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A Review on Study of Shell and Tube Heat Exchanger

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ABSTRACT

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Heat exchangers are used in a variety of industrial and technical settings. The design of heat exchangers is fairly sophisticated, since it necessitates an accurate study of heat transfer rate and pressure drop estimates, as well as considerations like as long-term performance and cost. Whenever heat transfer inserts are employyed, Along with the rise in heat transfer rate, the pressure drop increases as well. The pressure has risen.Energy conservation is critical for both industrial development and environmental impact reduction. Because of current energy prices, the need for energy conservation is rising. More resourceful gadgets can help reduce energy costs. In the refrigeration, automotive, chemical, and process sectors, heat exchangers are the most significant device. As a result, there is a demand in the industrial sector for heat exchangers that are less expensive, more efficient, and smaller. Inserts in channels are widely employed as part of a passive heat transfer augmentation technique.

Keywords: Shell and Tube Heat Exchanger, Parameters, Performance, Economic Evaluation.

I. INTRODUCTION

A heat exchanger is a device that allows heat to be transferred between two fluids that are at different temperatures. Due to its diverse structure and usage in heat transference processes for creating conventional energy, such as condensers, heaters, boilers, or steam generators, heat exchangers are widely employed in industry. They have enough surface area for heat transmission, and their mechanical and thermal properties allow for high pressure and high temperature operations[1].

The most popular and widely used basic heat exchanger configuration in industry is shell and tube heat exchangers in different construction modifications. The number of shell and tube passes involved in a shell-and-tube heat exchanger is categorised further. For high-pressure applications, shell and tube heat exchangers are commonly employed. The secondary fluid flows through the shell and over the tubes' surface when the tube bundle is put within a shell. This design of heat exchangers is commonly employed in nuclear engineering, as in the case of steam generators, which transform feed water into steam from heat produced in a nuclear reactor core. The heat exchange surface must be larger to increase the amount of heat transferred and the amount of power generated. The fluid enters the tube side of the exchanger through the front header. The Stationary Header is a term that is occasionally used to describe it.In exchangers with several tube side passes, the rear header is where the tube side fluid departs the exchanger or is returned to the front header.Tube bundle—consists of tubes, tube sheets, baffles, and tie rods, among other things, to keep the bundle together.The tube bundle is kept in the shell[2].

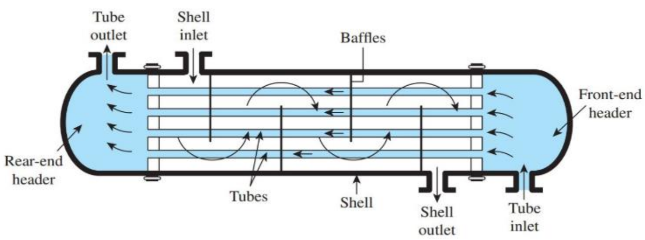

Figure 1: Schematic of heat exchanger[2]

In refrigeration systems, the vapour compression mechanism is commonly employed. The vapour compression cycle is used in this refrigeration system. The smooth execution of this cycle necessitates the inclusion of external labour.The Vapour compression refrigeration technology, which has a high coefficient of performance, is used in the majority of residential refrigerators. Components of the system include the compressor, condenser, expansion valve, and evaporator. The effect of all system components has an impact on the system's performance. By replacing the typical condenser with a micro channel heat exchanger, the performance of different condensers may be compared by varying the pressure and the COP of a vapour compression refrigeration system. Varied condensers have different heat transfer rates as a result of pressure variations[3].

The performance of heat exchanger is depending on different parameter. The design of heat exchanger depends on the use, area availability, space required, and rate of heat transfer and depends on the working fluid. In order to increase the performance of heat exchanger different input parameters and boundary conditions were enhance or optimize. In order to increase the heat transfer rate different flow pattern were used. Here in this work tube type heat exchangers are selected for the present research it has a plain finned tube configuration[4].

II. LITERATURE SURVEY

The author of this work has recognised the numerous types of heat exchangers utilised in the process sector, as well as their benefits and drawbacks, and has ultimately established the crucial characteristics linked to heat exchangers. Double pipe heat exchangers, shell and tube heat exchangers, plate heat exchangers, spiral plate and tube heat exchangers, and air cooled heat exchangers have all been investigated by the author. Author also used CFD to simulate heat exchangers and calculate temperature and pressure distribution in heat exchangers, concluding that heat exchangers are made to meet the demands of processes such as cool heaters, and evaporators, and that process conditions play an important role in heat exchanger selection[5].

When compared to other heat exchangers, shell and tube heat exchangers offer a larger area of heat transmission. Shell and tube heat exchangers are commonly employed to transfer heat between two liquids with high densities. In this study, we experimented with nano fluids in a shell and tube heat exchanger. Nano fluid is made up of 100 nano meter nano particles suspended in a base fluid. Metals, carbides, and oxides are the most common micro particles, whereas ethylene glycol, water, and oil are the most common base fluids. Many experiments have been carried out in order to improve the heat transfer rate in heat exchangers by using nano fluids.The use of nano fluids to enhance heat transfer rate is dependent on the type of nano particle used, its concentration in the base fluid, and the size of the nano particle. The focus of this study was on the evaluation of convective heat transfer coefficients, exchanger efficacy, and total heat transfer coefficients in shell and tube heat exchangers. The major goal of this study was to see how well the plate heat exchanger performed with these settings and a parallel flow configuration. Convectional fluid is commonly utilised as a working fluid in heat exchangers in industry. According to the findings, the heat transmission capability of nano fluids is greater than that of convectional fluids.As a result, utilising nano fluids as the working fluid in a heat exchanger will improve the heat transfer rate capabilities. Water was used as the working fluid at the commencement of the study. The nano fluids performed the best in the experiment, according to the results[6].

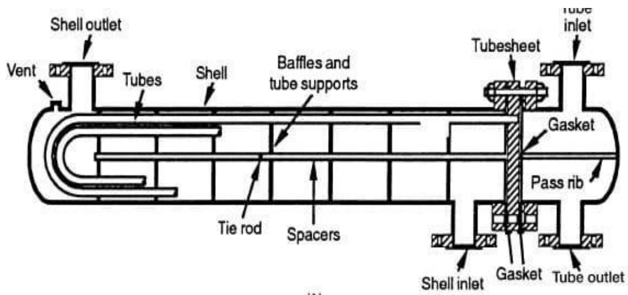

Figure 2: Internal Classificationof heat exchanger[6]

The author has included all of the shell and tube heat exchanger's design parameters in this work since they are important in the industry for heating, cooling, condensing, and pre-heating, and they are also frequently used in the refrigeration and air conditioning industries. The cost of a heat exchanger is mostly determined by the area required for heat transmission, and in this differential evaluation, the most cost-effective design of a shell and tube heat exchanger was chosen[7].

The author has addressed the performance of shell and tube heat exchangers in this work, since shell and tube heat exchangers play a critical role in industries for cooling and heating. Also, how the kind and direction of baffles affects the performance of shell and tube heat exchangers. More study on exchanger parameters such as tube diameter, working fluid, baffles, and shell diameter is needed. To make it more cost effective, a shell and tube heat exchanger will undoubtedly provide encouraging results[8].

The author of this paper investigated the baffles plates with different orientations used in heat exchangers to improve the performance of heat exchangers. He discovered that if segmented baffles are inclined rather than at 0° with sealing strips, the exchanger can provide better heat duty and improved performance, as well as less fouling and low pressure drop than an exchanger without such an arrangement[9].

The thermal performance, pressure drop, and direction of fluid flow are the main aspects to focus on while evaluating the performance of a heat exchanger in this study. The author of this research gives numerical calculations and simulations on baffles, such as single segmental and helical baffles. And it demonstrates how they affect pressure drop and heat transfer rate. This comparison shows that helical baffles are more effective than single segmental baffles because single segmental baffles form a dead zone, which reduces heat transfer rate and increases pressure drop, whereas helical baffles have fewer dead zones, resulting in lower pressure pressure drop and thus lower pumping costs increases the overall efficiency of the system[10].

Figure 3: BAFFLES[10]

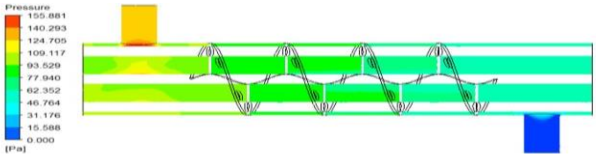

Figure 4: Pressure And Temperature Distribution In Heat Exchanger[10]

The author has looked at the basic design factors and equations for heat exchangers, as well as the relevance of heat exchangers in the chemical industry, in this study. Using computer numerical calculations and diagrams, the author has explored the design of two fluid heat exchangers. We may utilise the same design process for recuperator and regenerators, according to this research[11].

The author of this paper has developed an economic simulation model of heat exchangers for all flow patterns (co-current, counter-current, and cross-flow) using different inlet and outlet flow conditions obtained from static simulation, the NTU (number of transfer unit) method, and minimum heat capacity values, and then uses those values in economic simulation. For heat exchangers, he calculated the economic relationship between effectiveness and expenditure coefficient. He came to the conclusion that in cross flow, if the outlet flow conditions are known, the efficacy of the heat exchanger can be estimated using thermal calculations; otherwise, we can only use mathematical linear equations to determine the effectiveness of the heat exchanger. The same may be said for the other two flow patterns. As a result, using static simulation and thermal computation to get the results is a simpler procedure[12].

An increase or improvement in energy savings is always a major aim for the industrial sectors to attain. Because of the present energy prices, the need for energy conservation is growing. In the refrigeration, automotive, chemical, and process sectors, heat exchangers are the most significant device. In the industrial industry, there is a desire for cost-effective, more efficient, and smaller heat exchangers due to the danger of rising energy consumption. As a result, this article presents a detailed analysis of the experimentation as well as computations based on the experiment. This experimental examination of heat exchangers and their calculations aided in the development of some efficient and more effective new basics that may be utilised in the future to preserve heat and save energy. There is potential for growth in the future[13].

Heat exchanger design is a time-consuming process. Apart from the difficulties of long-term performance and economics, it necessitates a precise examination of heat transfer rate and pressure drop calculations. To keep the equipment as small as possible while yet achieving a high heat transfer rate with little pumping power. For heat transfer enhancement, such strategies are effective. Several strategies have been presented in recent years to obtain a desired heat transfer rate in an existing heat exchanger while using little pumping power, and are discussed in this work. All of the computations are specified using the classic Dittus Boelter equation, which states that when re grows, nu increases, and h increases as well. Because at larger flow rates, these values of the computations continue to rise with Reynolds number[14].

The heat transfer tube was analysed in this article using various parameters. The thermal analysis of shell and tube heat exchangers was performed in ANSYS utilising varied thermal loads and streams of water and steam. The computation was done in C code, which is useful for thermal analysis. Various materials have compared and contrasted different thermal materials. According to the findings, steel has a superior shell structure than cooper for tubes and baffles. The LMTD and surface area change as the water temperature rises. When the fouling factor of the oil increases, the total heat transfer coefficient decreases[15].

The technique for specifying a design is a feature of heat exchanger design. Heat transfer area and pressure drops, as well as ensuring that the anticipated design meets all requirements. This paper explains how to construct a shell and tube heat exchanger, which is the most common type of liquid-to-liquid heat exchanger. Design considerations in general and This document also includes illustrations of the design process. HTRI software is used to check manually calculated values in design calculations result. Following an examination of the literature, it can be determined that. As the fluid flow rate in the shell and tube heats up, the pressure drop increases.Pumping power is increased by using a heat exchanger.The genetic algorithm has a huge impact.when compared to the previous designs, there is an improvement in the optimal designs in comparison to classic designs Algorithm with genetics a programme for calculating the global minimum The cost of a heat exchanger is much lower, and offers a distinct advantage over other approaches in terms of obtaining several high-quality solutions As a result, the designer has additional options. It also shows that, in comparison to the genetic algorithm, the harmony search method can converge to the best solution with greater precision.Tube pitch ratio, tube length, tube layout, and baffle spacing ratio have all been identified as critical design elements that have a direct impact on pressure drop and produce a conflict between effectiveness and total cost.In summary, effective thermal design for shell and tube heat exchangers must be evaluated in order for industries to run at a low cost[16].

III. CONCLUSION

In this study, the many types of heat exchangers used in industry are addressed, as well as the criteria for selecting device based on performance, function and the economic aspect. Depending on the process parameters, they are built as condensers, evaporators, or heaters. After identifying widespread applications in industry, several researchers chose shell and tube heat exchangers as a key area to research. The performance of these heat exchangers was improved by altering various parameters using numerical and experimental simulations. Other parameters included baffles, baffle spacing, baffle angles, tube diameter, working fluid, and others. The results were encouraging, and the efficiency of shell and tube heat exchangers improved dramatically. According to their intended applications, shell and tube heat exchangers must be made less expensive and more efficient. There are several factors in shell and tube heat exchangers on which additional research may be done. Because of this, the attention may be mostly on baffles. And also the effectiveness of the heat exchanger in case of counter-current flow can be equal to 1 when we provide the ideal conditions because maximum possible heat transfer rate can be equal to the actual heat transfer rate since the temperature change not exceeds the pinch point condition, but in case of the parallel flow in shell and tube heat exchanger pinch point condition exceeds thus the effectiveness of the heat exchanger in case of parallel flow should be less than 1.

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