e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Issue:03/March-2023 Impact Factor- 7.868 www.irjmets.com

DESIGN OF PLATE HEAT EXCHANGER TO REDUCE THE OIL COOLING TIME

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DOI : https://www.doi.org/10.56726/IRJMETS34110

ABSTRACT

This paper features a discussion on design of Plate Type Heat Exchanger (PHE) to reduce oil cooling time. Conventional heat exchanger has many disadvantages such as complicated maintenance, high cost, consumes more space. While Plate Heat Exchanger has lot of advantages over conventional heat exchangers. PHE has larger surface area because the liquid spreads over the plate. The plate allows faster heat transfer hence the paper discuss and presents the design of the plate type heat exchanger, plate material, chevron angle, gasket material.

Keywords: Plate Heat Exchanger, Design, Materials.

I. INTRODUCTION

A heat exchanger is a device that is used to transfer thermal energy (enthalpy) between two or more fluids, between a solid surface and a fluid, or between solid particulates and a fluid, at different temperatures and in thermal contact [1]. There are typically no interactions between external heat and work. The heating or cooling of a fluid stream of interest as well as the evaporation or condensation of single- or multicomponent fluid streams are typical uses. In other applications, the goal might be to sanitize, purify, fractionate, distil, concentrate, crystallize, or control a process fluid. It might also be to recover or reject heat. The fluids that are transferring heat are in direct contact with a few heat exchangers. In majority of heat exchangers, temporary heat transfer between fluids occurs through a dividing wall or into and out of a wall. In many heat exchangers, a heat transfer surface keeps the fluids apart so that they don't mix or leak. These exchangers are known as direct transfer type, or simply recuperators. The plate heat exchangers are worked of thin metal heat transfer plates and pipe work is used to carry streams of fluid. Plate heat exchangers are generally utilized as a part of the liquid-to-liquid heat transfer and not appropriate for gas-to-gas heat transfer due to high pressure drop [2]. Research has shown that, when the plate has a wider pattern, the pressure drop is smaller and consequently the heat transfer coefficient will be smaller. This type of heat exchanger will therefore have a short thermal channel [3]. Yet, when two plates that have undergone various pressing patterns are put next to one another, the outcome is a variety of characteristics for both short and long channels, as well as for pressure drop and efficiency. Heat exchangers are utilized in many different applications, such as power plants, the petrochemical industry, air conditioning, etc.

II. LITREATURE REVIEW

Jogi Nikhil G., Assist. Prof. Lawankar Shailendra M, [4], explains corrugated plate heat exchangers have larger heat transfer surface area and increased turbulence level due to the corrugations. In this study, experimental heat transfer data will obtain for single phase flow (water-to-water) configurations in a corrugated plate heat exchanger for symmetric chevron angle plates.

Aydın Durmus et. al., [5] investigated the heat transfer in plate heat exchanger and he found that the heat transfer rate in plate heat exchanger is much more than that of conventional heat exchangers.

Wright and Heggs [6] shown how the operation of a two stream PHE can be approximated after the plate rearrangement has been made, using the existing PHE performance data. Their method can help when adjusting PHE, which is already in operation, for better satisfaction to required process conditions.

III. METHODOLOGY

After studying the existing shell & tube type heat exchanger and the requirement of the plant, we examined the many materials available for producing plate heat exchangers, the best plate material has been chosen. The heat duty of the heat exchanger is theoretically computed using the standard design process. Analytical method design calculation is used to determine the theoretical calculation in the same way. Theoretical and analytical computations are used to reach the same results. After that, the final plate is produced using an analytical computation of the theoretically determined plate material.

IV. MODELING AND CALCULATIONS

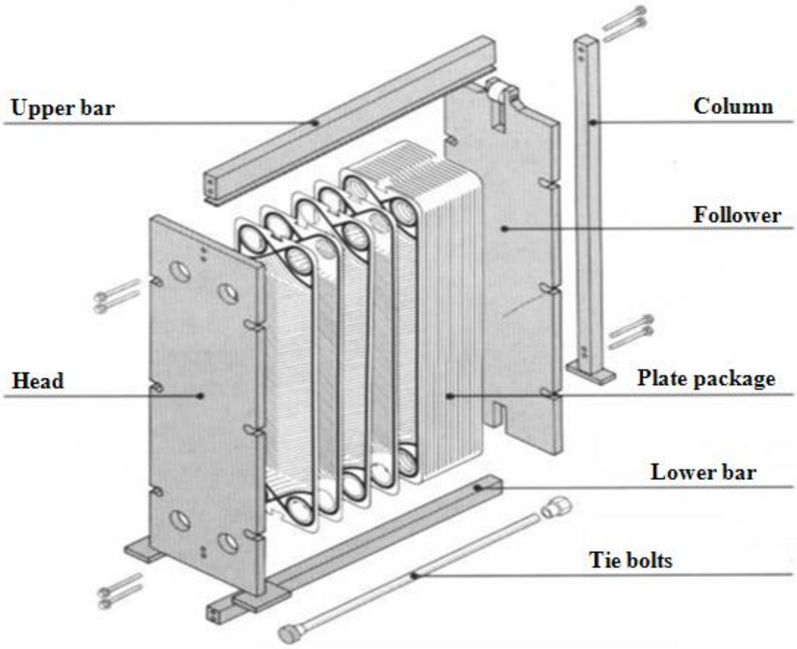

Figure 1: 3D view of Plate Heat Exchanger.[4]

Figure 1 shows the expolded view of Plate Heat Exchanger.

Material Selection

The choice of materials for plate heat exchangers is mostly driven by the plates and gaskets. This technique needs special consideration because these factors have a substantial impact on both the initial cost and the equipment life. The availability of a wide range of corrosion-resistant alloys for the fabrication of the heat transfer surfaces is one of the characteristics that makes plate-type heat exchangers so appealing for geothermal applications. Most manufacturers provide the following alloys :

Aluminum Bronze, Mone, Titanium, Tantalum, Incaloy 825, Hastelloy, Inconel, and 304, 316, and 317 Stainless Steels

A greater variety of optional alloys are also offered by special order in addition to these. The two most common stainless steels mentioned by manufacturers as the fundamental material are 304 and 316. The three most common materials for direct-use geothermal applications are titanium, 316 stainless steel, and 304 stainless steel.

Table 1: Gaskets Materials

Material	Common Name	Temperature Limit
Styrene Butadiene	Buna-S	185
Neoprene	Neoprene	250
Acrylonitrile – Butadiene	Buna-N	275
Ethylene	EPDM	300

Fluorocarbon	Viton	300
Resin-Cured Butyl	Resin-Cured Butyl	300
Compressed Asbestos	Compressed Asbestos	500

Table 1 shows the various gasket materials available in market.[7]

According to Radian Corporation's testing, Buna-N and Viton both work well in geothermal applications. According to test results, neoprene Buna-S and natural rubber both performed badly in a severe compression set (Ellis and Conover, 1981).

Although if Viton performs the best, its expensive price usually disqualifies it from consideration unless a particular attribute is required. Both the less expensive EPDM material and Buna-N, which is often the standard material recommended by most manufacturers, are typically suitable for geothermal applications.

Calculations:

Hot Side

Mass Flow Rate of Oil = 3480 kg/hr.

Thi = 75.5 °C

Tho = 40 °C

Cold Side

Mass Flow Rate of Water = 13250 kg/hr.

Tci = 35 °C

Q = mCp (Thi-Tho)

= 3480 x 2.242 (75.5-40)

Q = 277 x 10^3 Kcal/hr

Tco = Tci + [Q/mCp]

= 35 + [277 x 10^3/ (13250 x 4.182)]

Tco = 40 °C

LMTD = [(Thi – Tco) - (Tho – Tci)] / ln [(Thi – Tco) / (Tho – Tci)]

= [(75.5 – 40) - (40 – 35)] / ln [(75.5 – 40) / (40 – 35)]

LMTD = 15.56 °C

No. of plates N = At/Ap

Assuming Area of Plate (Ap) = 1.02 m^2

At = (Q/UxLMTDxF)

Where,

Q = 277 x 10^3 Kcal/hr

LMTD =**15.56** °C

U = 348.40 K cal/hr m2ºC

F = 1.048

At = (277 x 10^3/348.40x15.56x1.048)

At = 48.96 m^2

N = 48.96/1.02

N = 48.2 = 49

No. of plates = 49

V. RESULTS

After the detailed study of the company requirement and the calculations the plate material selected is 316 stainless And the gasket material as Buna-N also known as Nitrile Butadiene Rubber (NBR) which has the temperature limit of 275°C.The result shows that 49 plates require for the desired process.

VI. CONCLUSION

The conventional heat exchanger used in company facing many problems like larger space, high cost, low heat transfer rate, higher cooling time. By reducing this by designing new plate heat exchanger the cost is reduced, cooling time is reduced, increased heat transfer rate is achieved. The company is satisfied with the results of new plate heat exchanger.

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