Analysis of Shell And Tube Heat Exchanger

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Abstract- *The shell and tube heat exchanger setup is modelled and imported to numerical analysis with the equivalent boundary conditions. The numerical simulations are carried out to identify the effects such as heat transfer coefficient and pressure drop by using commercial CFD package. The shell side heat transfer coefficient, pressure drop, overall heat transfer coefficient and performance factors are obtained from three different tube layouts and three baffle cuts among varying number of baffles along with different mass flow rates. The CFD results of heat transfer coefficient, pressure drop and overall heat transfer coefficient are observed. The models are simulated to know the influences of tube layout and other design parameters in thermo hydraulic parameters. These, thermo hydraulic parameters are very helpful in evaluating the performance of shell and tube heat exchangers.*

I. INTRODUCTION

A heat exchanger is a piece of equipment that is utilized to transfer thermal energy (enthalpy) between at least two fluids, between a strong surface and a fluid, or between strong particulates and a fluid, at various temperatures. In heat exchangers, there are generally no outside heat and work co-operation. Ordinary applications include heating or cooling of a fluid stream and vanishing or building-up of single or multi-part fluid streams. In different applications, the target may be to recuperate or dismiss heat, or sterilize, pasteurize, fractionate, distill, concentrate, crystallize or control a course of action in a working fluid. In a couple of heat exchangers, the fluids exchanging heat are in contact. In most heat exchangers, the heat transfer between fluids takes place through an isolating wall or into and out of a wall in a transient manner. In many heat exchangers,the fluids are isolated by a heat transfer surface and they preferably do not blend. Such exchangers are referred to as direct transfer types, or recuperators. Conversely, exchangers in which there is discontinuous heat exchange between hot and cold fluids by means of thermal energy stockpiling and discharge through exchanger surface or matrix are referred to as indirect transfer types, or essentially regenerators. In general, such exchangers have leakage offluid from one fluid stream to the next, due to difference in pressure and matrix rotation as well as in exchanging of valve.

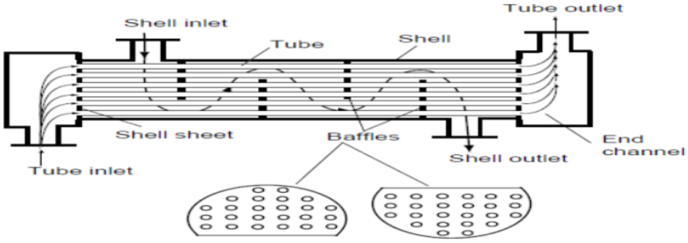
II. CONCEPT OF THE PROJECT

The design of a heat exchanger includes heat transfer rates between the liquids and the mechanical pumping power exhausted to defeat liquid friction and transfer the liquids through heat exchangers. For a heat exchanger working with high density fluid, the friction power consumption is by and large with respect to heat exchange rate. In any case, for low density fluid, for example, gases, it is anything but difficult to consume more mechanical energy in overcoming friction power as it is exchanged as heat.

It can promptly be demonstrated that for most flow passages, the heat transfer rate per unit of surface area can be expanded by increasing fluid flow velocity. This rate shifts as something not much as the first power of the speed. The friction power uses increments. Likewise with increasing flow velocities, the power changes as much as the third power of velocity and is never the square.

The friction power consumption in a specific application has a tendency to be higher. The designer may lessen the velocities by increasing the quantity of flow passages in the heat exchanger. This will likewise, diminish the heat transfer rate per unit of surface area. However as indicated by the above relations, the lessening of heat transfer rate will be impressively not much as the friction power decreases. The lost heat transfer rate is then remunerated by increasing the surface area like protracting the tubes, which thus additionally build the friction power usage. Yet just in an indistinguishable extent from the heat transfer surface area it is expanded.

III. WORKING OF SHELL AND TUBE HEAT EXCHANGER



The typical configuration of shell and tube heat exchangers, with labels for easy reading. As previously explained, the fundamental point of shell and tube heat exchangers is to pass a hot fluid through a cold fluid without mixing them, so that only their heat is transferred. The above diagram shows two inlets and two outlets, where each fluid starts at their respective inlet and exits the device at their outlets. The tube-side flow passes through the tube bundle (secured by metal plates known as tubesheets or tubeplates) and exits the tube outlet. Similarly, the shell-side flow starts at the shell inlet, passes over theses tubes, and exits at the shell outlet. The headers on either side of the tube bundle create reservoirs for the tube-side flow and can be split into sections according to specific heat exchanger types.

Each tube contains an insert known as a turbulator which causes turbulent flow through the tubes and prevents sediment depositing, or “fouling”, as well as increases the exchanger’s heat transfer capacity. Designers also cause turbulence in the shell with barriers known as baffles, which maximize the amount of thermal mixing that occurs between the shell-side fluid and the coolant pipes. The shell-side fluid must work its way around these baffles, which causes the flow to repeatedly pass over the tube bundle, thus transferring energy and exiting the heat exchanger at a lower temperature. Certain shell and tube exchangers use differing baffle shapes to maximize heat transfer, and some use none at all.

IV. FORMULAS

General condition of heat exchanger is
Q□UA0FT□TLM
where, ΔT is the Temperature difference between hot and cool fluidscan be used for hot fluid,
Q □□m Cp □Th
where, ΔT is the Temperature difference between hot fluid
Regarding energy flow for heat exchanger, this condition for cold fluid can be utilize,
Q □m Cp □Tc
where, ΔT is the Temperature contrast among hot liquids- **Pressure Distribution (Bc- 25%, Nb= 4)**

V. FLOW ANALYSIS OF SHELL AND TUBE HEATEXCHANGER

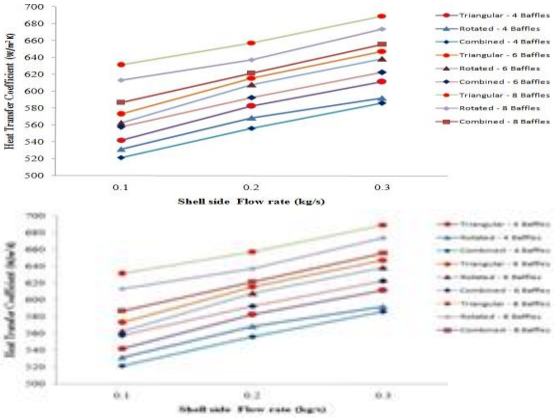


Figure 5.1 Shell sideflow rate (BC-25%)

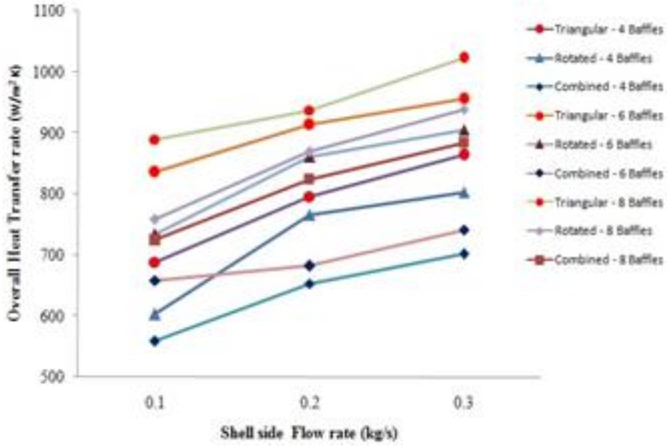


Fig 5.2 shell side flow rate(BC-30%)

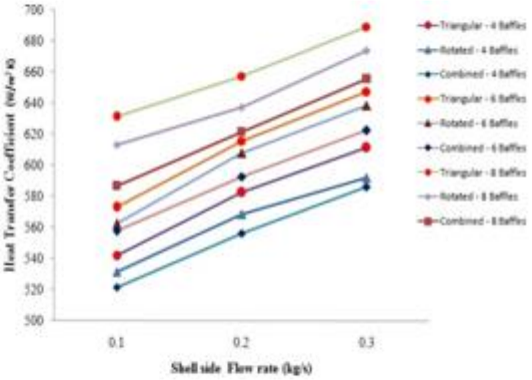


Fig 5.3 Shell side flow rate(BC-35%)

VI. ANALYISIS OF STHE

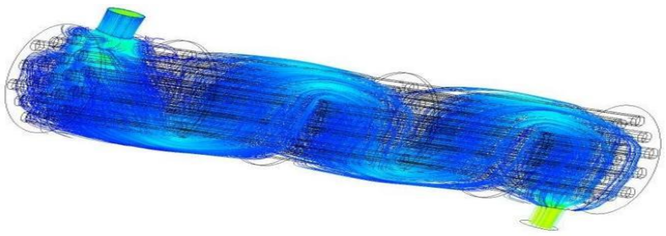


Figure 5.1 - 3D - Velocity Streamline (Bc- 25%, Nb= 4)

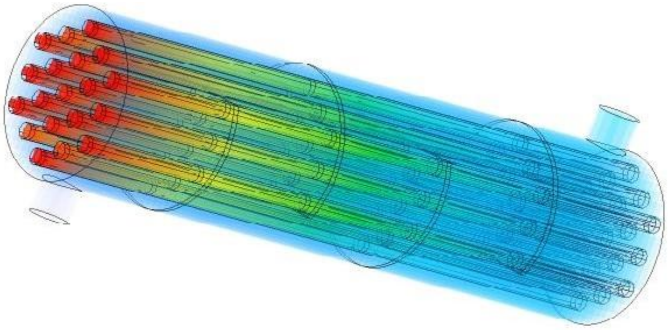


Figure 5.2 - 3D - Pressure Distribution (Bc- 25%, Nb= 4)

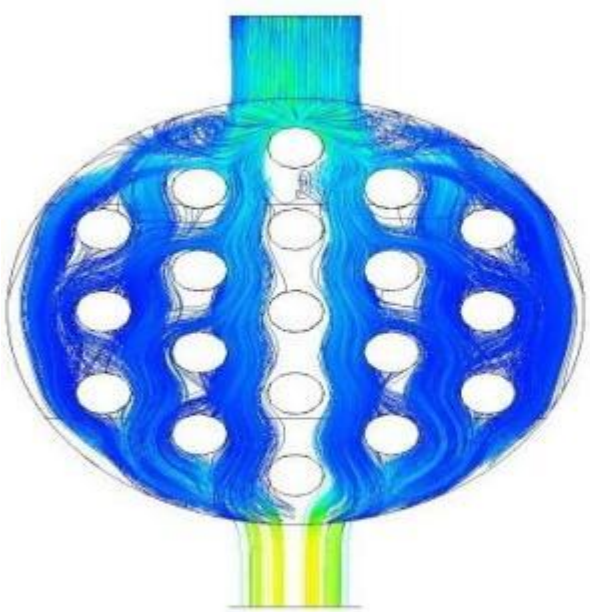
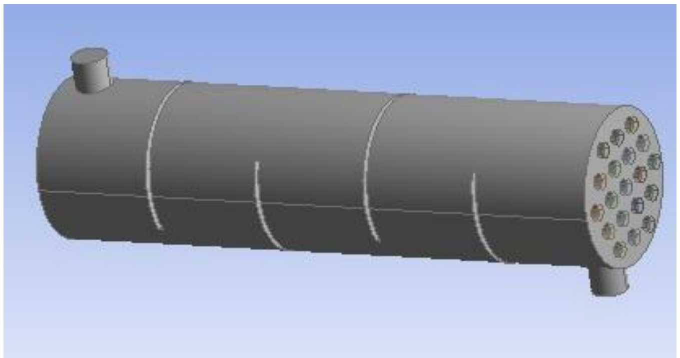
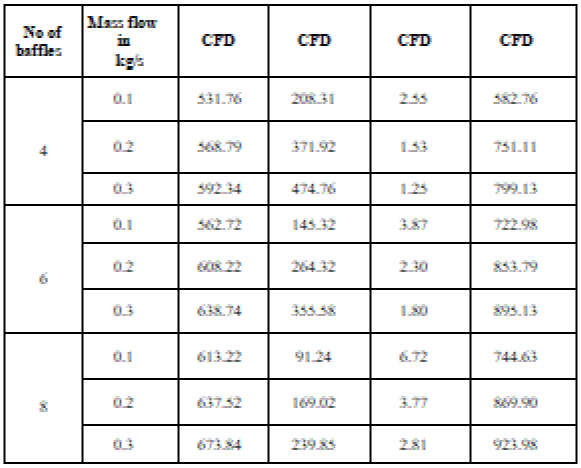


Figure 5.3 - Streamline flow in tube layout (Bc- 25%, Nb= 4)



Figurure 5.4- 3D CAD modelling of STHE

VII. RESULT



No of baffles	Mass flow in kg/s	CFD	CFD	CFD	CFD
4	0.1	531.76	208.31	2.55	582.76
	0.2	568.79	371.92	1.53	751.11
	0.3	592.34	474.76	1.25	799.13
6	0.1	562.72	145.32	3.87	722.98
	0.2	608.22	264.32	2.30	853.79
	0.3	638.74	355.58	1.80	895.13
8	0.1	613.22	91.24	6.72	744.63
	0.2	637.52	169.02	3.77	869.90
	0.3	673.84	239.85	2.81	923.98

The heat transfer coefficient increased when the mass flow rate increased. Also it increases. When the pressure drop increased due to increase in number of baffles from 4 to 8 in addition to increase in mass flow rate, the pressure drop in the shell side also increased. Since the heat transfer coefficient and pressure drop are increasing, while increasing the mass flow rate and number of baffles, it affected the performance factor of STHE. The overall heat transfer rate of STHE increase while increasing the number of baffles which increased the mass flow rate.

VIII. CONCLUSION

The study investigated the effect of change some parameters on heat transfer coefficient and pressure drop for shell and tube heat exchanger. The study concluded that as shell diameter increases the heat transfer coefficient and pressure drop increases. The pull-through head with triangular pitch can be the best choice to increase heat transfer coefficient. While, baffle spacing and cutting space reduced the heat transfer coefficient when increases. The fouling factor on shell side can affect the heat transfer heat more than that for tube side, therefore it is important to reduce fouling rate on shell side. The parameters selection has direct effect on both overall heat transfer coefficient and pressure drop.

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