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Review on the enhancement and performance of continues helical baffles tie double pipe heat exchanger

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Abstract: **This paper provides a review of the major work done on helical baffles to improve the performance of shell and tube heat exchangers. Some of the major factors affecting the performance of shell and tube heat exchanger are discussed. The CFD modeling and experimental are showed from different studies that an increase in turbulence intensity could be one of the reasons for higher performance augmentation methods with the plain tubes heat exchanger. Heat transfer performance and flow resistance of the shell side of the double-pipe heat exchanger with helical baffle can be done investigated by using CFD numerical simulation software.**

Keywords: **heat exchanger, shell, temperature, helical tube**

I. Introduction

A heat exchanger is a device that is used to transfer thermal energy between two or more fluids, between a solid surface and a fluid, or between solid particulates and a fluid, at different temperatures and in thermal contact. In heat exchangers, there are usually no external heat and work interactions.

Typical applications involve heating or cooling of a fluid stream and evaporation or condensation of single or Multi component fluid streams. In other applications, the objective may be to recover or reject heat, or sterilize, pasteurize, fractionate, distill, concentrate, crystallize, or control a process fluid. In a few heat exchangers, the fluids exchanging heat are in direct contact.

In most heat exchangers, heat transfer between fluids takes place through a separating wall or into and out of a wall in a transient manner. In many heat exchangers, the fluids are separated by a heat transfer surface, and ideally they do not mix or leak. Such exchangers are referred to as direct transfer type, or simply recuperates. In contrast, exchangers in which there is intermittent heat exchange between the hot and cold fluids via thermal energy storage and release through the exchanger surface or matrix are referred to as indirect transfer type, or simply regenerators. Such exchangers usually have fluid leakage from one fluid stream to the other due to pressure differences and matrix rotation/valve switching.

Common examples of heat exchangers are shell and tube exchangers, automobile radiators, condensers, evaporators, air pre heaters, and cooling towers. If no phase change occurs in any of the fluids in the exchanger, it is sometimes referred to as a sensible heat exchanger. There could be internal thermal energy sources in the exchangers, such as in electric heaters and nuclear fuel elements. Combustion and chemical reaction may take place within the exchanger, such as in boilers, fired heaters, and fluidized-bed exchangers.

Mechanical devices may be used in some exchangers such as in scraped surface exchangers, agitated vessels, and stirred tank reactors. Heat transfer in the separating wall of recuperate generally takes place by conduction. However, in a heat pipe heat exchanger, the heat pipe not only acts as a separating wall, but also facilitates the transfer of heat by condensation, evaporation, and conduction of the working fluid inside the heat pipe. In general, if the fluids are immiscible, the separating wall may be eliminated, and the interface between the fluids replaces a heat transfer surface, as in a direct-contact heat exchanger

II. Literature Review

Yadav, S., & Sahu, S. K. [1] Present investigation reports the effect of helical surface disc tabulators (HSDTs) on

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heat transfer and pressure drop characteristics in double pipe heat exchanger (DPHE). HSDTs has been utilized in the annulus region. Tests are conducted by insertion of HSDTs with various operating parameters including three different diameter ratios (DR=do/Di=0.42, 0.475 and 0.54), three different helix angles (ϕ=20°, 30° and 40°) and varied range of Reynolds Number (3500–10500). Water, used as hot fluid, flows in the inner tube, while air, used as cold fluid, flows through the annulus.

Xiaowei Zhao [2] in this paper presented are the globally, the integration of renewable energy (which has an intermittent nature) into the power system requires the system operators to improve the system performance to be able to effectively handle the variations of the power production in order to balance the supply and demand. This problem is seen as a major obstacle to the expansion of renewable energy if it is not handled in a suitable way.

M. Bhavadarani [3] the main objective of this work, focused on development of multi user remote system which encompasses IOT technology with Raspberry-Pi. In specific, IOT based controlling and monitoring is applied to double pipe heat exchanger, a thermal device. Heat exchanger is a device in which transfer of heat takes place from one high temperature fluid to another low temperature fluid.

Xue Chen at el. [4] 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.

III. Baffle

Baffle is a device used to put down the flow of a fluid, gas etc. Baffles serve two important functions. They support the tubes during assembly and operation and help prevent vibration from flow induced eddies and direct the shell side fluid back and forth across the tube bundle to provide effective velocity and Heat Transfer rates. The diameter of the baffle must be slightly less than the shell inside diameter to allow assembly, but must be close enough to avoid the significant performance penalty caused by fluid bypass around the baffles. Shell roundness is important to achieve effective sealing against excessive bypass. Baffles can be made from a variety of materials compatible with the shell side fluid. They can be punched or machined. Some baffles are made by a punch which provides a lip around the tube hole to provide more surfaces against the tube and eliminate tube wall cutting from the baffle edge. Baffles may be classified as transverse and longitudinal types. The purpose of longitudinal baffles is to control the overall flow direction of the shell fluid such that a desired overall flow arrangement of the two fluid streams is achieved. For example, two-pass shell with longitudinal baffle, split flow, double split flow [5]. Transverse baffles may be classified as plate baffles and grid. Plate baffles may be single segmental, double-segmental, and triple-segmental, nontubes-in-window segmental baffle and disk-and-doughnut baffle.

IV. Helical Baffle Exchanger

The Helical Baffle Heat Exchanger is also known as a Helix changer solution that removes many of the deficiencies of Segmental Baffle Heat Exchanger. It is very effective where heat exchanger is predicted to be faced with vibration condition Quadrant shaped baffle segment are arranged right angle to the tube axis in a sequential pattern that guide the shell side flow in a helical path over the tube bundle. The Helical flow provides the necessary characteristics to reduce flow dispersion and generate near plug flow conditions. The shell side flow configuration offers a very high conversion of pressure drop to heat transfer. Advantages over segmental STHE are increased heat transfer rate, reduced bypass effects, reduced Shell Fouling Factor, Prevention of flow induced vibration & Reduces Pumping cost. Shell and tube type heat exchanger with helical baffle diagram is shown in Fig. 1.

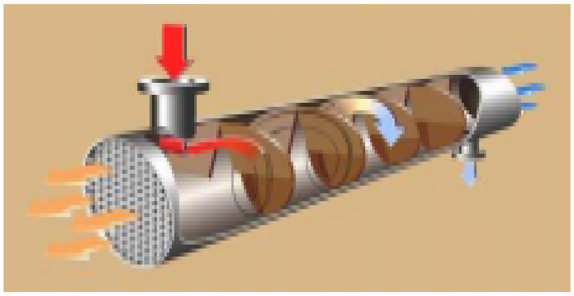

Fig. 1. Shell and tube type heat exchanger with helical baffle

V. Computational Fluid Dynamics

CFD is useful for studying fluid flow and heat transfer chemical reactions, etc. solving mathematical equations using numerical analysis. CFD solves the entire system in small cells and applies relevant equations to these discrete elements to find numerical solutions relating to pressure distribution and temperature gradients. This software can also create a virtual prototype of the system or device before it can be applied to the actual physics of the model and the software provides images and data that predict the performance of this project [6]. More recently, methods have been applied for the construction of internal combustion engines, combustion chambers of gas turbines and furnaces, as well as for fluid flows and heat transfer in heat exchangers.

VI. Algorithm Used For Computational Fluid Dynamics Analysis

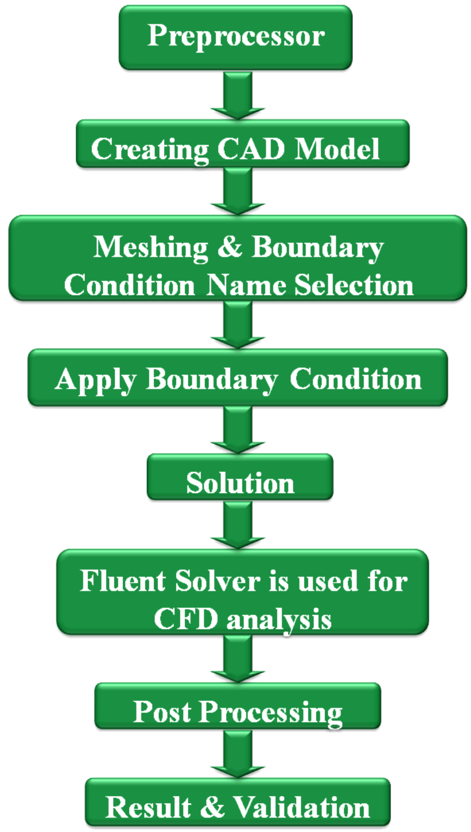

Fig. 2 Algorithm used for Computational fluid dynamics analysis

VII. Conclusion

Conventional methods of designing and developing helical baffles double pipe heat exchangers are expensive. CFD offers an alternative to the quick and inexpensive solution for the design and optimization of heat exchangers. CFD outcomes are an essential part of the design process and make prototypes superfluous. Due to the development of CFD models, the use of CFDs is no longer a particular activity. It is accessible to process engineers, plant operators, and managers. Additional research can optimize the performance of the helical baffles tie double pipe tube heat exchanger by varying the diameter of the tube and the jacket, a number of tubes, inclination angle, and impact angles. CFD is still an evolving art in predicting erosion/corrosion due to the lack of appropriate mathematical models to represent a physical process. In this study presented are CFD can be used to helical baffles exchanger design. New flow

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modeling strategies can be developed for flow simulation in baffles double heat exchangers.

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