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"A REVIEW ON PLATE TYPE HEAT EXCHANGER FAILURE "

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ABSTRACT

Heat exchangers are one of the most important heat transfer apparatus that find its use in industries like oil refining, chemical engineering, electric power generation etc. Plate type of heat exchangers has been commonly and most effectively used in Industries over the years. Plate heat exchangers are used regularly in the heating, ventilating, air conditioning, and refrigeration industry. There is an urgent need for detailed and systematic research regarding heat transfer and the fluid flow characteristics of these types of exchangers. As an initiative in this respect, a literature search is presented on plate heat exchangers. New correlations for evaporation heat transfer coefficient and friction factor are introduced, which are applicable to various system pressure conditions and plate chevron angles. This review paper presents the work of various researchers on the heat transfer enhancement of plate type heat exchanger.

Key Words: *Heat transfer, Plate heat exchanger, Design.*

I. INTRODUCTION

A plate heat exchanger is a type of heat exchanger that uses metal plates to transfer heat between two fluids. This has a major advantage over a conventional heat exchanger in that the fluids are exposed to a much larger surface area because the fluids spread out over the plates. This facilitates the transfer of heat, and greatly increases the speed of the temperature change. Plate heat exchangers are now common and very small brazed versions are used in the hot-water sections of millions of combination boilers. The high heat transfer efficiency for such a small physical size has increased the domestic hot water (DHW) flow rate of combination boilers. The small plate heat exchanger has made a great impact in domestic heating and hot-water. Larger commercial versions use gaskets between the plates, smaller version tend to be brazed. The concept behind a heat exchanger is the use of pipes or other containment vessels to heat or cool one fluid by transferring heat between it and another fluid. In most cases, the exchanger consists of a coiled pipe containing one fluid that passes through a chamber containing another fluid. The walls of the pipe are usually made of metal or another substance with a high thermal conductivity, to facilitate the interchange, whereas the outer casing of the larger chamber is made of a plastic or coated with thermal insulation, to discourage heat from escaping from the exchanger. The plate heat exchanger (PHE) was invented by Dr Richard Seligman in 1923 and revolutionised methods of indirect heating and cooling of fluids. Dr Richard Seligman founded APV in 1910 as the Aluminium Plant & Vessel Company Limited, a specialist fabricating firm supplying welded vessels to the brewery and vegetable oil trades. Plate heat exchangers (PHEs) are not a new concept or technology. One of the first patents was issued in 1890 to Langem and Hundhanssen, a German company. In the past, this type of exchanger has been successfully used in industries such as dairy, process, paper/pulp, and heating, ventilating, and air conditioning (HVAC). The main purpose of this article is to direct potential researchers to the subject of PHE, because current industries lack fundamental information about them. These types of evaporators are being used in the heating, ventilating, air conditioning, and refrigeration (HVAC&R) industry on a regular basis, yet there is no guidance whatsoever. The objective here is to present the current.

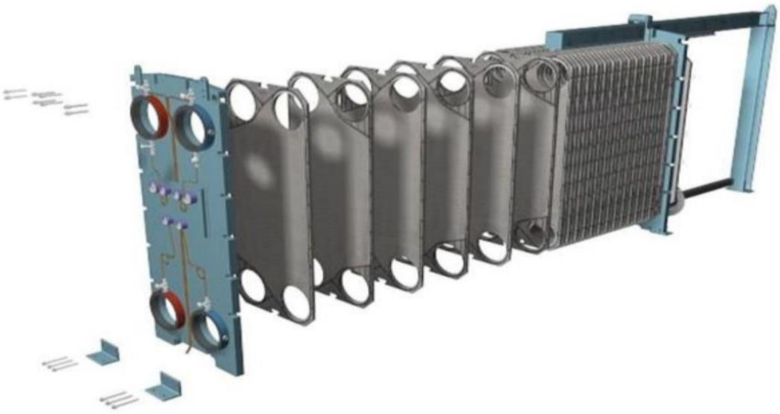

Figure 1: Plate Heat Exchanger

II. LITERATURE REVIEW

Following the research of SalmanAl zahrani et al. [2021] [1] Generally speaking, the thermal performance of plate heat exchangers is enhanced by using a range of Reynolds numbers. The efficiency of heat exchangers is calculated numerically using computational fluid dynamics (CFD) (HEs). Experiments demonstrate that a 20% increase in heat transfer rate may be achieved simply by changing the Reynolds number.

Dan Zheng et al. [2021] did the study. [2] In this investigation, we use a plate heat exchanger filled with ferrofluids to observe the effects of varying magnetic fields on heat transfer. The Fe3O4 nanoparticles used to make ferrofluid have a diameter of only 20 nm and are suspended in di-water. Even though the ferro fluid particles were just 0.1 nm in size, they nevertheless managed to increase the plate heat exchanger's overall thermal performance.

D.K. Rabha et alstudy .'s supports this idea. [2021.] [3] One aspect of this study was the construction and evaluation of a prototype passive-combined-active dryer that incorporated a biomass fired-heater and a plate heat exchanger. Drying chamber, biomass combustion chamber, and vertical plate heat exchanger together make up the improved drier. Passive plate heat exchangers are 35% more efficient than their active counterparts.

Researchers WenzheLi, et al .[2021] [4] A stop plate is defined, and its effect on heat transmission in brazed plate heat exchangers is theoretically analysed. For the purpose of obtaining the governing equations, a strength balance analysis is performed on a very simple section of the stop plate. In these computer simulations, we employ a plate heat exchanger that has had stop structures added to improve fluid flow.

YanWu et al. [5] The researchers in this work have devised a speed correlation variant well-suited to PHEs. Given the dynamic nature of fouling, it is necessary to investigate it throughout the course of the whole process time horizon, which is then broken down into several time intervals. This approach utilises the SA algorithm, or Simulated Annealing, to achieve optimization goals. The impact of fouling on the plate heat exchanger was cut in half.

The research of WenzheLi et al .[2021] [6] The results of an experimental and numerical analysis of the single-section waft distribution within brazed plate heat exchangers are presented here; however, the results may be applicable to other designs including a plate-and frame or a plate-and-shell configuration as well. Strain profiles in the heat exchanger are analysed by probing the headers. It may be possible to ascertain the flow distribution by measuring the pressure drop across the channels and finding a link between the two variables.

Ngoctan Tran et al., 2021) [7] The current simulation method is tested using a reference set of experimental data before being put into practise. In order to mitigate the impact of meshing on simulation outcomes, an accurate meshing approach is developed. We examine the velocity, pressure, and temperature profiles in three dimensions to learn about the fury of the fluid flow associated with the heat transfer behaviours. These profiles are shown to get larger after being transferred via the wavy plate heat exchanger.

Mohammad ForuzanNia et al. [2021] [8] indicate that increasing the optical thickness from low to high values displays a sweeping behaviour in the thermal overall performance of PHE, demonstrating the importance of gas radiation to heat transfer speed. A significant increase in heat transfer rate may be achieved by increasing the radiation-conduction (RC) parameter. It is, however, feasible to ignore the new flue gas's radiative values at the Pressure Drop (Pa) without any loss of accuracy.

The evaluation findings show that the suggested model accurately fits the experimental outcomes, as reported by MihaBobi et al. [9]. The findings of thermal imaging investigations may shed further light on the temperature distribution and the path of the temporary front along the fluid glide channels. To reliably predict the thermal fatigue existence-time of brazed plate heat exchangers, future research will require an experimental technique like this one. Additionally, the IR thermography-derived 2D local Heat transfer coefficient (W/m2K) distribution must be included into the proposed theoretical model.

This article's stated goal is to provide a numerical technique for thermal modelling of a PHE that accounts for the effect of maldistribution, as stated by HosseinShokouhmand et al. [10]. Experiments may be done to demonstrate the results of the proposed technique. The findings suggest that considering how one flows with the flow might significantly improve one's ability to make accurate predictions.

In addition, a parametric test was utilised to analyse the effects of these factors on PHE efficiency, and a wider plate supply is made available as heat transfer is enhanced by channel flow distribution. (2020) Chan, Lee, and colleagues [11] In a plate heat exchanger (PHE), the frictional Pressure Drop and port alter for both the single- phase flow of supercritical CO2 and the two-phase flow of R1234ze depending on the flow direction, number of channels, temperature, mass flux, and vapour quality (E). Supercritical CO2 flows as a single phase, whereas R1234ze(E) flows as a biphasic mixture. The resistance to flow through the channel guide in the PHE is directly proportional to the port-Pressure Drop. In a single-phase flow of supercritical CO2, the port-Pressure Drop is proportional to the number of channels and the Reynolds number, but the frictional Pressure Drop is practically independent of the number of channels.

A set of guidelines for investigating multistream heat exchangers was created in 2010[12] by Indranil Ghosh and colleagues. The effectiveness of the algorithm was confirmed by testing it on many real-world cases, including as a two-stream exchanger with external heat leakage, a three-stream exchanger, and a four-movement exchanger.

The drift and thermal properties of various fin designs, including the offset-strip fins, were studied numerically by Kim et al. (2011)[13]. They linked the fins' offsets to a blockage ratio of over 20%, suggesting the design choice was deliberate.

For the purpose of estimating the performance of a plate fin-and-tube heat exchanger, Ding et al. (2011)[14] developed a well-liked statistical framework of circuit topologies, as well as a preferred tube-via-tube simulation version and code. Heat Transfer included an article with the findings of these studies. The method was used to forecast the performance of a realistic condenser with a complex circuit, and the simulation results were analysed.

Lu et al.(2011)[15] examined the geometric parameters of a two-row fin-and-tube heat exchanger and then assessed the heat exchanger's overall performance. When the fin pitch was reduced, stress was reduced even more than heat transmission. Scientists found that when they increased the airflow through a fin-and-tube heat exchanger, the device was able to transfer more heat overall.

To determine the impact that adjusting plate fin heat exchanger operating parameters had on performance, Patil and Rathod (2012)[16] used computational analysis. We modelled the critical dimensions of a plate-fin-go-waft heat exchanger in a steady state in MATLAB. The effectiveness of the heat exchanger has a considerable effect on the size of the core. Reduced efficiency like this makes the impact of the mass-to-flow-rate ratio trade-off at float lengths look trivial by comparison. Heat may be transferred from one fluid to another with the help of a plate heat exchanger, which uses metal plates to do the job. Due to its great strength, excellent thermal stability, and low susceptibility to corrosion,stainless steel is the standard material for manufacturing metal plates. The primary functioning concept is relatively simple, despite the fact that the channels generated between the plates and nook openings are constructed in such a manner that the two fluids flow through alternating pathways. For optimal efficiency, heat is transferred from one set of channels to another through a thin plate, which in turn generates a complete counter cutting-edge glide. There will be no risk of fluids mixing with one another or escaping into the environment thanks to the gaskets that surround the plates and seal the device.

Using multiple motions of plate fin heat exchangers, Das and Ghosh (2012)[17] enhanced a heat exchanger with two flows. The design of two- movement exchangers made use of a number of different layout and simulation methodologies, including e-NTU and the LMTD method. Part of our CFD simulations have been completed.

Ben Saad et al. (2012)[18] were able to predict the stress drop characteristics of an offset strip fin heat exchanger. Two-segment input conditions and vertical up go with the flow were used to investigate the waft behaviour in a tiny heat exchanger. Because of the significant expenses of air drift, there is now more widespread homogeneity. Increasing the surface velocity of the gas caused the particles within the vacuum to become more evenly dispersed.

The CFD-CFD and CFD (common float down)-CFU (common float up) configurations were utilised by Sinha et al. (2013)[19] to improve the heat transfer of a plate-fin heat exchanger. And to get such results, they employed two rows of winglet-type vortex generators (VG). The Reynolds number range of 250-1580 was considered extensively during this investigation. The CFU-CFU arrangement is the most efficient in terms of heat transmission and first-rate product among the several kinds of arrangements in VG.

A titanium brazed plate-fin heat exchanger with offset strip fins was studied by Fernandez- Seara et al. (2013)[20] as one kind of liquid-liquid heat transfer system. They did a series of experiments to determine things like stress reduction and thermal conductivity. As a last resort, we used Wilson plot adjustments. They used empirical data to create a correlation that may be used to detect the existence of single-phase convection. To represent the heat transfer coefficient, which is a component of the Reynolds number, the symbol W/m2K is used. As waft velocity rose, the strain reduction improved in a quadratic way.

The relevance of this study is discussed in more detail below.

Verifying the CFD analysis of simulations produced by various model configurations of plate heat exchangers is the primary focus of the proposed research. This will be done by comparing and contrasting the findings of prior studies.
The goal here is to identify optimal configurations of plate heat exchanger models (such as waves, tapered plates, bubbled plates, and dimpled plates) for Reynolds numbers between 200 and 350.
The goal of this research is to compare the frictional pressure prop, input/exit port pressure props, and heat transfer coefficient across different plate heat exchanger types.
The goal is to predict the temperature profile, pressure, and velocity through a theoretical plate heat exchanger as a function of the fluid temperature ranging from 10 to 15 to 20 degrees Celsius.
After considering all important process parameters, the efficiency of the heat exchanger is determined by using the heat transfer coefficient (W/m^{2}K).

III. DESIGN OF PHE

The plate heat exchanger (PHE) is a specialized design well suited to transferring heat between medium- and low-pressure fluids. Welded, semi-welded and brazed heat exchangers are used for heat exchange between high-pressure fluids or where a more compact product is required. In place of a pipe passing through a chamber, there are instead two alternating chambers, usually thin in depth, separated at their largest surface by a corrugated metal plate. The plates used in a plate and frame heat exchanger are obtained by one piece pressing of metal plates. Stainless steel is a commonly used metal for the plates because of its ability to withstand high temperatures, its strength, and its corrosion resistance. The plates are often spaced by rubber sealing gaskets which are cemented into a section around the edge of the plates. The plates are pressed to form troughs at right angles to the direction of flow of the liquid which runs

through the channels in the heat exchanger. These troughs are arranged so that they interlink with the other plates which forms the channel with gaps of 1.3–1.5 mm between the plates. The plates produce an extremely large surface area, which allows for the fastest possible transfer. Making each chamber thin ensures that the majority of the volume of the liquid contacts the plate, again aiding exchange. The troughs also create and maintain a turbulent flow in the liquid to maximize heat transfer in the exchanger. A high degree of turbulence can be obtained at low flow rates and high heat transfer coefficient can then be achieved. The total rate of heat transfer between the hot and cold fluids passing through a plate heat exchanger may be expressed as:
$Q = UA\Delta T_m$ Where, U is the overall heat transfer coefficient,

A is the total plate area, and ΔT_m is the temperature difference. U is dependent upon the heat transfer coefficients in the hot and cold streams Applications o Power - Auxiliary cooling circuit isolation, co-generation applications, geothermal applications, lubrication oil cooling, diesel engine cooling, heat recovery. o HVAC - Cooling tower isolation, free cooling, heat pump systems, sea water isolation, thermal storage systems, pressure Interceptor.
o Marine - Seawater isolation exchanger, central cooling, jacket fresh water cooling, lube oil cooling, camshaft lube, oil cooling. Industrial Mining - Plating heaters & coolers, analyzing heaters & coolers, strike solution cooling, quench oil coolers, sulfuric acid, hydrochloric acid, hydrogen peroxide, titanium dioxide, chloride alkaline, soda ash, steel. Refinery - Brine cooling, crude oil/water interchanger, treated crude oil / untreated crude oil interchanger. Dairy - Milk pasteurization, milk reception, cultured milk treatment, UHT, cream pasteurization, ice-cream mix treatment, cheese milk heat treatment.

Advantages:

- Simple and Compact in size.
- Heat transfer efficiency is more
- Can be easily cleaned.
- No extra space is required for dismantling.
- Capacity can be increased by introducing plates in pairs.
- Leaking plates can be removed in pairs, if necessary without replacement.
- Maintenance is simple.
- Turbulent flow help to reduce deposits which would interfere with heat transfer.

Disadvantages:

- Initial cost is high since Titanium plates are expensive.
- Finding leakage is difficult since pressure test is not as ease as tube coolers.
- Bonding material between plates limits operating temperature of the cooler.
- Pressure drop caused by plate cooler is higher than tube cooler.
- Careful dismantling and assembling to be done.
- Over tightening of the clamping bolts result in increased pressure drop across the cooler.
- Joints may be deteriorated according to the operating conditions.
- Since Titanium is a noble metal, other parts of the cooling system are susceptible to corrosion.

IV. CONCLUSION

Various type of possible and cost effective technique of the heat transfer enhancement were presented in this literature review. It is clear the vortex generator technique is one of the promising approaches of heat transfer enhancement. Lot of work been carried out on various designs and use of simulation software made it easier. A review on the methods and analysis of different parameters of plate heat exchanger were carried by different method of analysis like experimental, numerical and simulation. The parameter considered here in this review paper are thermal–hydraulic performance, flow pattern, material and structure, pressure drop and heat transfer characteristics, fin geometry and heat transfer and pressure drop correlations. Still there is a strong need for proposing further techniques to improve the parameters in plate fin heat exchanger which will have a direct impact on operational cost, and last and not least the use of Nano fluids and their role in the design aspects of the exchanger, which is considered a new growing research area.

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