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Selection Of Tube Geometry To Enhance Heat Transfer Rate In Heat Exchanger

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***Abstract* - This review focuses on the various researches on CFD analysis and experimental studies in the field of heat exchanger.Different turbulence models available in general purpose commercial CFD tools likes k-ε model, K-ω model and K-ω SST models.Shell and Tube Heat exchanger are the basic types of heat exchanger one of the fluids flow through a bundle of tubes enclosed by a shell. The outer fluid is forced through a shell and it flows over the outside surface of the tubes. Such an arrangement is employed where reliability and heat transfer effectiveness. With relate to same to have a maximum heat transfer rate this paper gives various optimal design solutions using computational techniques. To measure the performance of different designs, its model is suitably designed so as to analyze the heat transfer rate. Thermal analysis has been carried out for different design with fluids and on the basis of comparative results is made which one give the best heat transfer rates.**

Keywords:

Heat Exchanger, CFD Analysis, Twisted tube, Helical Tube, Heat transfer coefficient, Effect of different tube designs

I .INTRODUCTION

In a Heat Exchanger, consists of bundle of tubes. One fluid flows through the tubes while the second fluid flows space between the tubes and shell. Tubes plays an important role while exchanging heat from hot fluid to cold fluid. Although they are not specially compact, their robustness and shape make them well suited for high pressure operations. They have larger heat transfer surface area to volume ratio than the most of common types of heat exchangers, and they are manufactured easily for a large variety of sizes and flow configurations. The main design objectives here are to accommodate thermal expansion, to furnish ease of cleaning, or to provide the least expensive construction. To get robust, least expensive and technically sound design, we will be dealing with four different designs viz. “Circular Tube”, “Twisted type” and “Helical Coil type” Along with construction issue we too come across the difficulties in improving heat transfer rates, which means to have high effectiveness, we were in flow to compromise the design and robustness. In order to achieve the maximum heat transfer rate an analysis is made on single tube for different designs with fluid Water in a shell and tube heat exchanger. This paper shows how maximum heat transfer rate has been achieved by comparing three different designs and getting optimal design solutions using computational techniques. To measure the performance of different designs, its model is suitably designed to analyse the heat transfer. Thermal analysis has been carried out for three different designs with two fluids and on the basis of comparative results is made which one give the best heat transfer rates.

II. LITERATURE SURVEY

Devised Analysis of 25 review papers is as follows

Amol Andhare et al [1] in their review paper, An experimental analysis was carried out to study heat transfer coefficients considering pitch ratio and curvature ratio of a helical coil heat exchanger. it is found that the shell side heat transfer coefficients are larger than the tube side heat transfer coefficient. Sunil B. Revagade et al [2] studied, due to change in material efficiency of heat exchanger changes and because of pressure loss of flow inside tube, U-tube type heat exchanger was not optimized in feasible region. Lastly it predicted that a U tube type heat exchanger would be heavier than a straight tube type heat exchanger by about 10.5% under the same constraints.

Siddhartha Behera et al[3] in their review paper, The study showed that there is not much difference in the heat transfer performances of the parallel-flow configuration and the counter-flow configuration. From the pressure and temperature contours it was found that along the outer side of the pipes the velocity and pressure values were higher in comparison to the inner values. Roshan. V. Marode et al [4] studied, shows the design and thermal analysis of different tubes. Experimentally, same designs are made and results are evaluated. With relate to same design tubes are thermally analysed in ANSYS software and compared both the results. After comparing the result for both water-water (Case-I) and water-Al2O3 (Case-II) for four different tubes we are in conclusion that twisted type of tube is giving high heat transfer coefficient.

Vishwas M. Palve et al[5], Studies have been carried out by varying pipe diameter with constant pitch circle diameter and pitch. Unlike the flow through a straight pipe, the centrifugal force caused due to the curvature of the pipe causes heavier fluid (water-phase) to flow along the outer side of the pipe. It was observed that the variation in tube diameter has greater influence on temperature drop and pressure drop. As the tube diameter goes on reducing the temperature drop increased along with loss of pressure also takes place i.e. pressure drop occur due to which pumping power increases. Temperature drop is maximum for lower flow rate and goes on reducing as the flow rate increases. Whereas pressure drop is directly proportional to flow rate. Shalini Patra et al[6], studied that Heat transfer analysis for water flowing through a smooth tube as well as a tube with a wire coil insert was done by calculation of friction factor and Nusselt number ,Results revealed that in laminar flow, wire coils mostly behave as a smooth tube with moderate increase in friction factor and Nusselt number values. P. Rodriguez[7] suggest the paper for providing frame work in making material selection.

Sidhant Nandi et al[8] suggested that the helical coil heat exchanger is found to have better efficiency as compare to straight tube heat exchanger and performed simulation on the heat exchanger. Bhardwaj Nitin et al[9], found that the hea transfer coefficient decreases with the increase in coil gap, with increase in tube diameter they performed simulation as well as experimental study in that heat exchanger. Dr. D. B. Zodpe[10], used experimental and analytical values and verified the CFD model he also found that at a low flow rate performance is better in plane tube but for higher rates twisted is better. Ashok Keche et al [11], found reynalds and prandalts no. by using CFD for different tubes also the temp at different points over the length were compared . He compared the analysis for different tubes in the heat exchanger.

Nitesh B. Dahare et al[12], suggested for the twisted tube we get higher turbulent flow compared to plane flow and the Reynolds no range for fully developed flow is from Re2500-126*10^6. Dilip S. Patel et al[13] , suggested that CFD provides cost effective alternative ,speedy solution and eliminate the need of prototype also parameters like diameter no of tubes pitch are important. R. Donald Morgan[14] ,suggested that twisted tube offers superior economic performance on cost per unit heat load also the vibration elimination, lower fouling and clinability. . K.Raja shekhar ,et al [15] suggested that rate of heat transfer can be improved by varing the tube diameter length and No. of tubes by changing the pitch,the rate of heat transfer can be improved. By changing the material and the temperature of the tube the rate of heat transfer can be improved.Vishwas palve et al. concluded that varing diameter has a great influence on temperature and pressure drop.

Durgesh Bhatt et al [16] suggested that higher the conductivity of tube metallurgy,higher the heat transfer rate achived.A.Gopichand, et al [17] studied all parameters and overall analysis of shell and tube heat exchanger.Usman ur rehman [18] found out optimisationof performance velocity and Reynolds No. in heat exchanger. Ranjeet govda et al[19] suggested that the passive active and compound techniques were studied in heat exchangers used in twisted angles . Sandip K. Patel et al [20], concluded that there is increase in pressue drop with increase in fluid flow rate . The tube pitch ratio, length, baffle spacing ratio were found to be important parametersalso the algorithm provides significant improvement in design .

Gajanan Nagare et al,[21] concluded that CFD can be used as design tool in preliminary stage of design of heat exchanger .Analytical values of results obtained can be compared with theoretical design. Hetal Kotwal et al[22], foumd out that the overall effectiveness of heat exchangers increases with the decreasing composition of water also the results of MATLAB compared with the experimental values are close. Vivek P. Thawkar et al[23], concluded that the parameters such as friction factor, temperature, overall HT coefficient and Reynolds no. were studied in twisted tube heat exchanger. Anil Kumar et al[24], suggested based on the experimental data the co relations for heat transfer coefficient and pressure drop were developed for the continuous helical baffle heat exchangers. T. Venkatash,et al[25], suggested that provision of baffle in heat exchanger causes pressure drop of heat transfer in the fluid.also the Increase in Nusselt number increase heat transfer rate.

III. RESULT AND CONCLUSION

It is found that in helical coil exchangers shell side heat transfer coefficient is more than tube side . In heat exchangers U-tube type heat exchanger is tested but it was not optimized in a feasible region. In study of double piped helical coil insert it is found that there is no large change in heat transfer by using counter flow and parallel flow but heat transfer rate changes with change in diameter greatly.

It is seen that the design of the tubes inside the shell greatly affects the heat transfer rate of the shell and tube heat exchanger, different types of tubes (i.e. straight, helical, twisted) gives different readings experimentally. For helical coil Heat Exchanger temperature drop is maximum for lower flow rate and goes on reducing as the flow rate increases. Whereas pressure drop is directly proportional to flow rate.

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