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COMPARATIVE ANALYSIS OF SHELL AND TUBE TYPE HEAT EXCHANGER WITH EFFECT OF HELICAL BAFFLES AND NANO FLUID: A REVIEW

Shubham V. Deshmukh
BE, Department of Mechanical Engineering, Dr. D. Y. Patil College of Engineering & Innovation, Varale, Talegaon, Pune, EmailId- shubbud00@gmail.com

Ganesh A. Dukare
BE, Department of Mechanical Engineering
Dr. D. Y. Patil College of Engineering & Innovation, Varale, Talegaon, Pune

Kishor R. Borade
BE, Department of Mechanical Engineering
Dr. D. Y. Patil College of Engineering & Innovation, Varale, Talegaon, Pune

Abhijeet D. More
BE, Department of Mechanical Engineering
Dr. D. Y. Patil College of Engineering & Innovation, Varale, Talegaon, Pune

ABSTRACT - In shell and tube type heat exchanger, the thermal performance and pressure drop are dependent on the type of fluid flow and type of baffles used in it. In order to improve the efficacy of heat exchangers, Nano fluids are recently employed as coolants in them. Regarding unique characteristics of Nano fluids, research studies in this area have witnessed a remarkable growth. This paper presents the simulations carried out on different baffle i.e. helical baffles and different type of fluid i.e. Nano fluid and water. This shows the effect of baffles on heat transfer of fluid in shell and tube heat exchanger. Single segmental baffles show the formation of dead zones where heat transfer cannot do properly. Double segmental baffles reduce the vibrational damage to system as compared to single segmental baffles. The use of helical baffles can decrease in pressure drop by the elimination of dead zones. The less dead zones result in high heat transfer. The helical baffles can create the turbulence flow, which increase heat transfer rate, which increases the overall efficiency of the system. In this paper we will comparatively study of shell and tube type heat exchanger with Nano fluid and water on different mass flow rates.

Keywords- Heat transfer, Helical baffles, Pressure drop, Dead zone, Baffles types, Nano fluid.

I. INTRODUCTION

Shell and tube heat exchangers are widely used in various industries such as oil refining and large chemical process, power generation and air-conditioning system. The baffles are of mainly used for improving mixing levels of fluid and consequently enhancing heat transfer rate of shell and tube heat exchangers. In the past, various types of baffles have been used in shell and tube heat exchangers to improve the shell side efficiency. Segmental baffles are generally used in shell and tube heat exchanger. Where, the single segmental baffles have some disadvantages such as large back mixing, fouling, high leakage flow, and dead zone. In addition, a single segmental baffle gives significant pressure drop across the exchanger when changing the direction of fluid flow.

Baffle is a device used to mixing 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, forth across the tube bundle to provide effective velocity and change Heat Transfer rates. The diameter of the baffle must be 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.

The Helical Baffle Heat Exchanger is also known as a Helix changer solution that removes the deficiencies of Segmental Baffle Heat Exchanger. It is very effective where heat exchanger is predicted to be faced the 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.

To improve heat transfer characteristics of conventional fluids, the concept of "Nano fluid" was proposed by Choi [8] in 1995. Combination of conventional fluids and solid nanoparticles called Nano fluid. Nano fluids are advanced heat transfer fluids which can overcome the restrictions of poor thermos physical characteristics related to conventional fluids such as low thermal conductivity. Researchers have proven that Nano fluids have advantages such as great thermal conductivity and proper stability.

An experimental study on the forced convective heat transfer and flow characteristics of water–Al_2O_3 Nano fluids flowing in a STHX under turbulent conditions. The results showed that The heat transfer coefficient of Nano fluid is slightly higher than that of the base liquid at same mass flow rate and same inlet temperature. The heat transfer coefficient of the Nano fluid increased with an increase in the mass flow rate and the concentration, however increasing the concentration caused increase in the viscosity leading to increase in friction factor. The value of the overall heat transfer coefficient of the Nano fluid was 57% greater than that of pure water.

II. EASY OF USE

This paper deals with heat transfer rate of the heat exchanger which is dependent on the types of baffles i. e.

helical baffles. It is more efficient than segmental types of baffles, which increases the turbulence flow, which effect on the heat transfer rate of the system at nano fluids and mass flow rates.

III. LITERATURE REVIEW

The Numerical simulations are carried out on different baffles i.e. segmental, double segmental and helical baffles which show the effect of baffles on pressure drop in shell and tube heat exchanger in which increasing the number of baffles beyond certain number gives serious effects on pressure drop.[1]

At the same volume flow rate, larger helix angle results in lower pressure drop and lower heat transfer rate. The present work combined with previous researches suggested that the optimal helix angle should be around 40° [2]

The effectiveness of the heat exchangers with two-layer helical baffles is higher than that of the heat exchanger with single layer helical baffles.[3]

Under the identical operating conditions, the shell side heat transfer coefficient of optimum STHXsHB is inferior to the conventional STHXsSB and the pressure loss of the optimum STHXsHB has also a considerable smaller than the conventional STHXsSB.[4]

The heat exchangers with helical baffles will have a higher heat transfer coefficient when having the same pumping power. The enhanced performance increases with the increase of baffle inclination angle when $\alpha<45^\circ$, and decreases when $\alpha>45^\circ$. [5]

The shell-side heat transfer coefficient increases with the increasing volume flow rate, and it is negatively correlated with the baffle helix angle at the rate of the same shell-side volume flow. [6]

At the same mass flow rate and the same working condition, longer baffle spaces result in lower heat transfer coefficients. [7]

By applying nanofluids in heat exchangers can vary considerably depending not only on thermo physical properties but also on the geometrical parameters of the heat exchanging equipment and the working conditions. [8]

IV. STUDY

Our review paper deals with, the study can be carried out using 45 angles of helical baffles with different mass flow rate in the shell and tube type heat exchanger for increasing the turbulence of flow.

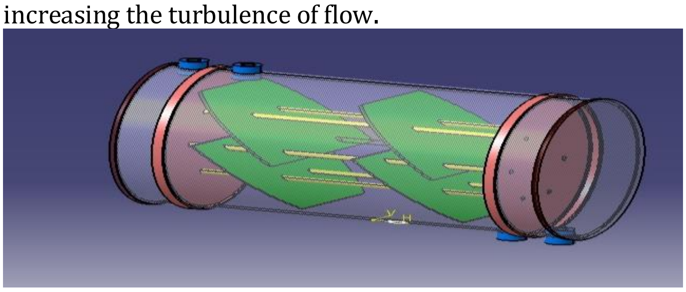

Fig.1 Model Shell and tube type heat exchanger

By varying mass flow rate which will effect on heat transfer rate and the pumping power of the heat exchanger which increases the overall efficiency of the system.

Performance Parameter:

Heat Transfer Rate, $h=Q/A\Delta Tm$

ΔTm = Logarithmic mean Temperature Difference =

$$\frac{(Ts_1-Tt_2) - (Ts_2-Tt_1)}{\ln (Ts_1-Tt_2)/(Ts_2-Tt_1)}$$

Where, h = Heat transfer coefficient

Q = Heat Transfer rate = $M_t*c_{pt}*(T_{t2}-T_{t1})$

A= Heat Transfer Area = n*π*do*lc

M_t = mass flow rate

C_{pt}= Specific heat

N = Number of tube

L_c = Length of tube

T_{t2} = Outlet temp. from tube

T_{t1} = Inlet temp. from tube

T_{s2} = Outlet temp. from shell

T_{s1} = Inlet temp. from shell

V. SUMMARY

A model will be developed to evaluate thermal analysis of a helical baffle heat exchanger as well as the comparative analysis between the thermal parameters between nano fluid and water has carried out. The model evaluates the rate of heat transfer of a helical baffle heat exchanger with the angle of 45° at different mass flow rates.

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