Experimental and CFD Simulation in Modified Heat Exchanger with Baffles

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Abstract - *An In current modern period heat move the board has been given a prime significance so as to accomplish an effective framework. The shell and cylinder type heat exchangers are the most noticeably utilized heat move equipment's. The structure of shell and cylinder heat exchanger requires a reasonable methodology between the heat plan and weight drop. In present research existing heat exchanger are altered to expand the mass stream rate alongside pressure drop in streaming liquid across confounds. Baffles have two significant capacity one is to go about as an supportive network for tubes in shell and second one to give guidance to ceaseless streaming liquid. In this way, because of exorbitant weight of streaming water aperture in baffles is to be given least number of openings to improve mass stream rate alongside decline in pressure across shell outlet. Thermocouples are utilized to quantify the temperature of water at the delta and outlet. The stream control valves are utilized to control the stream rate. The impact of mass stream pace of liquids on heat exchanger was considered. CFD method is utilized to consider stream rate across shell and cylinder heat exchanger alongside standard plan in CATIA software. The outcome and end were drawn after the exploratory resting. Test approval of CFD results is to be performed.*

Key Words: ANSYS Fluent, CFD, Baffles, Perforations

1. INTRODUCTION

The energy protection is one of the crucial issues of the twenty-first century, and it will absolutely be one of the most critical difficulties sooner rather than later. In this manner, researchers, architects and specialists are impressively attempting to address this significant concern. The advances made in heating or cooling in modern gadgets cause energy sparing and heat move improvement, and increment the operational existence of the hardware. Energy investment funds can be performed by the productive utilization of energy. Energy transformation, preservation and recuperation are a few courses for energy sparing. To previously mentioned reason, different sorts of heat exchangers are used in numerous modern territories, for example, power plants, atomic reactors, petrochemical industry, refrigeration, cooling, process industry, sun powered water heater, nourishment building, and concoction reactors. Various advances are utilized to improve the productivity of heat exchangers. For quite a long time, endeavours have been gained to ground heat move in heat exchangers, decline the heat trade time lastly improve the framework proficiency. A heat exchanger is a gadget used to move heat between at least two liquids. At the end of the day, heat exchangers are utilized in both cooling and heating procedures. The liquids might be isolated by a strong divider to forestall blending or they might be in direct contact. They are broadly utilized in space heating, refrigeration, air conditioning, power stations, synthetic plants, petrochemical plants, oil processing plants, flammable gas handling, and sewage treatment. The great case of a heat exchanger is found in an inward ignition motor in which a coursing liquid known as motor coolant moves through radiator loops and wind currents past the curls, which cools the coolant and heats the approaching air. Another model is the heat sink, which is an aloof heat exchanger that moves the heat produced by an electronic or a mechanical gadget to a liquid medium, frequently air or a fluid coolant.

1.1 LITERATURE REVIEW

Swapnil S.Kamthe et.al [1], in this paper it presents a study of exploratory research work that intends to take a gander at the effects of different baffles on pressure misfortune and heat move in heat exchanger. From the current survey it very well may be deduced that helical baffles fill in as an all the all the more reassuring advancement because of having less loss of weight in shell, better heat trade execution, less fouling and less fluid prompted vibration. The weight drop for the STHX with helical baffles is around 26% lower than the weight drop for the STHX with segmental bewilders. Heat trade coefficient of the CH-STHX is around 13.1% higher than SG-STHX. Twofold layer helical perplex give less weight drop contrasted and diverse bewilder. The general weight drop Δpm of the Double layer helical baffles is around 13% lower than that of the single layer helical confounds. Under a comparative mass stream rate M, the expansive execution h/Δpm of the CSSP-STHX is around 39.7% and 6.1% higher than those of the SG-STHX and CH-STHX, exclusively. Heat trade coefficient for the STHX with trefoil-opening confound is higher generally speaking by around 11% and 9% than STHX with segmental and helical perplex exclusively. From the audit study it tends to be said that helical baffles gives best out of accessible confounds with least weight drop for same heat move.

Hasan kucuk et.al [2], In this writing it speaks to investigate on shell side heat move and weight drop of a smaller than usual channel shell and cylinder heat exchanger (MC-STHE) planned and fabricated utilizing Kern's technique. A shell with an inward distance across of 30 mm and four on a level plane situated transverse baffles with a 25% confuse cut were utilized in the smaller than expected channel heat exchanger. Utilizing pivoted triangular format, the cylinder group was made out of 13 smaller than usual channel copper tubes with an external measurement of 3 mm and a length of 240 mm. The shell-side Reynolds numbers went from 250 to 2500 while the cylinder side Reynolds number was kept steady at 5900 dependent on the test surface stream zone goodness factor (j/f) results. The shell side convective heat moves coefficients and all out weight drop results were contrasted and connections for large scale tubes normally utilized in the writing. The trial absolute weight drop of the MC-STHE was 2.3 occasions higher than that of large-scale tube heat exchangers. Also, the Nusselt number and Colburn factor relationships were proposed for the estimation of shell side convective heat move coefficient in MC-STHEs. The ideal working extent for shell side is Re < 1000 as indicated by surface stream region goodness factor by which heat move and hydrodynamic impacts in MC-STHE are assessed together.

Xing Cao et.al [3] In this journal it presents a promising substitute for the segmental ones, the helical baffles have been steadily advanced in shell-and-cylinder heat exchangers. Quadrant helical baffles are normally used to prompt a pseudo-winding stream design in the shell side of helical bewilder heat exchangers, however the triangular spillage misfortune at the combination indents between nearby confounds has consistently been the bottleneck. The altered stream field normal for sextant helical bewilder heat exchangers (SHBHXs) is analyzed in detail in examination with quadrant helical baffles heat exchangers (QHBHXs). It reasons that the opposite stream in the triangular spillage zone is mostly hosed by righteousness of extraordinary covered structure of neighboring sextant helical confuses, and shell-side hub speed displays the element of uniform circulation. After research it is inferred that the heat presentation and the thorough exhibition are vastly improved while the weight drop is a lot of lower in SHBHXs than in QHBHXs, which can be explained by a better field collaboration property in SHBHXs based on the field cooperative energy hypothesis.

Efi N E, Shahriman et.al [4], This paper presents a similar test concentrate on shell and cylinder heat exchanger with four distinctive segmental baffles arrangements (BC) searching for upgrading the heat, water powered and thermodynamic exhibitions. The bewilder designs are ordinary single segmental baffles (CSSB), stunned single segmental confuse (SSSB), Flower segmental perplex (FSB) and half and half segmental baffles (HSB). Each BC is tried with different shell side stream rates (SSFR) fluctuated somewhere in the range of 12 and 17 LPM. The improvement in U by utilizing HSB design was 185–248%. HSB baffles arrangement improves the exergy productivity by 1.27 to 1.4 occasions contrasted with CSSB. The HSB arrangement improves the heat exchanger generally speaking heat move coefficient, adequacy, and NTU of the heat exchanger by 185%–248%,134%–149%, and 148.9%–189%, individually contrasted and CSSB. The HSB design improves the exergy productivity proportion ($\eta ex/\eta ex$ CSSB) by 1.27 – while estimations of this proportion are 1.074=1.091 and 1.024–1.024 for SSSB and FSB, individually. The shell side stream opposition for the cross-breed baffles arrangement (HSB) was higher than in different designs. The HSB design is the best one among other setup in any case its negative impact on pressure drop.

Pranita bichkar et.al [5] In this journal it passes on explore on heat execution and weight drop are subject to the way of liquid stream and kinds of baffles in various directions separately. This lessens the framework efficiency. It likewise presents the numerical recreations did on various baffles for example single segmental, twofold segmental and helical baffles. This shows the impact of baffles on pressure drop in shell and cylinder heat exchanger. Single segmental confuses show the development of no man's lands where heath move can't occur viably. Twofold segmental confuses decrease the vibrational harm when contrasted with single segmental perplexes. The utilization of helical baffles shows a decline in pressure drop because of the end of no man's lands. The less no man's lands bring about better health move. The lower pressure drops brings about lower siphoning power, which thus expands the general framework proficiency. Expanding the quantity of perplexes past certain number gives genuine impacts on pressure drop. Single segmental baffles show the arrangement of no man's lands where health move can't happen successfully. This issue is fathomed by use of twofold segmental perplexes. It additionally diminishes the vibrational harm when contrasted with single segmental bewilders. Be that as it may, the utilization of helical astounds over other two brings down the weight drop which thus builds the general framework efficiency. In this way, it is demonstrated that helical baffles are more invaluable than other two kinds of bewilders.

1.2 PROBLEM STATEMENT

Heat exchangers are an indistinguishable piece of the enterprises, for example, power plants, process ventures, oil refining, etc. In the interim, the shell and cylinder heat exchangers (STHE) have 40% offer contraption of the diverse business. Along these lines, centre around this mechanical assembly is expected to improve the presentation of this gadget. Confounds and cylinder design and their course of action profoundly affect the presentation of this sort of heat exchanger. So, we are concentrating on baffle plate for act of spontaneity of heat transfer rate

2. OBJECTIVES

1. The design of shell-and-tube heat exchanger is designed by using CATIA V5R20 software.

2. Shell and tube heat exchanger with a conventional single plate and a new type of porous baffles plate is designed and tested by compared using CFD simulation in ANSYS Fluent software.

3. To understand the effect of baffle plate in Shell and tube heat exchanger for improvisation of heat transfer rate.
4. To manufacture shell-and-tube heat exchanger according design parameter.
5. Comparison of experimental and CFD result of Shell and tube heat exchanger with a conventional single plate and a new type of porous baffles plate.

3. METHODOLOGY

Step 1:- Initially research paper is studied to find out research gap for project then necessary parameters are studied in detail. After going through these papers, we learnt about shell-and-tube heat exchanger and study of baffle plate.

Step2:-Research gap is studied to understand new objectives for project.

Step 3:- After deciding the components, the 3D Model and drafting will be done with the help of CATIA software.

Step 4:- Computational Fluid Dynamics (CFD) simulations of single plate and a new type of porous baffles plate with shell-and-tube heat exchanger will be done with the help of ANSYS Fluent software.

Step 5:-The actual manufacturing shell-and-tube heat exchanger will done and after that experimental reading are note down.

Step 6:- Validation of the experimental & CFD result.

3.1EXISTING HEAT EXCHANGER

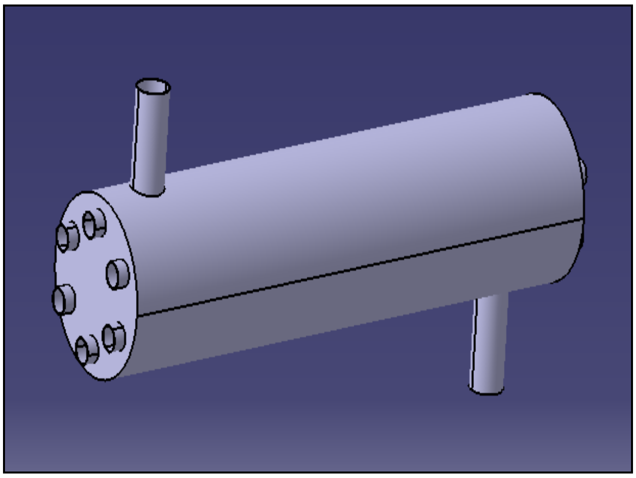


Fig No.1. CATIA model of heat exchanger

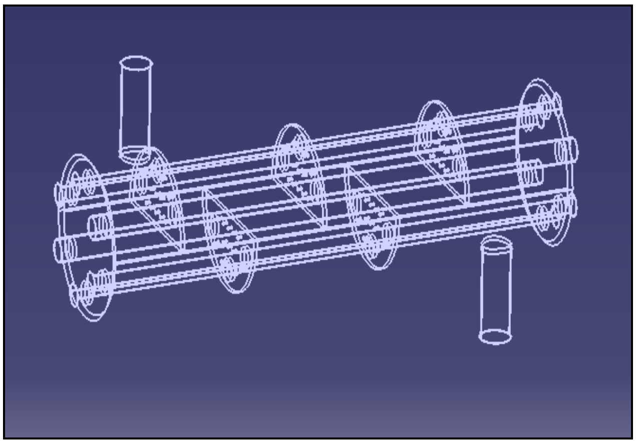


Fig.No.2 Wireframe geometry for internal view of baffles

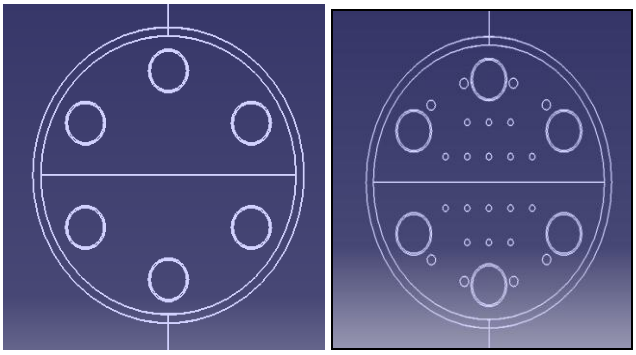
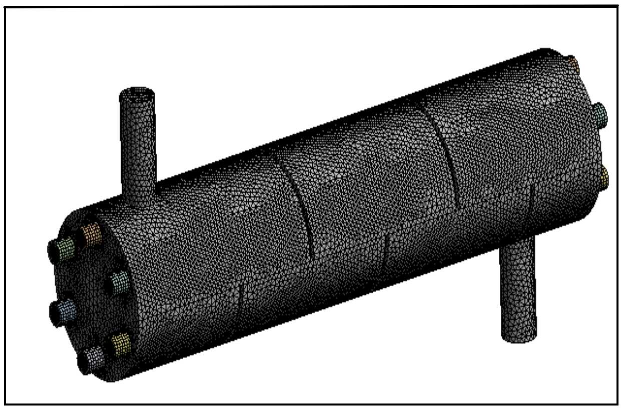


Fig.No.3 CATIA model of heat exchanger without and with perforation on baffles

3.2 Mesh

In ANSYS meshing is performed as similar to discretization process in FEA procedure in which it breaks whole components in small elements and nodes. So, in analysis boundary condition equation are solved at this elements and nodes. ANSYS Meshing may be a all-purpose, intelligent, automated high-performance product. It produces the foremost acceptable mesh for correct, economical metaphysics solutions. A mesh well matched for a selected analysis may be generated with one click for all elements in a very model. Full controls over the options accustomed generate the mesh are accessible for the skilled user who needs to fine-tune it. The ability of parallel processing is automatically accustomed reduce the time you have got to wait for mesh generation.



Statistics	
Nodes	357886
Elements	1100751

Fig.No.4 Details of meshing of heat exchanger

3.3 Computational fluid dynamics (CFD)

It is a branch of fluid mechanics that uses numerical analysis and data structures to analyze and solve problems that involve fluid flows. CFD is now recognized to be a part of the computer-aided engineering (CAE) spectrum of tools used extensively today in all industries, and its approach to modeling fluid flow phenomena allows equipment designers and technical analysts to have the power of a virtual wind tunnel on their desktop computer.

STEPS IN CFD PROCEDURE

1. Initially geometry is designed in CATIA software.
2. Importing of geometry in ANSYS fluent geometry section to create fluid domain for CFD simulation.
3. In model section geometry in meshed fine and respective named selection is defined for each section.
4. In setup CFD simulation boundary conditions are defined
5. Gravity is defined as -9.81 m/s^2 in Z direction.
6. Energy is kept on, along with viscous model as k-epsilon, standard and standard wall function
7. Cold water inlet along with hot water inlet with respective temperature is defined.
8. In solution hybrid initialization is performed and 400 iteration are calculated.
9. In CFD post pressure contour are plotted along with stream line plot.

Fig.No.5: CFD simulation convergence graph

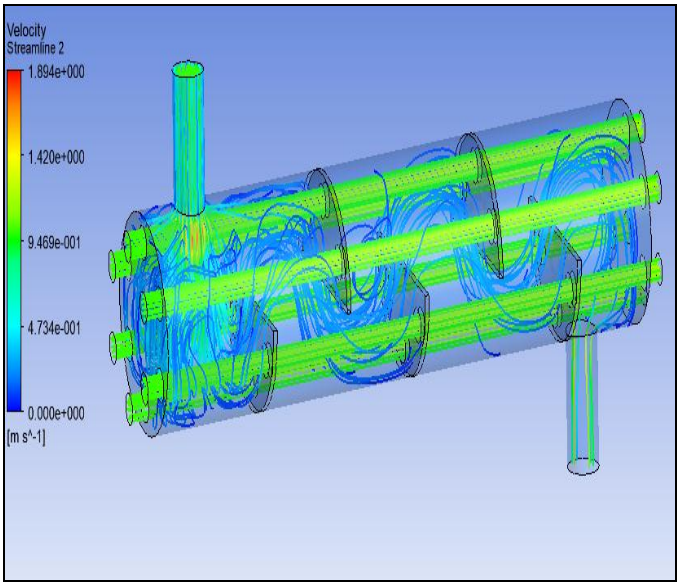


Fig.No.6 Stream line flow of water in existing heat exchanger

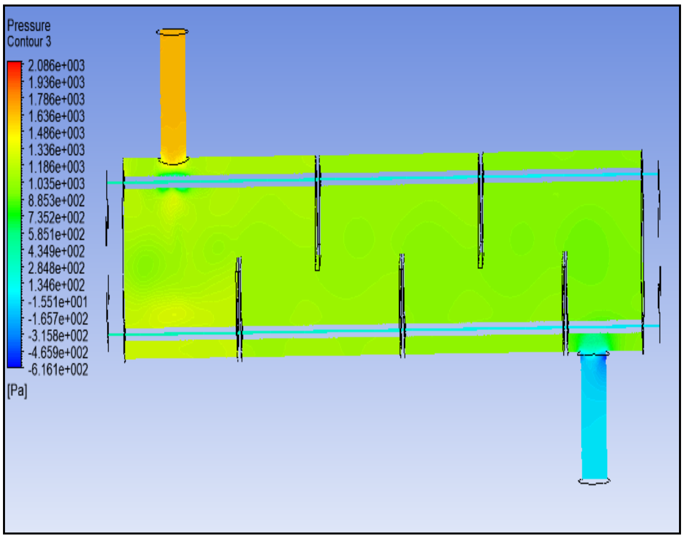


Fig.No.7 Pressure contour of existing heat exchanger

It is observed that in existing heat exchanger pressure of maximum2.086MPa with contribution of more amount of water to reduce or pressure drop perforation effect on baffle plated is being performed as shown in below figures.

3.4 MODIFIED HEAT EXCHANGER

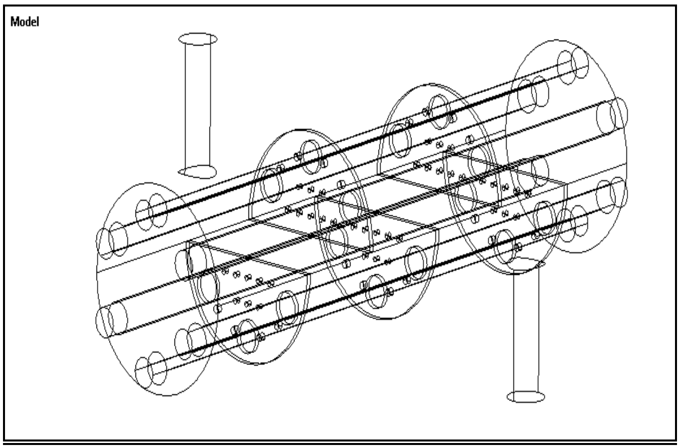


Fig.No.8 Wireframe view of baffles with perforation

Modifying the existing heat exchanger to drop the pressure by introducing perforation of diameter 4 mm and 6 mm along the baffle plates.

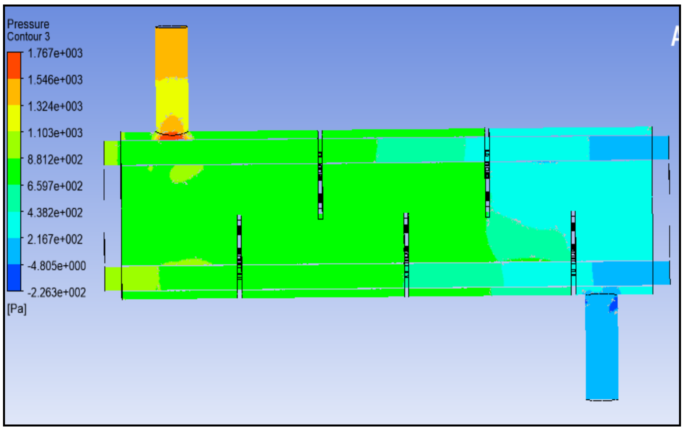


Fig.No.9 pressure contour for modified heat exchanger

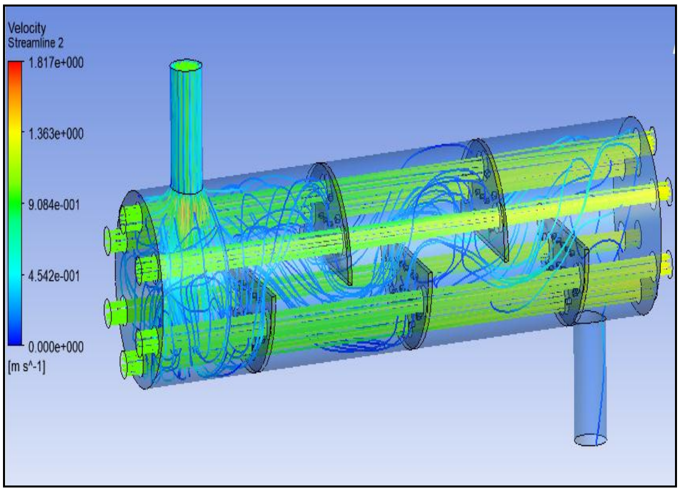


Fig.No.9 Stream line flow of water in modified heat exchanger

It is observed from contour that modified geometry around 1.76 kPa of pressure.

4. CONCLUSION

It is observed from pressure contour plot that baffles with perforation have improved ta mass flow rate along with decrease in pressure drop i.e. in existing geometry pressure was 2.11kPa but with modified geometry it is observed around 1.76 kPa.

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