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Design and analysis of shell and tube heat exchanger

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ABSTRACT

Heat Exchanger is a very important device in every modern industry; in the time when resources are limited and there is tough competition in the market heat exchanger marks special importance For evaluation of shell and tube heat exchanger, thermal performance and pressure drop are considered as major factors. Both, thermal performance and pressure drop are dependent on the path of fluid flow and types of baffles in different orientations respectively. In this project the thermal performance analysis of a pipe in pipe heat exchanger is performed by varying the composition of nanofluids used, which is a mixture of SiO2 and Glycol & Increasing the complexity of baffles enhances heat transfer which also results in higher pressure drop which means higher pumping power is required. This reduces the system efficiency. This paper presents the numerical simulations carried out on different baffles i.e. single segmental and double segmental .This shows the effect of baffles on pressure drop in shell and tube heat exchanger. Single segmental baffles show the formation of dead zones where heat transfer cannot take place effectively. Double segmental baffles reduce the vibrational damage as compared to single segmental baffles. The lower pressure drop results in lower pumping power, which in turn increases the overall system efficiency. .Experimental results such as heat transfer rates, overall heat transfer coefficient, and heat exchanger effectiveness have been calculated to assessing the performance of heat exchanger.

Keywords: shell and tube, heat exchanger

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I. INTRODUCTION

Heat exchangers are used for transferring thermal energy between two or more fluids, at different temperature and in thermal contact. The essential principle of a heat exchanger is that it transfers the heat without transferring the fluid that carries the heat. In heat exchangers, there are no external thermal energy and work interactions. The heat transfer occurs mainly due to conduction and convection. The heat exchangers are classified according to transfer processes, number of fluids, and degree of surface compactness, construction features, flow arrangements, and heat transfer mechanisms. Heat exchangers are extensively used in many engineering applications such as chemical engineering processes, power generation, petroleum refining, refrigeration, air conditioning, food industry and so on. Among different types of heat exchangers, shell and tube heat exchangers are relatively easy to manufacture and have multipurpose application possibilities for gaseous as well as liquid media in large temperature and pressure ranges . In shell and tube heat exchanger, two fluids of different temperature flow through the heat exchanger. One flows through the tubes (the tube side) and other flows outside the tubes but inside the shell (the shell side). Heat is transferred from one fluid to the other through the tube walls, either from tube side to shell side or vice versa. The fluids can eitherbe liquids or gases on either the shell or the tube side. In order to transfer heat efficiently, a large heat transfer area is used, leading to the use of many tubes.

This is an efficient way to use energy and avoid wastage of thermal energy. B.I. Master et al. in 2006 found that more than 30% heat exchangers are used of shell and tube type . Shell and tube heat exchangers can be custom designed by considering its operability, maintainability, flexibility and safety. This makes it very robust and serves major reason to be used widely in industries . For efficient heat transfer process, heat exchanger should have low pressure drop, high shell side mass flow velocity, high heat transfer coefficient, and no or very low fouling and so on. Heat transfer also depends on the amount of turbulence created in shell side. This turbulence can be created by using baffles. Various types of baffles are enlisted in literature. Some of the commonly used are segmental, double segmental, triple segmental.

II. LITERATURE SURVEY

[1] KARTHIK SILAIPILLAYARPUTHUR & HASSAN KHURSHID: The paper considered a review for the design of a shell and tube heat exchanger. Therein, popular analytical techniques such as log mean temperature difference (LMTD) and effectiveness-number of transfer units (ε-NTU) were considered in the analysis. In the design, analysis, performance charts and tables describing the performance of the shell and tube heat exchanger in terms of crucial dimensionless parameters were developed. These fundament alimension less parameters account for the thermal & the physical properties of the fluids and the heat exchanger (HX) material. Using the information from the performance charts and tables, a basic design for the shell and tube heat exchanger can be readily formulated. The basic design involves choosing an appropriate number of transfer units (NTU) and capacity rate ratio for a given application. The NTU and capacity rate ratio can then be extrapolated to develop a detailed design for the shell and tube heat exchanger. Since NTU and capacity rate ratio accounts for all the significant physical and thermal properties of the heat exchanger, performance tables and charts would certainly help in maximizing the performance and minimizing the cost of the shell and tube heat exchanger. In the case considered here in, both LMTD and ε-NTU techniques yield the same exact results.

[2] M. Mani Bharathi, Shams Hari Prasad Mohan,Santhosh Sivan.M, Karthikeyan.S: A Heat Exchanger is a equipment used for transferring heat from one medium to another. There is a wide application of coiled heat exchanger in the field of cryogenics and other industrial applications for its enhanced heat transfer characteristics and compact structure. Lots of researches are going on to improve the heat transfer rate of the heat exchanger. Here, we have fabricated the shell and tube heat exchanger with selecting the materials on the primary objective of enhancing the heat transfer effectiveness. We casted the tube in the spiral shape with the helical angle of 30˚.Then we intended to perform calculation on the heat transfer Effectiveness. We are intended to show the merits of spiral coiled heat exchanger to that of the conventional parallel type heat exchangers.

[3] Prof Basudeb Munshi, Anil Kumar, Samal Roll: In present day shell and tube heat exchanger is the most common type heat exchanger widely used in oil refinery and other large chemical process, because it suits high pressure application. The process in solving simulation consists of modeling and meshing the basic geometry of shell and tube heat exchanger using CFD package ANSYS 13.0. The objective of the project is design of shell and tube heat exchanger with helical baffle and study the flow and temperature field inside the shell using ANSYS software tools. The heat exchanger contains 7 tubes and 600 mm length shell diameter 90 mm. The helix angle of helical baffle will be varied from 00 to 200. In simulation will show how the pressure varies in shell due to different helix angle and flow rate. The flow pattern in the shell side of the heat exchanger with continuous helical baffles was forced to be rotational and helical due to the geometry of the continuous helical baffles, which results in a significant increase in heat transfer coefficient per unit pressure drop in the heat exchanger.

[4] Arjun K S, Prof.Mr.Gopu K.B.: The present work has been carried out with a view to predicting the performance of a shell and tube heat exchanger. The process in solving simulation consists of modeling and meshing the basic geometry of shell and tube heat exchanger using Computational Fluid Dynamics package ANSYS 13.0. The performance of the heat exchanger has been evaluated by using the CFD package FLUENT and has been compared with the existing experimental values. An attempt has also been made to calculate the performance of the above heat exchanger by considering helix baffles instead of regular Segmental Baffles and the result so obtained have been compared. The performance parameters pertaining to heat exchanger such as effectiveness, overall heat transfer coefficient, energy extraction rate etc., have been reported in this work. The objective of the project is design of shell and tube heat exchanger with helical baffle and study the flow and temperature field inside the shell. The heat exchanger contains 7 tubes of outer diameter 20 mm and a 600 mm long shell of inner diameter 90 mm. The helix angle was varied from 00 to 200. The simulation shows how the pressure vary in shell due to different helix angle and flow rate. The flow pattern in the shell side of the heat exchanger with continuous helical baffles was forced to be rotational and helical due to the geometry of the continuous helical baffles, which results in a significant increase in heat transfer coefficient per unit pressure drop in the heat exchanger.

III. PROBLEM STATEMENT

In a recent research design and development in heat exchanger are done by various methods by using various nano fluid like Al2o3and TiO2and property of nanofluid checked, also heat transfer rate of nano fluid and heat exchanger are calculated also they check the COP of fluid for various nanofluid but for checking the another nanoparticles properties of Cuo/Sio2 fluid is used in pipe in pipe heat exchanger. Also we changes the concentration of nanofluid and we check the property and heat transfer rate and COP of material.

IV. BLOCK DIAGRAM

A cylindrical shell with multiple tubes running inside the shell. One fluid passes through the tubes and then exits the heat exchanger; the other fluid circulates on the outside of the tubes within the cylindrical shell. Heat is transferred from one fluid to the other through the walls of the tubes. The flow path of the fluid within the cylindrical shell is directed through the vessel by means of double segment baffles, which has the effect of increasing the flow path and thus contact time of the fluid heat transfer interchange.

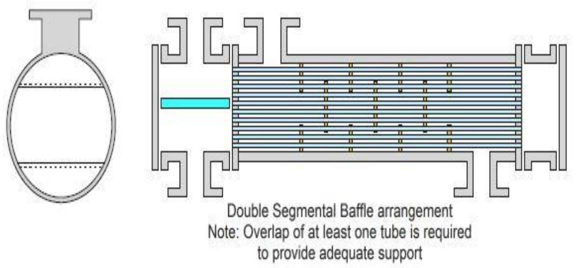

Fig 1. Block diagram

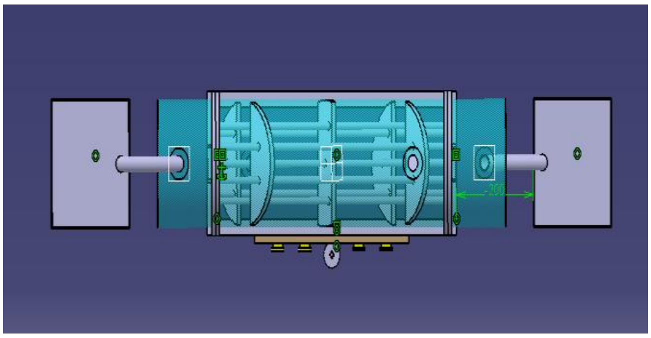

Fig 2. Design View

V. CONCLUSION

- Heat transfer rate is directly proportional to Reynolds number.
- Pressure drop increases with increase in volume concentration.
- Spherical shaped nano-material give better heat transfer rate than other shapes.
- Increase in size of nanoparticles leads to decrease in heat transfer rate due to low area per unit volume.

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