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INVESTIGATION OF SHELL & TUBE HEAT EXCHANGER PERFOMANCE FOR PLASTIC INJECTION MOULDING MACHINE

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Abstract: *The shell and tube heat exchanger is widely used in industries as a chillers plant for transfer waste heat from the injection molding machine to the cooling water from improve the effectiveness of the injection molding machine.the transformation of the waste heat from injection molding machine to the cooling water dependent on the heat exchangers. To increase the heat exchanger capacity of heat exchanger is invite the optimization problem which seeks to identify the best parameter combination of heat exchangers. In order to tackle such an optimization problem in present work the Taguchi method is applied to perform screening of experiments and to identify the important significant parameters which are affecting the efficiency of shell and tube type heat exchanger. The prefix parameters (tube diameter, mass flow rate and pitch length) are used as input variable and the output parameter is maximum temperature difference of shell and tube heat exchanger..Result obtained from the Taguchi analysis shows that which combination of design parameter gives the minimum outlet temperature of water. The most affected parameter on temperature of water from tube diameter, pitch length and mass flow rate is found out from Taguchi analysis. Also the Taguchi results are validated by performing experiment for L9 array.*

Key words: *Heat exchenger, ANSYS 12.0, Minitab 16.*

I.INTRODUCTION

A heat exchanger is a device built for efficient heat transfer from one medium to another. The media may be separated by a solid wall, so that they never mix, or they may be in direct contact. They are widely used in space heating, refrigeration, air conditioning, power plants, chemical plants, petrochemical plants, petroleum refineries, natural gas processing, cryogenics applications and sewage treatment. One common example of a heat exchanger is the radiator in a car, in which the heat source, being a hot engine-cooling fluid, water, transfers heat to air flowing through the radiator (i.e. the heat transfer medium).

Shell and tube heat exchangers consist of a series of tubes. One set of these tubes contains the fluid that must be either heated or cooled. The second fluid runs over the tubes that are being heated or cooled so that it can either provide the heat or absorb the heat required. A set of tubes is called the tube bundle and can be made up of several types of tubes: plain, longitudinally finned, etc. Shell and tube heat exchangers are typically used for high-pressure applications (with pressures greater than 30 bar and temperatures greater than 260°C). This is because the shell and tube heat exchangers are robust due to their shape.

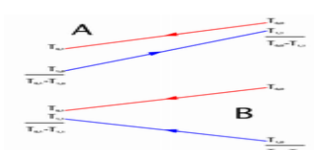

Fig. 1.Countercurrent (A) and parallel (B) flows

There are two primary classifications of heat exchangers according to their flow arrangement. In parallel-flow heat exchangers, the two fluids enter the exchanger at the same end, and travel in parallel to one another to the other side. In counter-flow heat exchangers the fluids enter the exchanger from opposite ends. The counter current design is most efficient, in that it can transfer the most heat from the heat (transfer) medium. See countercurrent exchange. In a cross-flow heat exchanger, the fluids travel roughly perpendicular to one another through the exchanger.

For efficiency, heat exchangers are designed to maximize the surface area of the wall between the two fluids, while minimizing resistance to fluid flow through the exchanger. The exchanger's performance can also be affected by the addition of fins or corrugations in one or both directions, which increase surface area and may channel fluid flow or induce turbulence.

II.MODELLING OF SHELL AND TUBE HEAT EXCHANGER

Solid works is a computer graphics system for modelling various mechanical designs for performing related design and manufacturing operations. The system uses a 3D solid modelling system as the core, and applies the feature base parametric modelling method. In short solid works is a feature based parametric solid modelling system with many extended design and manufacturing applications.

1) Shell – 150 ND, 750 mm long provided with end boxes.

2) Tubes 7.525 I.D., 9.525 O.D., 750 mm copper tubes with triangular pitch (32 nos.)

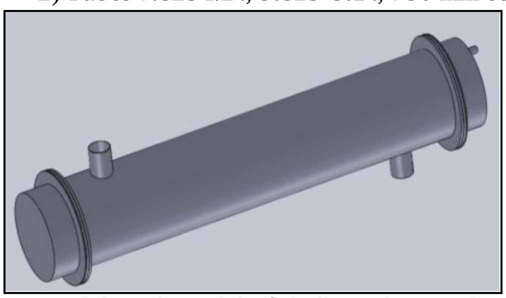

Fig.2 Solid work model of shell & tube type heat exchanger

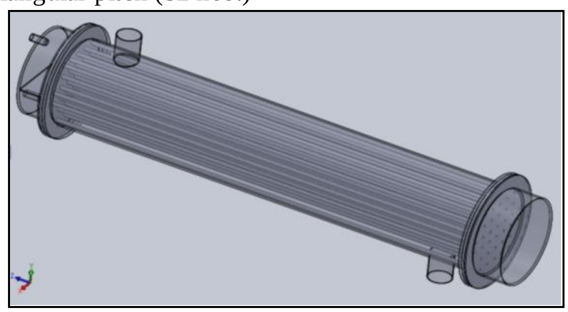

Fig.3 3D model of shell & tube type heat exchanger

III .CFD ANALYSIS OF SHELL AND TUBE HEAT EXCHENGER

This field is known as computational fluid dynamics. At the core of the CFD modelling is a three-dimensional flow solver that is powerful, efficient, and easily extended to custom engineering applications. In designing a new mixing device, injection grid or just a simple gas diverter or a distribution device, design engineers need to ensure adequate geometry, pressure loss, and residence time would be available. More importantly, to run the plant efficiently and economically, operators and plant engineers need to know and be able to set the optimum parameters.

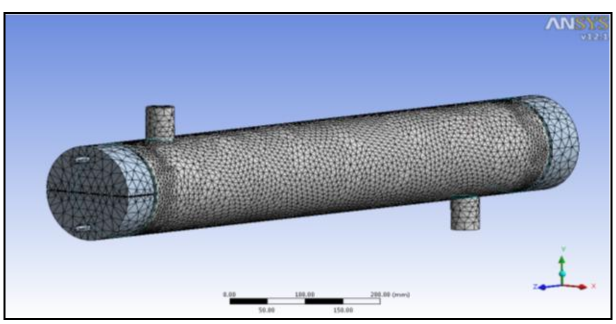

Fig.4 Meshing

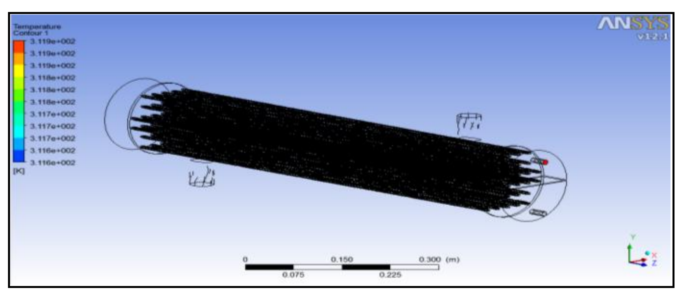

Fig.5 Outlet Temperature for Tube Side

Boundary Condition:

Sr no	Domain Name	Condition
1	Hot water	stationary
2	Copper pipe	stationary
3	Cold water	stationary

Table 1: Domain name and Condition

Sr no	Input condition	Value
1	Inlet Temperature of hot water	40 ˚c
2	Inlet Temperature of cold water	26˚c
3	Mass flow rate of hot water	0.062 kg/s
4	Mass flow rate of cold water	0.318 kg/s

Table 2: Input Condition

The practical value of the Inlet and Outlet temperature of shell and tube heat exchanger are showing below. This value is taken by temperature sensor mounted at various locations.

	Inlet temperature	Outlet temperature
Hot water temperature (Practical Reading) (Tube side)	313 k	311 k
Hot water temperature (ANSYS result) (Tube side)	313 k	311.7 k

Table 3:Compere with prectical and ansys tube side outlet temp.

IV. DESIGN OF EXPERIMENTS

The world experiment is used in a quite precise sense to mean an investigation where the system under study is under the control of the investigator. This means that experiment is the process in which purposeful changes are made to the input variables of process or systems so that we may observe and identify the reasons for changes that may be observed in the output response. Therefore to reduce the number of Experiments and to obtain good quality of investigation the term named Design of experiments (DOE) is highly useable method in all over the world.

Taguchi method:

Taguchi's methods of experimental design provide a simple, efficient, and systematic approach for the optimization of experimental designs for performance quality and cost. The main purpose of Taguchi method is reducing the variation in a process through robust design of experiments. It was developed by Dr. Genichi Taguchi of Japan. The experimental design proposed by Taguchi involves using orthogonal arrays to organize the parameters affecting the process and the levels at which they should be varied; it allows for the collection of the necessary data to determine which factors most affect product quality with a minimum amount of experimentation, thus saving time and resources.

Selection of Process Variable and orthogonal array:

Shell and tube heat exchanger is widely used in the industries therefore it is taken for the analysis. The effectiveness of the shell and tube heat exchanger depends upon the many parameters like tube diameter, pitch length of the tube. Longitudinal pitch, mass flow rate, tube material, shell material, types of the baffles, baffles angles, etc. So that tube diameter, pitch length and mass flow rate is most effective parameter for effectiveness of the heat exchanger. and The selection of orthogonal array for experiment was done by use Minitab-16 statistical software. By putting parameter variation levels as per Table 1 in Minitab-16 statistical software the Minitab suggest that mix level L9 (1*2, 3*3) fractional factorial orthogonal array is most compatible for our experiment. The experiment table suggested by Minitab- 16 for L9 orthogonal array is shown in Table 3

Variation level	Tube (mm)	Pitch Length(mm)	Mass Flow Rate(kg/s)
1	8.25	23	1.2
2	9.25	25	1.5
3	10.526	27	1.8

Table 4:Selection of variable

Experiment	P1	P2	P3	P4
1	1	1	1	1
2	1	2	2	2
3	1	3	3	3
4	2	1	2	3
5	2	2	3	1
6	2	3	1	2
7	3	1	3	2
8	3	2	1	3
9	3	3	2	1

Ta ble 5:L-9 array table

Sr. No	Tube Outer Dia.(mm)	Pitch of tube(mm)	Mass Flow Rate(kg/s)
1	8.525	23	1.2
2	8.525	25	1.5
3	8.525	27	1.8
4	9.525	23	1.5
5	9.525	25	1.8
6	9.525	27	1.2
7	10.525	23	1.8
8	10.525	25	1.2
9	10.525	27	1.5

Table 6: Selection of orthogonal arrays

CFD ANALYSIS OF TAGUCHI SELECTED ARRAY OF RESULT OF NINE CASES:

Tube dia.	Pitch of length	Mass flow rate	Outer Temperature(K)
8.52	23	1.2	305.66
8.52	25	1.5	305.37
8.52	27	1.8	303.38
9.52	23	1.5	306.86
9.52	25	1.8	306.4
9.52	27	1.2	305.7
10.52	23	1.8	304.51
10.52	25	1.2	308.46
10.52	27	1.5	307.31

Table 7: Reasult of nine **cases**

V. CONCLUSION

Shell and tube heat exchanger is widely used in industries. Today the main problem of industries is effectiveness of the heat exchanger. In present work for Based on the practical and ANSYS results, it is found that the mass flow rate is the Primary parameter and pitch length is the secondary element that has an effect of improvement of effectiveness of heat exchanger. Also from results of Taguchi analysis it can be concluded hat optimum parameter to increase the effectiveness of shell and tube heat exchanger is meeting at outlet temperature 303.38 K are tube diameter 8.52 mm, pitch length 27 mm and mass flow rate 1.8 kg/s. ANSYS and experimental result are compared and found in good agreement, thus proving the strength of model. After completing CFD Analysis Results, we can say that CFD Analysis is a good tool to avoid costly and time consuming Experimental Work.

REFERENCE

[1] P.S.Gowthaman. Analysis of Segmental and Helical Baffle in Shell and tube Heat Exchanger. International Journal of Current Engineering and Technology.
[2] Thundil Karuppa Raj, Srikanth Ganne. Shell side numerical analysis of a shell and tube heat exchanger considering the effects of baffle inclination angle on fluid flow using CFD.journal of science direct.
[3] Sunil S. Shinde, Samir S. Joshi, Dr. S. Pavithran. Performance Improvement in Single phase Tubular Heat Exchanger using continuous Helical Baffles.journal of International Journal of Engineering Research.
[4] Sandeep K. Patel, Professor Alkesh M. Mavani. Shell & tube heat exchanger thermal design with optimization of mass flow rate and baffle spacing. Journal of International Journal of Advanced Engineering Research and Studies.
.[5] Muhammad Mahmood Aslam Bhutta, Nasir Hayat, Muhammad Hassan Bashir, Ahmer Rais Khan, Kanwar Naveed Ahmad, Sarfaraz Khan. CFD application in various heat exchanger designs.journal of science direct.
[6] lin liu. Analysis on flow and heat transfer characteristics of EGR helical baffled cooler with spiral corrugated tubes.journal of science direct.
[7] Gh.S. Jahanmir, F. Farhadi. Twisted bundle heat exchanger performance evaluation by CFD.journal of science direct.
[8] Usman ur rehman. Heat Transfer Optimization of Shell-and-Tube Heat Exchanger through CFD Studies. Journal of science direct.
[9]Lim Eng Aik "Computational Fluid Dynamics Analysis of Shell and-double Concentric-tube Heat Exchanger." . Journal of science direct.
[10] Arjun K.S. and Gopu K.B. Design of Shell and Tube Heat Exchanger Using Computational Fluid Dynamics Tools.journal of Research Journal of Engineering Sciences.

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