

Performance Study of Shell and Tube Heat Exchanger with Y-Shaped Fins

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ABSTRACT: A shell and tube heat exchanger is a type of heat exchanger that is made up of a cylindrical shell with a series of tubes. In order to transfer heat between the two fluids, one fluid flows through the tubes, while the other fluid flows through the tubes. This design commonly used in a variety of industrial and HVAC applications, such as power plant, chemical plants, and refrigeration systems. It is known for its high heat transfer efficiency and durability. In a shell and tube heat exchanger, the Y-shaped fins increase the heat transfer surface area, allowing for more efficient heat exchange. When compared to heat exchanger without fins, the cooling rate is higher. The temperature distribution is higher by using the Y shaped fins. This can lead to a smaller overall size for the heat exchanger, or the ability to handle a larger heat load with the same size heat exchanger. Additionally, Y-shaped fins can increase the heat transfer coefficient, further increasing efficiency of the heat exchanger.

KEYWORDS: HVAC, Baffles, Phase change material, Heat transferring fluid.

I. INTRODUCTION

One of the types of heat exchangers is shell and tube. It consists of a group of tubes that are collectively referred to as a "tube bundle" and are covered by a closed cylindrical container termed as "shell." A number of baffles support each tube in it. The baffles also affect the fluid flow on the shell's side. Each tubes pass through the tube sheets. One of the tube sheet is free to move and other one is fixed, this helps to thermal expansion. The "tube side" fluid is the substance that is circulating through the tubes. The "shell side fluid" is the fluid that is pouring out of the tubes. There is one intake and one output for each fluid. Shell and tube heat exchangers are reasonably affordable, have good qualities, and a simple design.

Shell and tube are primarily utilized in a variety of industries, including pharmaceutical firms, food processing firms, chemical firms, pulp and paper firms, ships for cooling hydraulic oil, etc. The addition of Y-shaped fins will aid in improving the fluid's thermal efficiency and cooling rate. In this study, the heat-transferring fluid is water. When compared to a shell and tube without fins, the one with Y-shaped fins is more time-efficient. Y-shaped fins aid in accelerating convection. Convection is used to transfer heat, which has the added benefit of hastening cooling.

The heat exchange rate of the shell and tube heat exchanger can be increased by mounting y-shaped fins on the tubes. It is inexpensive and efficient to attach Y-shaped fins. The efficiency of the y-shaped fins on the tubes of the shell and

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tube heat exchanger is assessed in this study. Here, five distinct shell and tube configurations were experimentally examined and contrasted;

Case 1: The shell and tube heat exchanger without fins.

Case 2: One Y-shaped fin was attached to each tube of shell and tube.

Case 3: Attached two Y-shaped fins to the shell and tube's individual tubes.

Case 4: Three Y-shaped fins were attached to each tube of shell and tube

Case 5: Placed four Y-shaped fins on each tube of shell and tube.

II. RELATED WORK

The concept of y-shaped fins attaching on the tubes of shell and tube is introduced by Abdeldjalil Belazreg et al. [1] It's a numerical attempt of adding y-shaped fins to the tubes of the shell and tube heat exchanger will increase the thermal efficiency of the device. [2] Authors investigated shell and helically coiled finned tube numerically and experimentally with simple annular fin on the helically coiled finned tube. [3] In this paper numerically studied the effectiveness of the helical fins on the tubes of shell and tube. Helical fin improves the thermal efficiency of the shell and tube. [4] Authors studied numerically the influence on the melting time of the PCMs by attaching TEE shaped fins on the shell and tube heat exchanger. Fins minimized the melting time of the PCMs. [5] In this paper developed a innovative designed shell and tube with metal foam fin and numerically studied. Best performance achieved by the shell and tube with suitable combination of the foam and fin. Metal foam can distribute temperature uniformly and also solidification become uniform by the presence of metal foam. [6] In this paper conducted a experimental study on a shell and tube with circular fins on the tubes of shell and tube and without circular fins on the tubes of shell and tube. [7] Authors conducted a comparison studies between reference LHTESS and LHTESS with curve shaped fins. The LHTESS with curve shaped fins achieved the best performance than the reference LHTESS. [8] This paper is a comparison study between trapezoidal fin and rectangular shaped fin which are attached to the shell and tube ex-changer. This study says that heat transfer rate and pressure drop are not only depend upon the way tubes arranged they also depend upon the geometric shape of the fins attached on the tubes of the shell and tube. It is found be trapezoidal fins increased the heat transfer rate than rectangular fins. [9] Comparison study between finless tube mode, finned tube mode and optimized finned tube mode about their thermal and hydraulic performance. The study says that the finned tube mode has the best heat transfer rate and pressure drop among these three types of shell and tube. [10] In this experimental study adding annular fin on the tubes of shell and tube to improve thermal conductivity of the PCMs and to improve the performance of the shell and tube. This study says that spiral fins can increase average nusselt number than annular fins.

III. METHODOLOGY

The primary goal of the project is to increase the heat transfer rate by using the Y shaped fins. Manufacturing the shell and tube and Y shaped fins. In this project developing the shell and tube heat ex-changer and altering it by adding the Y shaped fins. The project work is carried out in a certain methodology. The shell and tube heat ex-changer consist of series of tubes housed with in a cylindrical PVC container known as shell. The tubes are made up of steel. Each tubes are supported with a series of baffles which are made up of aluminium brass. The baffles also control the shell side fluid. Each tube pass through the tube sheet. This method of adding Y shaped fins will help us increase the thermal efficiency by comparing it with the tubes without fins. To increase effectiveness the tubes are linked to Y-shaped fins. Here we are doing five cases, The first case in this study is the shell and tube heat ex-changer without fins and after that adding one Y shaped fin in each tube then add another Y shaped fin in each tube until four of the fins are attached. Here the fluid utilised to transmit heat is water.

IV. EXPERIMENTAL RESULTS

In this paper attaching y shaped fins which are made up of steel by welding on steel tubes of the shell and tube heat ex-changer. Designing of y shaped shown in Fig. 5 and also designing of y shaped fins attached on the tubes of shell and tube shown in Fig. 4. By employing 4 y shaped fins getting more improved performance than other cases. Y shaped fin improves the thermal efficiency, heat transfer rate and pressure drop of the shell and tube. It can also act as best temperature distributor in shell and tube heat ex-changer.

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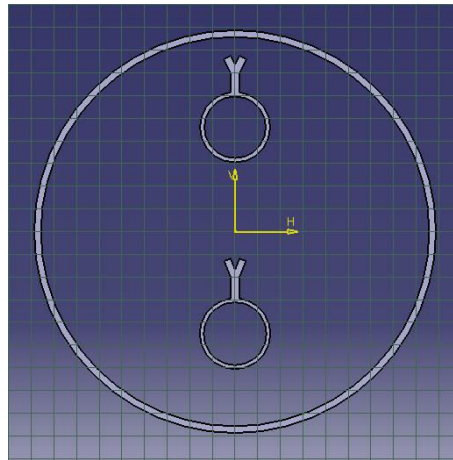


Fig. 1: 2D view of shell and tube with one y shaped fin.

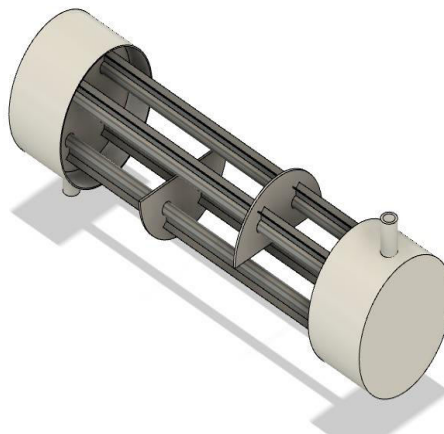


Fig. 2: 3D view of shell and tube one y shaped fin.

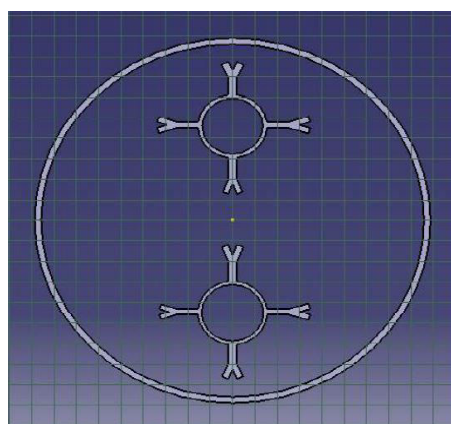


Fig. 3: 2D model of shell and tube with 4 Y shaped fins.

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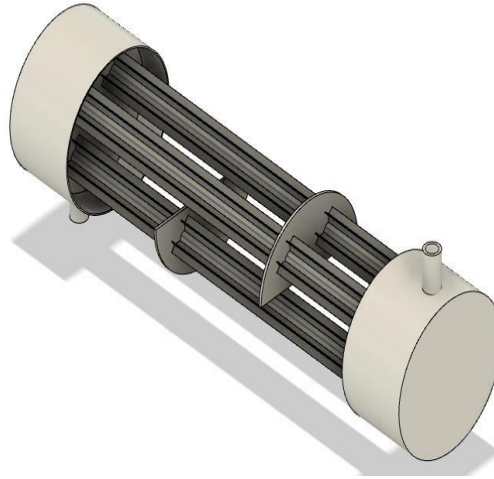


Fig. 4: 3D view of shell and tube with 4 Y shaped fins.



Fig. 5 : 3D view of Y shaped fin.

The above drawn design of the shell and tube with 4 Y shaped fins is more faster in cooling the fluid and it has more thermal efficiency compared to the shell and tube heat ex-changer without fins. When the thermal efficiency of the heat ex-changer increases it results in the cooling the fluid faster and help the industry to increase their production. Heat ex-changers are used in many different types of applications, such as power generation in power plants, refrigerator and in air conditioning systems, food processing and chemical industries, car radiators etc. Shell and tube heat ex-changer are used in a wide range of applications. In this study the heat transfer fluid is water. There is an inlet for the enter of the cold water and another for the enter of the hot water. Using the electric water heater hot water is produced. There is two outlet for the outward of hot water and cold water.

The first test that conducted is the shell and tube heat ex-changer without fins. At that time itself the velocity flow rate is also find. The tubes and fins used is the steel. Welding is done for making the Y shaped fins, sheets of steel are kept in shape of Y and joined it by using the welding. Welding does not melt the work piece so that small and thin sheets can be joined using the welding. The steel tubes and the Y shaped fins are also joined by the method welding. After joining the Y shaped fins various test are conducted as tube with two, three, and four fins. The temperature is measured by using digital temperature sensor. Four temperature sensors are used to identify the hot water inlet, discharge temperature and cold water inlet and discharge temperature.

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From the experimental testing it got to know that the four Y shaped fins used testing show more thermal efficiency compared to the three Y shaped fins, the two Y shaped fins and without fins.

V. CONCLUSION

The shell and tube heat ex-changer were examined both having and without fins with various temperatures. The Y shaped fins fixed in the tubes is having more thermal efficiency compared to tubes not having the fins. The tests conducts proves that the Y shaped fins can give high efficiency. With the use of Y shaped fins help to reduce the melting time of PCM materials, It increases the life of PCM materials. The Shell and tubes are used in a variety of sectors, including quench oil cooling, hydraulic oil cooling, lubricating oil cooling, pulp and paper manufacturing, food processing, and chemical manufacturing. So according to our experimental project on increasing efficiency of Shell and tube will be helps the industries mentioned above.

REFERENCES

- [1] Abdeldjalil Belazreg, Aissa Abderrahmane, Naef A.A. Qasem, Ndolane Sene, Sahnoun Mohammed, Obai Younis, Kamel Guedri, Navid Nasajpour- Esfahani, Davood Toghraie Effect of Y-shaped fins on the performance of shell-and-tube thermal energy storage unit, 2022.
- [2] Xiaohu Yang, Fengfei Xu, Xinyi Wang, Junfei Guo, Ming-Jia Li, Solidification in a shell-and-tube thermal energy storage unit filled with longitude fins and metal foam: A numerical study, 2021.
- [3] A.K Rostami, D.D Ganji Selecting superior fin geometry among four suggested geometries for shell and helically coiled finned tube heat ex changers with numerical simulation and experimental validation, 2022.
- [4] Ahmed H.N. Al-Mudhafara, Andrzej F. Nowakowski, Franck C.G.A. Nicolleau, Enhancing the thermal performance of PCM in a shell and tube latent heat energy storage system by utilizing innovative fins, 2021.
- [5] Man-Wen Tian, Awatef Abidi, Shu-Rong Yan, Davood Toghraie, Mohamed Degani, Economic cost and efficiency analysis of the employment of inserting rods with helical fins in a shell and tube heat ex changer under magnetic field and filled with nanofluid, 2021.
- [6] Haonan Cheng, Tao Luo, Jiabang Yu, Xiaohu Yang, Yanhua Liu, Zhaolin Gua, Liwen Jin, Experimental study of a shell-and-tube phase change heat ex changer unit with without circular fins, 2018.
- [7] M. Alizadeh, R.U. Haq, M. Hamid, V.B. Nguyen, T.H. Truong, D.D. Ganji, Z.F. Tian, An analysis of latent heat thermal energy storage in a hexagonal triplex-tube unit with curve shape fin and CNTs, 2022.
- [8] Balaram Kundu, Beneficial design of unbaffled shell-and-tube heat ex changers for attachment of longitudinal fins with trapezoidal profile, 2018.
- [9] Xiaohu Yanga, Fengfei Xua, Xinyi Wang, Junfei Guo, Ming-Jia Lib, Solidification in a shell-and-tube thermal energy storage unit filled with longitude fins and metal foam: A numerical study, 2022.
- [10] Ahmed H.N. Al-Mudhafara, Andrzej F. Nowakowski, Franck C.G.A. Nicolleau, Enhancing the thermal performance of PCM in a shell and tube latent heat energy storage system by utilizing innovative fins, 2022.