A REVIEW ON SHELL & TUBE HEAT EXCHANGER BY CHANGING GEOMETRICAL SHAPE OF BAFFLES

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ABSTRACT

A Shell and tube heat exchangers are widely used today in the industries like petrochemicals, pharmaceutical, oil and refineries, according to one survey 40% of heat exchangers of the world are shell and tube heat exchangers due to its high pressure application it is more suitable in the field of oil & petrochemical application, the main components of Shell and tube heat exchangers are Shell, Tubes, Tubesheet, Baffles etc; with passing of time there are changes done in the design of shell and tube heat exchangers the purpose of this research is about to Study the geometry of baffles and change the geometry of baffle and improving the heat transfer co-efficient by reducing the shell side pressure drop, modified baffle geometry is able to create more turbulence in the shell side flow and improve the performance of shell and tube heat exchanger with suitable baffle spacing and angular arrangement of baffle angle, helical baffle geometry is introduced which gives less pressure drop then segmental baffle geometry as the obstruction of flow is less in helical baffle. by reducing pressure drop shell side pumping power can be reduced so the overall efficiency of the heat exchanger can be increased, different baffle geometry are studied in this review which gives less pressure drop and higher heat transfer co-efficient.

Keyword: *Baffle, Heat exchanger, Shell, Tubes, Tubesheet, Tubebundle*

1. INTRODUCTION

A shell and tube heat exchanger is a class of heat exchanger designs. It is the most common type of heat exchanger used in oil refineries and other large chemical processes, It suited for higher-pressure applications. As its name implies, this type of heat exchanger consists of a shell (a large pressure vessel) with a bundle of tubes inside it. One fluid runs through the tubes, and another fluid flows over the tubes (through the shell) to transfer heat between the two fluids. The set of tubes is called a tube bundle, apart from Tube and shell baffles are important part in design of Shell and tube heat exchanger, TEMA has defined various shapes for the design of Front and rear head as well as shell of heat exchanger. [11]

Baffles being an integral part of STHE provide support to the tube bundles especially when the length of the heat exchanger is too long, It maintain desirable velocity & path for the shell side fluid flow, Baffle create turbulence and resist tube vibration to enhance the fluid velocity as well as the heat transfer coefficient, Baffle is important part for calculating the Shell side Pressure drop in the heat exchanger, changing in the baffle geometry affect the shell side pressure drop, helical baffles are having less pressure drop with compare to segmental baffle but fabrication of helical baffle is quite difficult especially when the diameter of the shell is too large so the researchers are trying to develop some new kind of baffle geometry which resulting less pressure drop and give more heat transfer co-efficient, Baffle space is one of the prominent factor in the design of shell and tube heat exchanger, it affect the performance of shell and tube heat exchanger, trisection, quadrant, helical are the different types of baffles, the single and double segmental baffles are most frequently used as they divert the flow most effectively across the tubes.

Pressure drop is an important parameter in heat exchanger design. The heat exchanger should be design in such a way that unproductive pressure drop should be avoided to maximum extent in area like inlet and outlet bends, nozzles and manifolds by reducing the shell side pressure drop the pumping power can be saved, more turbulence can be maintain at shell side resulting in less fouling and higher heat transfer coefficient.

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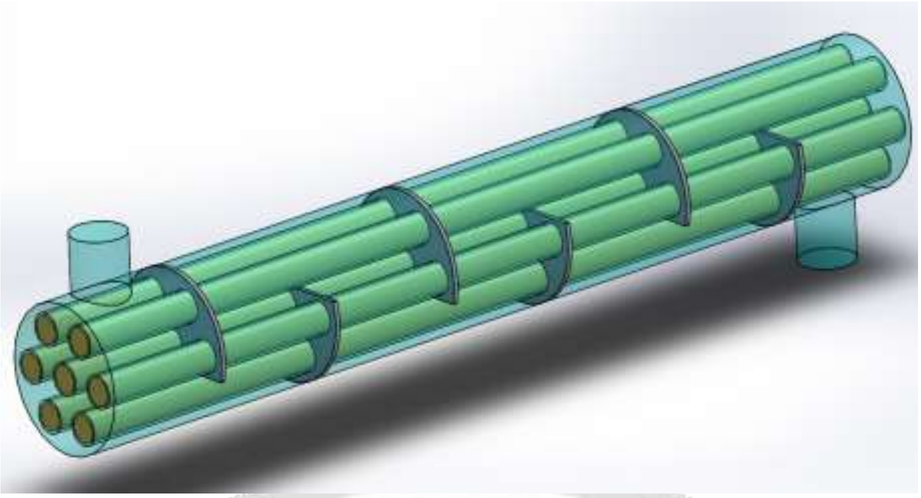

Fig -1: Segmental Baffle Heat Exchanger

Baffle geometry playing an important role for finding pressure drop in shell and tube heat exchanger. In this study comparison of Segmental baffle heat exchanger with other baffle geometry is to be carried out, Number of baffles and all the geometrical dimensions of both heat exchangers are same as shown Below, The purpose of study is to reduce the shell side pressure drop by changing baffle geometry.

2. LITRETURE REVIEW

Jian Wen et al. [1] had studied Experimental investigation on performance comparison for shell and tube heat exchanger with different baffles and they have proposed ladder type folded baffle geometry and compare it with segmental baffle heat exchanger; the experimental system consists of water loop system, oil loop system, and data acquisition system. In the oil system oil is transported from oil tank by oil pump and passes through the electric heaters where it is heated by a transformers with power of 150 kW, oil flows at shell side is cooled by tube side cold water, in the water system water is circulated by water pump from water tank.

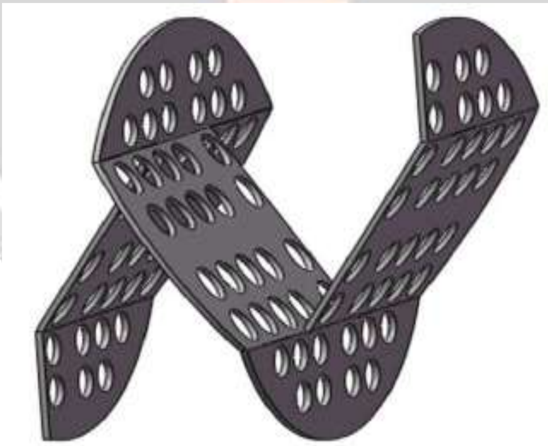

Fig -3 Ladder Type folded baffle [1]

The result shows that the heat transfer coefficient of Ladder type baffle was higher than that of the segmental baffle heat exchanger and the helix angle of 40° is the best.

Luhong Zhang et al. [2] had done Pilot experimental study on shell and tube heat exchangers with small-angles helical baffles they have done comparison between three helical baffle heat exchangers with various helix angle of 7°, 13° and 25°and 1 segmental baffle heat exchanger**.**

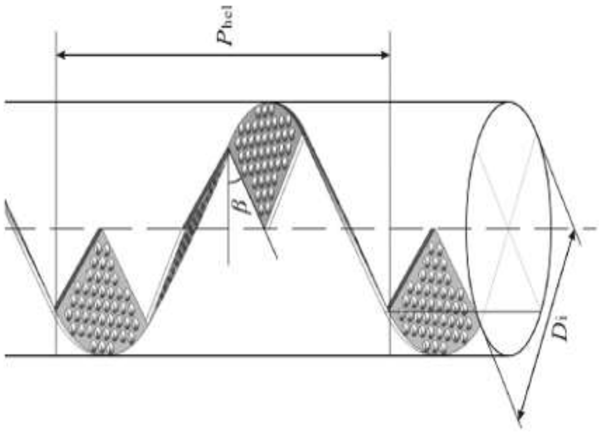

Fig -4 Quadrant Type baffle [2]

In Experiment setup water was employed as the test fluid and the setup consisted of a cooling water loop and a heating water loop, the experiment consisted of several test groups as the change of operation condition. For each test group, the volumetric flow rate and the inlet temperature in the shell and tube side were set fixed, the outlet temperature and the pressure drop of the shell side and tube side were recorded. The volumetric flow rates in the shell side and tube side varied from 50 m^3/h to 150 m^3/h; and 50 m^3/h to 90 m^3/h respectively, and the inlet temperatures of shell side and tube side were controlled at 70 °C and 40 °C. Only after the system had maintained steady for 10 min, the temperature data and pressure data were recorded. The temperatures were measured at the inlet/outlet of the test heat exchangers by the temperature sensors with the precision of 0.2 °C, the shell side pressure drops were measured by pressure transmitters with the accuracy of 0.1% at a range 0–1.0MPa, and the volumetric flow rates for both side were measured by vortex flow meters with the precision of 0.75% of 0–250 m^3/h;

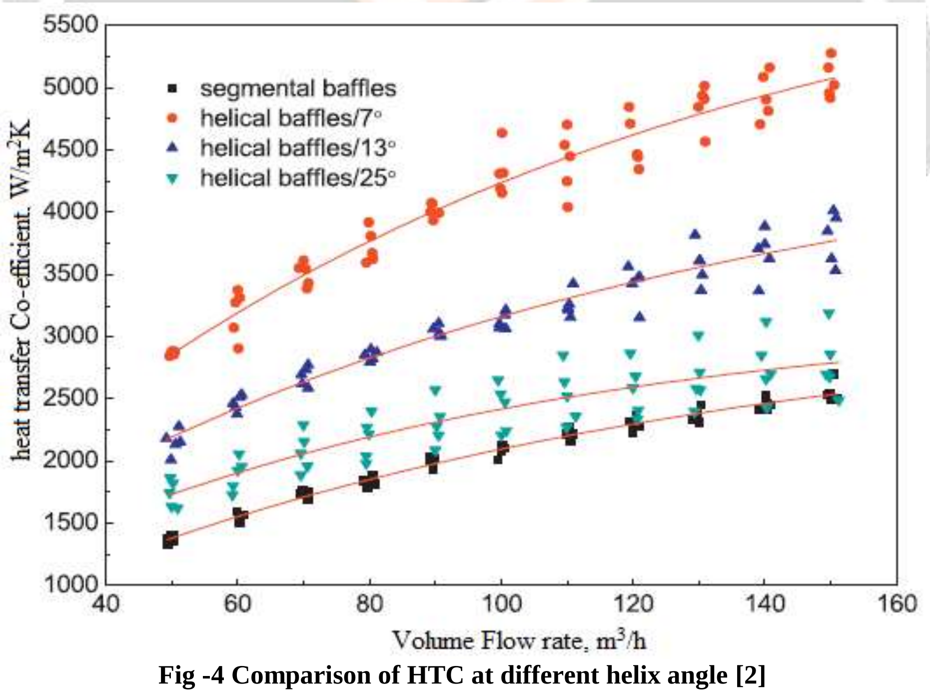

Fig -4 Comparison of HTC at different helix angle [2]

Result shows that when helical angle ranges from 7° to 25°, the shell side heat transfer coefficient for the helical baffles heat exchanger falls with the increase of helical angle under the same volume flow rate.

Cong dong et al. [3] studied An efficient and low resistant circumferential overlap trisection helical baffle heat exchanger with folded baffles, The impacts of the folded baffles on shell-side helical flow, secondary vortex flow, Pressure drop and Heat transfer Co-efficient were analyzed.

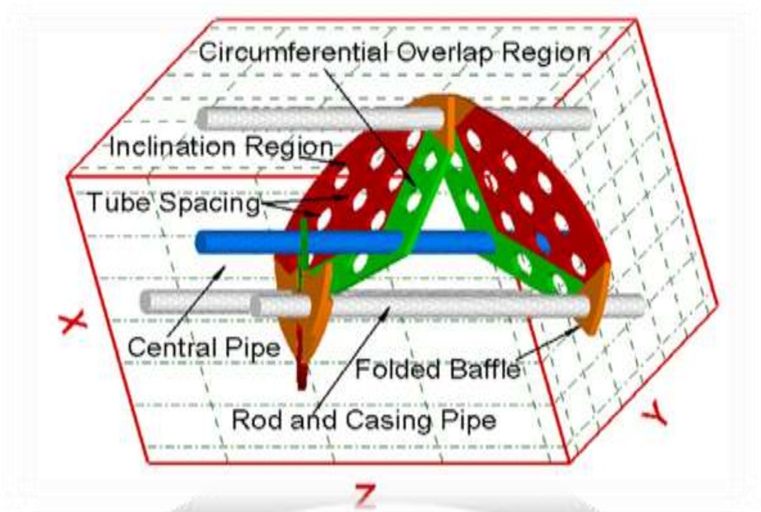

Fig -5 circumferential overlapped trisection helical baffle [3]

The water (tube side)-water (shell side) experimental tests of the SBHE have been made in research, The COTH combines the structural modifications of folded baffles for facilitate baffle supporting frame with rods and sleeves and widened straight edges accommodate one row tubes for damper leakage flow at triangular regions (V-notches) of adjacent baffles. The schematic of ‘‘tube spacing”, The water is selected as working fluid for both shell side and tube side of the COTH and SBHE, which corresponds to the working fluid of experimental tests for the SBHE,

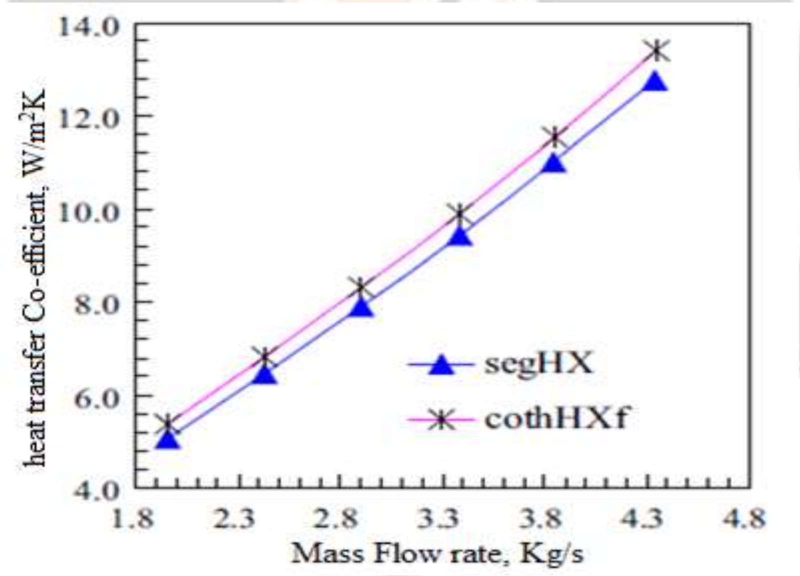

Fig -6 Comparison of HTC between COTH & Segmental baffle [3]

The results show that under the same flow rate, the heat transfer performance and comprehensive performance of the COTH Baffle are obviously higher than those of the Segmental baffles.

Cong dong et al. [4] have studied Flow and heat transfer performances of helical baffle heat exchangers with different baffle configurations, the flow and heat transfer performances of four helical baffle heat exchangers were simulated with spiral pitch and different configuration, TCO-20º, QCO-18º, QEE-18º, CH-18.4º.

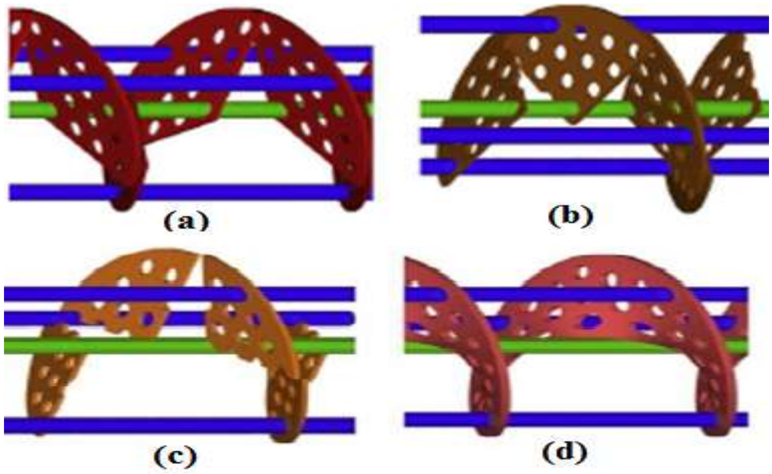

Fig -7 (a) TCO at 20° (b) QCO at 18° (c) QEE at 18° (d) CH Baffle at 18.4° [4]

Result show that TCO-20º possesses highest shell side heat transfer factor, The CH-18.4º performs difficulty in manufacturing.

H Li et al. [5] had done Analysis of local shell side heat and mass transfer in the shell-and-tube heat exchanger with disc-and doughnut baffles, in study the fluid flow adjacent to the tube is analyzed and the heat transfer in the zones of separated flow discussed, the experimental setup consists of a shell and two removable tubesheets which support a bundle of tubes and six tie rods

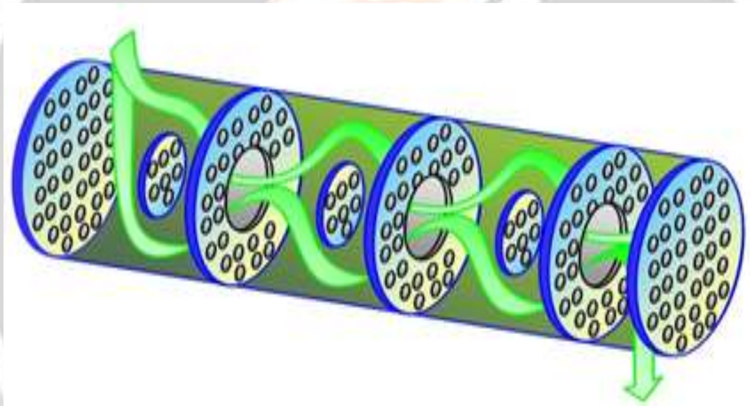

Fig -8 Disc and Doughnut Type Baffle [5]

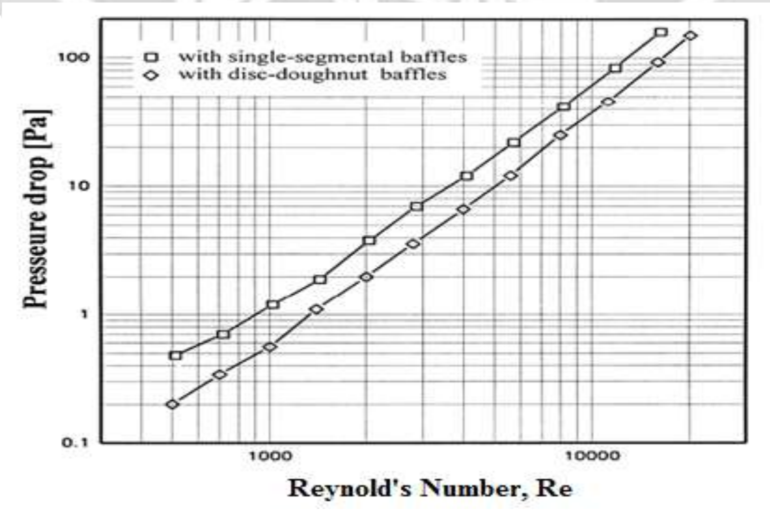

Fig -9 Comparison of Pressure Drop between SBHE & Disc and Doughnut Type Baffle [5]

Results shows that Compared to the single segmental baffle the disc and doughnut baffles have a higher pressure drop, and lower Heat transfer Coefficient than segmental baffle.

3. CONCLUISONS

The heat transfer coefficient as well as pressure drop both are increases with increasing of mass flow rate but at the cost of pressure drop increasing the heat transfer co-efficient is not feasible as the pumping power is also increasing with increasing of pressure drop, but changes in baffle geometry affect the shell side pressure drop so we have to choose that type of geometry which allow low pressure drop, The helical baffle heat exchanger having high heat transfer co-efficient than segmental baffle due to more turbulence in shell side flow, due to high turbulence the fouling is less compare to segmental baffle and due to less fouling the heat transfer co-efficient is higher, The advantage of reducing the pressure drop are like pumping power is reduced for pumping the shell side flow, so the overall efficiency of the heat exchanger can be increased, other reason is due to more turbulence in the shell side flow the fluid is passing towards all the surface of tube in short by passing is reduced and it resulting in increasing the heat transfer co-efficient, other reason is due to more turbulence the fouling is less and due to less fouling the heat transfer will increase and the maintenance cost can be saved

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