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Experimental Investigation of a Brazed Chevron Type Plate Heat Exchanger

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Abstract

Heat exchanger is an instrument used to transfer heat from medium of one fluid to another fluid. In this paper, an experimental setup for testing a chevron type brazed plate heat exchanger is utilized to investigate the thermal characteristics of the fluid. A numerical simulation as carried out a local element-by-element analysis utilizing e-NTU method as employed for simulating the heat exchanger. In this approach, Nusselt number is expressed in terms of friction factor which in turn, is given as a function of chevron angle of the heat exchanger. The experiment is performed by using various no of plates, several fluid flow rate and inlet &outlet temperature values. The experimental results are validated to numerical result of a brazed plate type heat exchanger. In a chevron type plate heat exchanger looks like compactness, so increased the overall heat transfer coefficient of fluid as compared to normal plate type heat exchanger. The main advantages of a chevron brazed type plate heat exchanger as occupy less space and cost wise reduced and then increase the heat transfer coefficient of a fluid, though with increased pressure drop.

Keywords: Brazed Plate Heat Exchanger, Chevron Type and Heat Transfer Characteristics

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I. INTRODUCTION

The plate heat exchanger (PHE) was invented by Dr Richard Seligman in 1923 and revolutionized methods of indirect heating and cooling of fluids. Plate heat exchangers (PHEs) were introduced in the 1930s and were almost exclusively used as liquid/liquid heat exchangers in the food industries because of their ease of cleaning. Over the years, the development of the PHE has generally continued towards larger capacity, as well as higher working temperature and pressure. Recently, a gasket sealing was replaced by a brazed material, and each thermal plate was formed with a series of corrugations (herringbone or chevron). These greatly increased the pressure and the temperature capabilities.

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 much larger surface area because the fluids spread out over the plates. This facilitates the transfer of heat, and greatly increases a speed of temperature changes.

Plate heat exchangers (PHE) are widely used in many applications (food, oil, chemical and paper industries, HVAC, heat recovery, refrigeration, etc.) because of their small size and weight, the case of cleaning as well as their superior thermal performance compared to other types of heat exchangers.

A compact brazed plate heat exchanger (BPHE) is built up from a package of corrugated stainless steel plates which are brazed together using materials such as copper and nickel. The plate package is generally sealed by front and rear plate packages to form a self contained unit. Each plate has a characteristic corrugation pattern that governs the degree of thermal efficiency and hydraulic behaviour of the BPHE unit.

Further, four to six apertures are placed in the corners/edges of these plates. Alternate plates are arranged at 180° to each other resulting in formation of the inlet and outlet port manifolds for the various process fluid circuits. Two channel plates are put together and used as a single plate for applications where immediate leak detection and prevention of cross contamination is vital.

During the brazing process of the plate package, the filler or brazing material is drawn to the contact points between the alternate plates due to capillary forces forming braze junctions. These brazed junctions greatly improve the structural integrity of the BPHE units and renders it suitable for higher operating pressures as high as 30-45 bar.

In some cases, a frame can be used to improve the operating pressure range of the BPHE units by several orders of magnitude. The basic components in a symmetric BPHE unit are shown in Fig 1. A wide variety of alternate options for assembly of plate packages are also possible for formation of flow arrangements suitable for different applications.

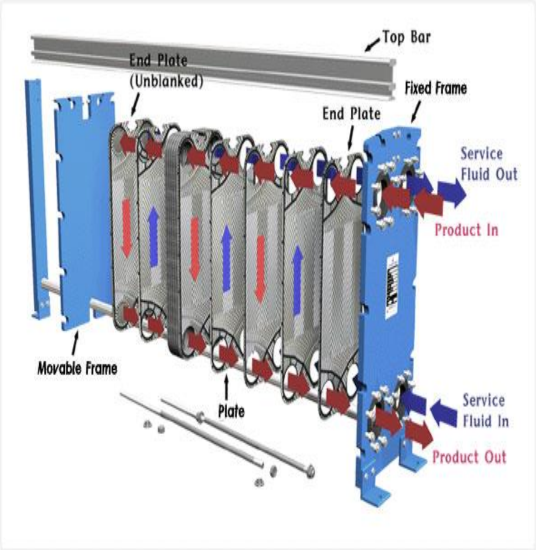

Fig. 1: A Layout of Chevron Type Pate Heat Exchanger

II. LITERATURE REVIEW

According to Wei Li et al. [1],studied Numerical and Experimental analysis of composite fouling in corrugated plate heat exchanger, they provides a numerical and experimental analysis on precipitation and particulate fouling in corrugated plate heat exchangers with different geometric parameters which are plate height, plate spacing and plate angle. Corrugations in plate heat exchangers enhance heat transfer rate by increasing heat transfer area and increasing turbulence mixing at low flow rates. Due to fouling in the plate heat exchanger they reduce a thermal efficiency, decreases heat flux, decrease a heat transfer rate, induces under-deposit corrosion, increases pressure drop.

Kanaris et al. [2], studied experimentally and numerically the flow and heat transfer in a two-channel PHE, Was an effective and reliable tool to predict flow characteristics, pressure losses and heat transfer in this type of equipment.

Xiao-Hong Han et al. [3], to investigate a numerical and experimental study of chevron, corrugated-plate heat exchangers. This paper produces a result of temperature, pressure, and velocity fields. The highest temperature appears around the upper port, while the lowest temperature appears in the cold fluid inflow around the lower port. From the pressure field, we can see that the fluid pressure is gradually reduced along the flow direction the simulated results are compared with the experimental values and found that trends of the outside temperature are consistent with those of pressure drop are similar.

Cagin Gulenoglu et al. [4], studied a Experimental comparison of performances of three different plates for gasketed plate heat exchangers. In this study, an experimental set-up for testing chevron type gasketed plate heat exchangers is utilized to investigate the thermal and hydraulic characteristics of three different plate geometries. The experiments are performed using various numbers of plates, several flow rate and inlet and outlet temperature values. so that the Reynolds numbers (300e5000) and Prandle numbers vary for all the plates that have due to chevron angle. Plate-specific correlations are derived for Nusselt number and friction factor by using the experimental results.

Iulian Gherasim et al. [5], validated a Experimental investigation for Heat transfer and fluid flow in a plate heat exchanger. This paper presents an experimental investigation of the hydrodynamic and thermal fields in a two channel chevron-type plate heat exchanger for laminar and turbulent conditions.

N.Manigandan et al. [6] studied a Numerical investigation of a chevron type brazed plate heat exchanger, they provides a numerical simulation of brazed plate heat exchanger at an element by element along to a length of a plate.

Finally I concluded the literature review a brazed Plate heat exchanger is preferably used because of high effectiveness and widely used in industrial applications. The chevron, corrugated-plate heat exchangers to increasing a heat transfer rate due to increases a pressure drop compare to normal plate type heat exchanger.

A. Specifications Of Brazed Chevron Type Heat Exchanger:

A typical chevron type brazed plate heat exchanger (Fig. 2) is taken into consideration for experimentation to contain following specifications:

Fig. 2: A Typical Chevron Type Brazed Plate Heat Exchanger

B. Specifications:

Overall length : 315 mm
Port to port length : 278 mm
Overall width : 73 mm
Port to port width : 40 mm
Overall height : 37 mm
Total no. of plates : 14
No. of channels-hot waterside : 6
No. of channels-cooling
Waterside : 7
Channel diameter : 4 mm
Channel height : 2 mm
Chevron angle : 60°
Port diameter : 16 mm
Hold up volume of
Hot water circuit : 234 cm^3
Hold up volume of
Cooling water circuit : 273 cm^3

III. EXPERIMENTAL SETUP

The actual experimental setup is shown in figure (3) as consists of two flow circuits, one is hot water circuit and another one is cold water circuit. The each circuit which comprises of a flow loop, a heating unit, a cooling unit and a flow measuring unit .The flow loop contained a reservoir, pump, and valve for controlling the flow rate in a flow meter. After a flow meter a hot water circuit is connected to inlet section of a heater and the outlet section of a heater is connected to a hot water inlet section of the heat exchanger and the cooling water circuit as directly connected to the cold water inlet section of a heat exchanger. The hot and cold water outlet section of a heat exchanger is used as various applications.

Fig. 3: Actual Experimental Setup of Brazed Chevron Type Plate Heat Exchanger

IV. RESULTS AND DISCUSSION

The experimental set up are tested to a parallel and counter flow condition with water as a working fluid of both hot and cold fluid section and the experiments are conducted based upon the different flow rates of 100,150,200,250,300 (l/h) of hot water and cold water flow rates respectively, due to varying a flow rate, the inlet temperature of hot water are also varied. Under this inlet condition to obtained experimental results. The obtained experimental results are shown in the below graphs.

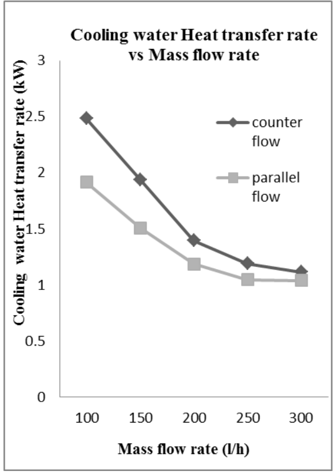

Fig. 4: Cooling Water Heat Transfer Rate along the Mass Flow Rate

In this graph given a counter flow are more efficient and obtained more heat transfer rate and cold water outlet temperature as increased and reduced a hot water temperature as compared to parallel flow condition. Due to that condition an effectiveness of a heat exchanger as increased under a counter flow condition.

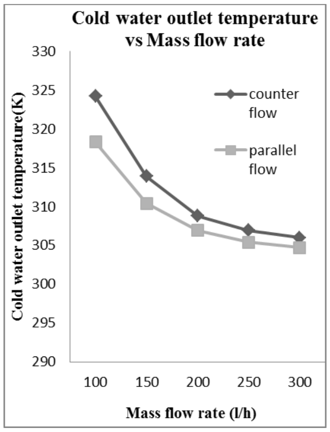

Fig. 5: Cold Water Outlet Temperature along the Mass Flow Rate

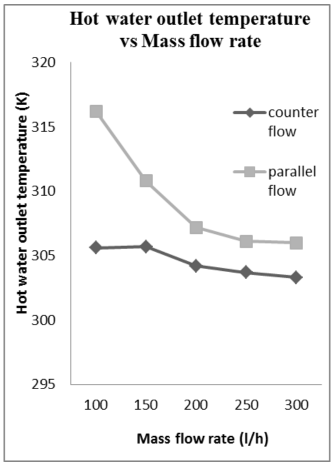

Fig. 6: Hot Water Outlet Temperature along the Mass Flow Rate

The obtained experimental results are valuated to numerical values given in N.Manigandan et al [6] paper. The valuated results are shown in a below graph.

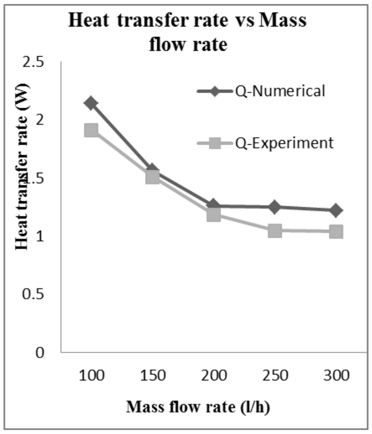

Fig. 7: Heat Transfer Rate along the Mass Flow Rate

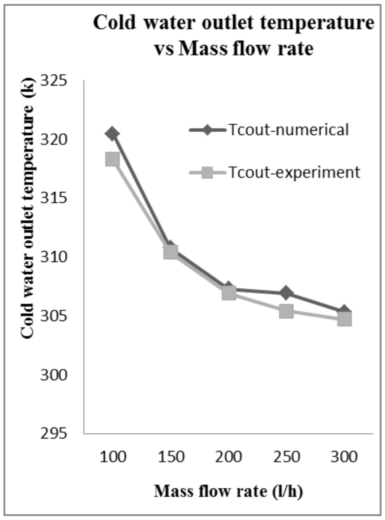

Fig. 8: Cold Water Outlet Temperature along the Mass Flow Rate

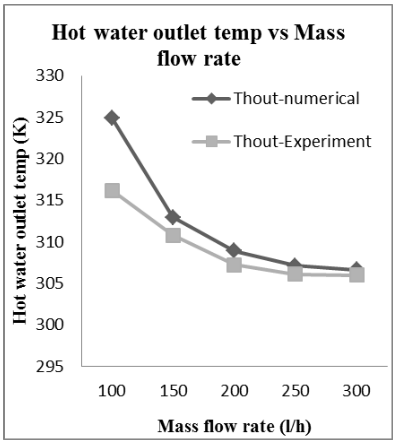

Fig. 9: Hot Water Outlet Temperature along the Mass Flow Rate

To evaluate the numerical and experimental results in an above graph, the numerical values are obtained slightly higher than the experimental results.

Then brazed chevron type plate heat exchanger experimental values are compared to normal plate type heat exchangers. The compared results are shown in below graphs.

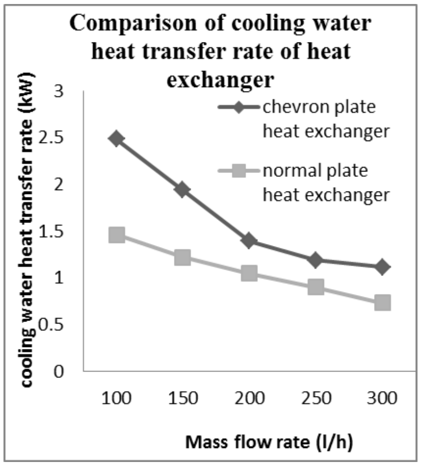

Fig. 10: Cooling Water Heat Transfer Rate along the Mass Flow Rate

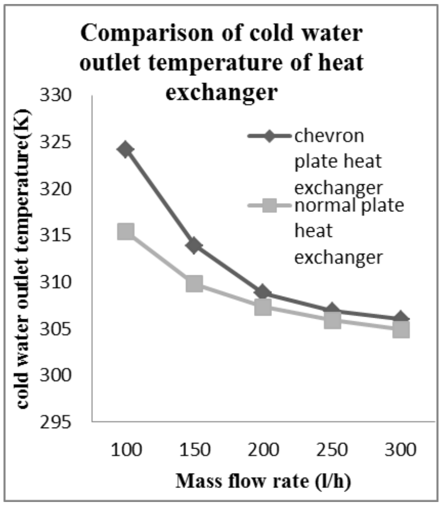

Fig. 11: Cold Water Outlet Temperature along the Mass Flow Rate

V. CONCLUSION

In the present study related to the heat transfer performance of water as a fluid in the plate type heat exchanger. The following conclusions have arrived from the data:

1) The overall heat transfer coefficient, heat transfer rate and cold water outlet temperature are increased in a chevron type brazed plate heat exchanger as compared to normal plate type heat exchanger in (42%) and tube and tube heat exchanger (50%) by means of compactness and more contact between hot and cold fluid with using a number of flow passage are increased in it.
2) Every 100c are rise in hot water inlet temperature, the 60c are rise in a cold water outlet temperature.
3) Heat duty of chevron type brazed plate heat exchanger is more than that of normal plate type heat exchanger.
4) Pressure drop across chevron type brazed plate heat exchanger is more than that of normal plate heat exchangers for the same operating conditions. Hence Chevron type plate heat exchangers have to be operated at slightly higher operating pressures.

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REFERENCES

[1] Wei Li, Hong-xia Li , Guan-qiu Li , ShichuneYao,Numerical, Experimental analysis of composite fouling in corrugated plate heat exchangers, International Journal of Heat and Mass Transfer 63 (2013) 351–360.

[2] A. G. Kanaris, A. A. Mouza, S. V. Paras, Flow and Heat Transfer in a Corrugated Plate heat Exchanger using a CFD code, Chem. Engg. Tech. 29(8) (2006) 923-930.

[3] Xiao-Hong Han, Li-Qi Cui, Shao-Jie Chen, Guang-Ming Chen, Qin Wang, A numerical and experimental study of chevron, corrugated-plate heat exchangers, International Communications in Heat and Mass Transfer. 37 (2010) 1008–1014.

[4] Cagin Gulenoglu, Fatih Akturk, Selin Aradag, Nilay Sezer Uzol, Sadik Kakac, Experimental comparison of performances of three different plates for gasketed plate heat exchangers, International Journal of Thermal Sciences. 75 (2014) 249-256.

[5] Iulian Gherasim, Matthew Taws, Nicolas Galanis, Cong Tam Nguyen, Experimental investigation for Heat transfer and fluid flow in a plate heat exchanger, International Journal of Thermal Sciences. 50 (2011) 1492-1498.

[6] N.Manigandan, M.Suresh, Numerical Investigation of a Chevron Type Brazed Plate Heat Exchanger, Applied mechanics and materials journal, ISSN No: 16609336