanger is widely used to enhance the heat transfer in many thermal engineering fields. Huge amount of hot flue gases is generated from Boilers, Kilns, Ovens and Furnaces. If some of this waste heat produced by different methods could be recovered, a considerable amount of primary fuel could be saved. The energy lost by waste gases produced by the furnace cannot be fully recovered. However, much of the heat could be recovered and loss minimized by adopting following method discussed.

This work attempts the analysis of double tube heat exchanger with the comparison of with fin to without fin. This work also attempts the analysis of double tube heat exchanger with different mass flow rate and regress the friction on changing the mass flow rate. We have to increase the mass flow rate then velocity should be increased. If velocity increased Reynolds number is also increased and friction should be minimized.

II. LITERATURE REVIEW

Deepak Kumar S et.al.[1] " Design And Performance Analysis of Double Pipe Heat Exchanger In Counter Flow" In this paper we observed that to improve the heat exchanger's efficiency, one must think of heat transfer enhancement in the heat exchanger. In addition, heat transfer improvement makes it possible to reduce the size of the heat exchanger significantly. For a compact heat exchanger, a high heat transfer rate with minimum space requirement is required. The counter flow heat exchanger increases the heat transfer feature of the double pipe heat helical fins that have been mounted on the inner tube's outer surface, and the additional insert is used to improve the effectiveness. The heat pipe model is designed by the software CREO PARAMETRIC and analyses by the ANSYS software. To check the temperature difference in varying hot water flow rates. Furthermore, compare and select the best model of the double pipe heat exchanger. The main advantage of double pipe heat exchanger in Plain tube (PT), Plain tube with Helical fins, and Helical fins with inserts, yields better thermal performance due to the effect of Helical fins with an inserted.

M.J. Scott et.al.[2] "Discussed the analysis of the performance of internally finned tubes in turbulent forced convection heat exchange". The analysis compares the performance of an internally finned tube exchanger with that of smooth tubes heat exchanger. The calculations are performed for three different design cases. By change the internal fin geometric parameters, we have to show the performance of heat exchanger and allow using of minimum tube material. The suitable axial internal fins offer less than 10 percent material savings for same pumping power and heat.

Hamid Nabati [3] "Numerical analysis of heat transfer and fluid flow in heat exchangers with emphasis on Pin Fin technology" In this paper, Computational fluid dynamics (CFD) is a computer simulation technique used for fluid flow and heat transfer modeling. Based on increasingly powerful computer resources, CFD can be applied to solve industrial flow and complex phenomenon problems. However, there still exists a lack of data for CFD applications in different industrial areas enabling the development of general guidelines in specific numerical heat and flow studies. Compact heat exchangers (CHE) have recently become subject to extensive research because of their importance to a wide variety of engineering applications. Fins play a vital role in enhancing their performance. Large numbers of different heat exchangers are used in vital industries like power plants, power transformers,and pulp and paper mills, especially in their steam boilers—the heart of the industrial plant.The efficiency of the gas-side heat transfer is a primary consideration when determining the best heat exchanger for a particular application. Surface enhancement using pin fins could be a promising method to overcome the described problem as well as to improve maintenance requirements. As yet, no detailed study on the performance of such finned tubes has been carried out; the present research investigates the heat transfer characteristics of different shaped pin fins from numerical point of view.This worked started with an evaluation of pin fins as extended surfaces for heat transfer enhancement. A numerical model based on governing physical equations was built. This model was verified using a theoretical energy balance equation. Then it was implemented in a power transformer cooling system and verified according to operational data from the manufacturer. Then, the verified model was applied to a more complicated two-phase flow modeling process to evaluate the pin fin effect in condensation efficiency.

Shiva kumar, et.al [4] "Numerical study of heat transfer in a finned double pipe heat exchanger" In the present study the performance of a concentric tube heat exchanger is analyzed with passive heat transfer technique. The performance of the heat transfer process in a given heat exchanger is determined for three different longitudinal fin profiles, rectangular, triangular and parabolic. Numerical analysis was carried out in a parallel flow double pipe heat exchanger for the above profiles for varied mass flow conditions both in the inner and outer tube. Base width and height of the fin were kept constant for all the three types. Simulated results indicated an enhancement in the heat transfer rate for a finned tube compared to the unfinned one. Among the different configurations, fin with rectangular profile showed marginal improvement over triangular and concave parabolic profiles in terms of heat transfer characteristics. For a constant value of mcc = 0.02kg/s and varying mch, rectangular finned tubes showed an average improvement of 6.1% over the triangular and 9.2% over parabolic finned tube. Similarly For a constant value of mch = 0.02kg/s and varying mcc, it showed an improvement by 2 and 5% over the triangular tube and parabolic finned tube respectively Fins with concave parabolic profiles exhibited minimum pressure drop and has reduced by 38% and 65% compared to the triangular and rectangular finned tube. Hence it can be concluded that parabolic finned configuration can be a better alternative compared to the triangular and rectangular because of reduced pressure drop and reduced weight of the finned assembly even though the thermal performance is being marginally reduce.

Wael M. El-Maghlany.et.al[5] "Experimental Study for Double Pipe Heat Exchanger with Rotating Inner Pipe" The present study aims to investigate experimentally fluid flow and performance characteristics of a double-pipe heat exchanger with rotating inner tube. Parameters that can be used to measure the performance of this type of heat exchanger are also presented, investigated and estimated. The experimental results are reported for the effect of cold and hot water mass flow rates, the heat exchanger arrangement (parallel or counter) and the rotation speed on NTU and effectiveness of the heat exchanger. This study was done for $0 \leq N \leq 1000$ R.P.M, $0.022 \leq m\ c \leq 0.09$ kg/s and $0.022 \leq m\ h \leq 0.09$ kg/s. The work focused on the entrance region of the annulus with simultaneous development of velocity and temperature profiles.

Lei et al. [6] studied the existence of hydrodynamic instabilities leads to the formation of Taylor vortices in flows in the annulus between two concentric cylinders with one or both cylinders rotating.

III. SYSTEM MODEL

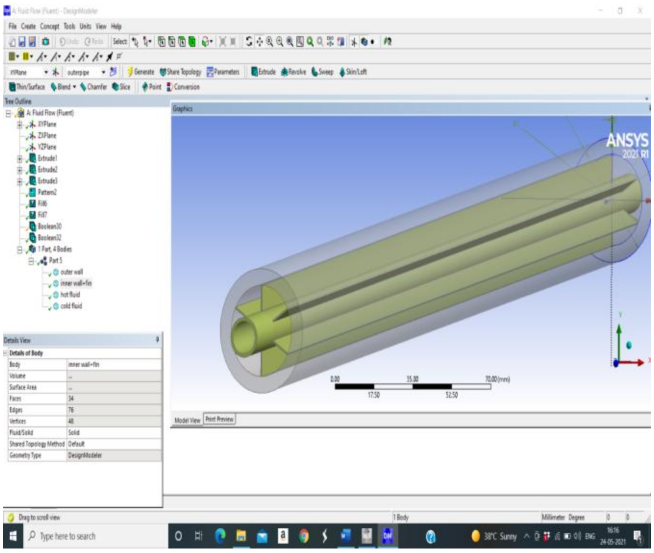

Figure 1: Concentric double tube heat exchanger with internal fins

IV. PROPOSED METHODOLOGY

1. Analyze the double tube heat exchanger by passive method.
2. With the help of four fins sample of blossom shape fins numerically analyzed.
3. The effects of geometric structure on different temperature analyze.
4. To develop the mathematical modelling.
5. See the effect of temperature on different mass flow rate.
6. The heat transfer rate on different mass flow rate is calculated.
7. The dimensionless number that is Reynolds number is regressed.
8. Friction factor on the changing of different mass flow rate were analyzed.

V. CONCLUSION

According to analysis of the double tube heat exchanger with fins and without fins it is found that it is always beneficial to use heat exchanger which is equipped with fins. Heat transfer in concentric double tube heat exchanger with fins is more than the without fins. The shape of fin is change the heat transfer rate is increased if effectiveness of the fins should be more than 1. The mass flow rate is changed then the heat transfer rate should be increased. By changing the mass flow rate friction is minimize

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