Review of Literature on Heat Transfer Enhancement in Heat Exchangers

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Abstract

Heat exchangers are extensively discussed in this study as a means of improving heat transmission. There are several advantages to enhancing heat transfer through Process Integration. To put it another way, a "heat exchanger" is the device which transfers heat from one liquid or gas to another without requiring that two fluids mix or to come into the contact directly. Everywhere we look, we could see heat exchangers at work, whether it's to heat or cool the buildings, or to improve the performance of equipment and motors. In this paper you will get to know about types of heat exchangers in brief.

Keyword: Heat exchanger, types of heat exchanger, shell and tube heat exchanger, Double pipe heat exchangers, Plate heat exchangers, Condensers, Evaporators

Introduction

As a device for exchanging thermal energy, a heat exchanger may be used to transport heat from one fluid to another, in between solid particles and fluid or between the two fluids which are both at different temperatures and in the thermal contact. No external heat and work exchanges are normally present in the heat exchangers. Examples include the heating or cooling of the fluid stream of interest and the evaporation or condensation of the single or the multi-component streams of the fluid. Sterilization, pasteurization, fractionation, distillation, concentration, crystallization, or control of a process fluid might be the goal in various applications. Heat exchangers with direct contact between the heat-exchanging fluids may be found in certain cases. Transient heat transmission into and out of the wall or dividing wall is typical in most heat exchangers. Ideally, the fluids in the heat exchanger should not mix or leak since they are separated by the heat transfer surface. Direct transfer exchangers, or simply "recuperators," are the most common form.

A term "indirect transfer type" or merely "regenerators" refers to the heat exchangers that use thermal energy storage and release via an exchanger surface or the matrix in order to perform the intermittent heat exchange. Because of the pressure differences and the matrix rotation or valve switching, these exchangers often exhibit fluid leakage through one fluid stream to another. Shell-and-tube heat exchangers, vehicle radiators, air preheaters, evaporators, condensers, and also cooling towers are common types of the heat exchangers. An exchanger in which no phase change happens in any of its fluids is called the sensible heat exchanger. A heat exchanger may have internal thermal energy sources, like electric heaters and nuclear fuel components. In fired heaters, boilers, and also the fluidized-bed exchangers, combustion and chemical reactions may occur. Some exchangers, like agitated vessels, the scraped surface exchangers, and the stirred tank reactors, might need mechanical devices.

A "heat exchanger" is the device designed to transfer the heat from one medium to other in an effective manner. A substantial wall might keep the media apart, or they might be in close proximity.

Space heating, cooling, and air conditioning, and petrochemical, chemical, and petroleum refinery operations, and processing of natural gas and sewage, all make use of them. Coolant passes through the radiator coils and air moves through coils, cooling the coolant while heating the incoming air. This is the most common heat exchanger used in the internal combustion engine.

Types of heat Exchangers

There are the variety of the heat exchangers to choose from, depending on the design parameters outlined above. Several of the most often used versions in the industry include:

1) Shell and tube heat exchangers
2) Double pipe heat exchangers
3) Plate heat exchangers
4) Condensers, evaporators, and boilers

Shell and Tube Heat Exchangers

This kind of the heat exchanger is referred to as a shell and the tube heat exchanger. A frequent heat exchanger in oil refineries and other major chemical processes, its design is well-suited to high-pressure environments. This form of the heat exchanger has a shell (a huge pressure vessel) with the bundle of tubes within it, as the name indicates. It is the very efficient heat exchanger. Heat is transferred between the tubes and the shell by a second fluid that passes over them (via the shell). There are several sorts of tubes that make up a tube bundle, including longitudinally finned, plain, and so on.

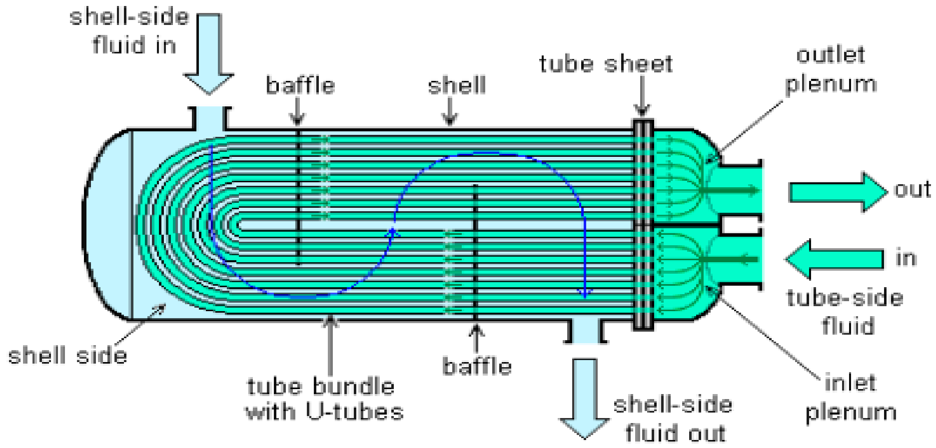

Figure 1: Shell and tube heat exchanger

A heat exchanger is used to transfer heat between the two fluids of the different temperatures. One travels through the tubes, while the other travels outside tubes but still inside the shell. It is possible to transmit heat from a tube side to shell side or another way around. Depending on fluid, it may be either liquid or gaseous. A broad heat transfer area necessitates the employment of several tubes in order to effectively transport heat. As a result, unused heat energy may be put to good use. This is an effective method for reducing energy use.

Parts of shell & tube heat exchanger include:

1) **Front Header**—fluid enters exchanger's tube side. The term "Standard Header" is occasionally used to describe it.
2) **Rear Header**—tube side fluid exits the exchanger or returns to front header in the exchangers with several tube side passes at this location.
3) **Tube bundle**—Bundle securing devices such as tie rods or tube sheets are included here.
4) **Shell**—A tube bundle is included in this package.

Double pipe heat exchangers

Figure 2 is worth a closer look. The inner tube is carrying a hotter flow, whereas an outer shell is holding the colder flow. The inner pipe wall of twin pipe heat exchanger is built of the conductive material like steel or aluminium, and this allows heat from one flow to be transferred to the other. Counter flow, in which fluids flow in opposing directions, is a common use for the twin pipe heat exchanger. The concentric tubes of twin pipe exchangers allow for true counter flow, and the designers take benefit of this to maximise heat transfer coefficient of system. Parallel flow may also be employed, however counter flow is frequently most thermally efficient mode of operation.

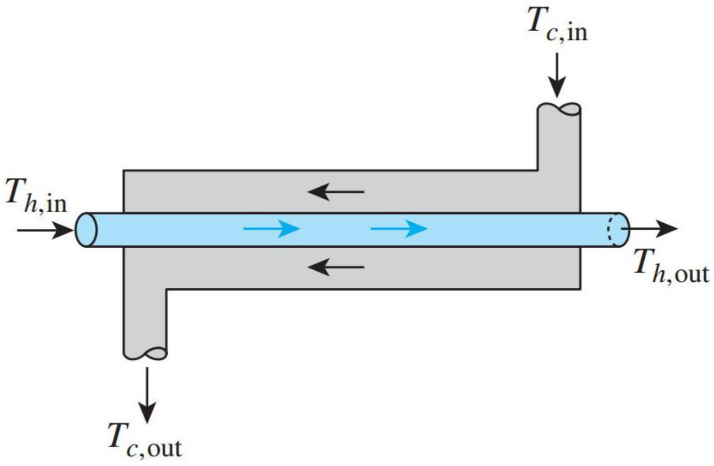

Figure 2: Double pipe exchangers are shown in the simplified schematic diagram. There is a left-to-right movement of inner fluid (blue), yet an upward movement of outer fluid (grey).

High temperatures and the high pressures are no problem for the double pipe exchangers since for their simple design and ability to expand easily. For example, if cold flow's outflow temperature is higher than hot flow's outflow temperature (Tc,out), the temperature cross occurs (Th,out). Temperature cross might well be beneficial for certain applications, while other designs, like the, are unable to accomplish this.

The tiny, modular form of the twin pipe heat exchanger makes it ideal for use in areas where traditional shell and the tube heat exchangers are either unsuitable or too costly. Double pipe exchangers may be connected in either series or parallel to boost the system's heat transfer rate. Additionally, fins and U-bends may be added to maximise heat transmission, rendering these devices adaptable, simple to repair and modify, and extremely successful at their task.

Plate heat exchangers

In the plate heat exchanger, the metal plates are used to transfer the heat from one fluid to another. When compared to a typical heat exchanger, this has the significant benefit in those fluids being exposed to a significantly wider surface area. This aids in the transport of heat and speeds up temperature change significantly. “Small brazed plate heat exchangers" are increasingly commonplace in millions of the combination boilers' hot water sections. As a result of their compact size and great heat transfer efficiency, the combination boilers are now able to produce more "domestic hot water".

It has had a major influence on household heating and the hot water. Brazed plates are used in larger commercial versions and gaskets in smaller ones. Using pipes or the other containment containers, heat exchangers heat or cool the fluid by transferring the heat from one fluid to the another. As a rule, the fluid exchanger is made by passing one fluid through another in the coil. While the bigger chamber's outside casing is often composed of plastic or covered with the thermal insulation, pipe's walls are typically constructed of metal or another material that has the high thermal conductivity to assist the exchange.

Figure 3: Plate heat exchanger

In 1923, Dr. Richard Seligman devised “plate heat exchanger”, which revolutionized the indirect heating and cooling technologies. It was formed in 1910 by Dr Richard Seligman as Aluminium Plant and Vessel Company Limited, the specialized fabricator for the brewing and the vegetable oil industries that supplies welded vessels. Heat exchangers, such as plate heat exchangers, have been around for some time now. German companies Langem and Hundhanssen received one of the earliest patents in 1890. The process, dairy, paper or pulp, and HVAC sectors have all employed this sort of exchanger in past with great success. The primary goal of this study is to point future researchers in the direction of PHE, a topic on which the present industry is woefully underinformed. Although they are used on a daily basis in HVAC and refrigeration sector, such evaporators are not regulated in any way.

Boilers, evaporators, and condensers

The boiling or the condensing fluid solely on a single side of an evaporator, boiler, or condenser is exchanged with either the single-phase or the two-phase flow on another. Approximately 60% of entire industrial heat exchangers employ the two-phase flow paradigm for their operation. Air conditioning and refrigeration systems, and power generation and process equipment, all make use of them. Different kinds of boilers and vaporizing exchangers and condensers are all examples of the two-phase-flow equipment. The process function, construction type, and the heat transfer procedure may all be used to categories such heat exchangers. Application, heal transfer methods, flow arrangements, fluid phase number, and the number of fluid phases.

Literature Review

(Bhagwan, 2021) A heat exchanger is the piece of equipment designed to efficiently transfer heat between two different media. A complete wall might very well be used to keep the media from ever mixing or coming into touch with one another. Heating, cooling, air conditioning, refrigeration, and power generation facilities all rely on the heat exchangers for a variety of applications. The radiator in an automobile serves as an illustration of heat exchanger since it uses water to transfer the heat from hot engine cooling fluid to air passing through it.

(Sohoni, 2013) The current paper is the review of early studies on the improvement of heat transmission by ribs installed in duct. In order to create the heat exchangers that are both highly efficient and low-cost, heat transfer improvement has become a popular research area among engineers. Industrial heat exchangers have long made use of numerous heat transfer improvement methods such dimples, rib tabulators, pin fins, and swirl chambers to help save energy. The most often used method for improving heat transmission is to connect ribs to a flow route. Ribs, on the other hand, are very versatile and may be used in a wide range of sectors. Circular and rectangular, segmented, and triangular ribs, and V-ribs, were used to increase the heat transmission rate (broken and simple v-ribs). Due to its influence on the bubble separation and kinetic energy output, the form of the rib has a significant impact on heat transfer enhancement. Using a variety of rib kinds, heat transmission is enhanced by the number and height of the ribs, and a variety of rib combinations.

(Prof et al., 2021) Due to technical advancements, we've had difficulty satisfying cooling demand in last several decades. This article provides a detailed discussion of current developments in design of the heat exchangers. In order to improve the heat transfer efficiency in the heat exchangers, more work is being done. In order to increase the range of available heat transfer calculation techniques, a thorough review of literature on design methodology is conducted. In order to do more in-depth study on the heat exchanger design, this article reviews and critically analyses previous studies that have been published on the subject.

(Kurnia & Sasmito, 2019) As the name implies, the primary goal of this research is to determine whether or not PCMs can effectively smooth out the variable output temperatures of a two-tube heat exchanger. It is used to evaluate conjugate heat transfer in between PCM and heat transfer fluid within a tube heat exchanger under variable intake temperature conditions. A conjugate heat transfer between the "heat transfer fluid" and PCM within heat exchanger is investigated using the "computational fluid dynamics" mod l that has been developed, verified, and tested. It was determined that the melting temperature of the three organic PCMs, n-Eicosane (C20H42), n-octadecane (C18H38), and myristic Acid (CH3(CH2)12COOH), had a significant impact on PCM performance.

In a literature, the district heating networks are often mentioned as among the best ways to reduce the heat exchanger. It was shown that melting temperature of the organic PCMs n-eicosane (C20H42), n-octadecane (C18H38),and myristic acid (C3(CH2)12COOH), had a significant impact on how well PCM-based thermal capacitor performed. It was also studied the influence of heat transfer fluid inlet Reynolds number. Building sector greenhouse gas emissions have been confirmed by the study's findings. These devices need hefty expenditures, but PCM's use as the heat smoothing device pays for itself in the long run . As sales rise, so does the variability in outlet temperature. Thermal capacitor predicts that future heat demand may be reduced as a result of altered climatic conditions and building refurbishment programmes. In addition, the influence of the heat transfer fluid inlet Reynolds was examined. The results show that the Reynolds number at the intake has the potential to rise. Choosing a PCM with right melting point is essential to ensuring the successful application and extending return on investment. PCM as a device for easing. Furthermore, the variation in the output temperature was observed to decrease an inlet Reynolds number increased. For a thermal capacitor use of PCM, selecting PCM with the melting points that are acceptable is critical.

(Rather & Yadav, 2019) Heat exchangers made of shell and tube are briefly discussed in this study. Heat exchangers made of tubes and shells are widely used in industries for both cooling and heating. STHXs' performance has been improved several times throughout the years. Baffle kinds are the primary focus of such efforts. The variety of baffle types and baffle angles opens up a wide range of possibilities. Baffles may be configured in a variety of ways to achieve various outcomes at different points in their lifespan. STHXs still have a long way to go before they reach their full potential. STHX may be tweaked in a variety of ways. This document provides a summary of the successful revisions that have left adequate traces for future revisions.

Conclusion

According to research published on the heat exchanger design, the majority of studies have used a variety of various designs. All aspects of the heat exchanger performance would improve if the design is correct. The optimization of a large number of design factors is noted in overall study paper, and not one paper takes an alternative heat transfer fluid to water into consideration. Heat exchangers with two pipes are used in both industrial and commercial settings. Heat exchange rates may be analysed in more detail if tube's diameter and material are altered.

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