International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 07 Issue: 04 | April - 2023 Impact Factor: 8.176 ISSN: 2582-3930

DESIGN OF PLATE HEAT EXCHANGER FOR HEAT TREATMENT INDUSTRY

A.C. Waghmare*1, Yash A. Thakre*2, Ketan D. Pande*3, Shantanu V. Pantawane*4, Abhishek D. Kshirsagar*5, Rahul S. Somkuwar*6

*1Professor, Dept Of Mechanical Engg, K.D.K College Of Engineering, Nagpur, Maharashtra, India.

*2,3,4,5,6Student, Dept Of Mechanical Engg, K.D.K College Of Engineering, Nagpur, Maharashtra, India.

---***---

Abstract - This study discusses the design of plate type heat exchangers (PHE). Conventional heat exchangers have many drawbacks, including difficult maintenance, high cost, and increased area usage. In contrast, plate heat exchangers have a number of benefits over traditional heat exchangers. Because the liquid spreads across the plate, PHE has a bigger surface area. The study discusses and explains the design of the plate type heat exchanger, plate material, chevron angle, and gasket material since the plate allows for faster heat transmission.

Key Words: Plate heat exchanger, Design, materials.

1.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]. Normally, there are no interactions between work and outside heat. Common uses include the heating or cooling of an interest fluid stream, as well as the evaporation or condensation of single- or multicomponent fluid streams. A process fluid may need to be sanitised, purified, fractionated, distillated, concentrated, crystallised, or controlled in other applications. It could potentially be used to reject or recover heat. A few heat exchangers are in direct touch with the fluids that are transporting heat. Most heat exchangers use a dividing wall or an inward and outward wall to temporarily transfer heat between fluids. A heat transfer surface separates the fluids in many heat exchangers so they won't mix or leak. These converters are referred as direct transfer type, or simply recuperators.

Thin metal heat transfer plates are utilised in plate heat exchangers, and pipes are used to transport streams of fluid. Due to the considerable pressure drop, plate heat exchangers are often used in liquid-to-liquid heat transfer and are not suitable for gas-to-gas heat transfer. [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]. The result, however, is a diversity of characteristics for both short and long channels, as well as for pressure drop and efficiency, when two plates that have undergone distinct pressing patterns are placed next to one another. Heat exchangers are used in a variety of settings, including air conditioning, petrochemical production, and power plants.

2. Literature 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.

3. METHODOLOGY

We investigated the various materials available for creating plate heat exchangers after evaluating the existing shell & tube type heat exchanger and the needs of the plant, and the best plate material was ultimately selected. The conventional design technique is hypothetically used to calculate the heat duty of the heat exchanger. The theoretical calculation is similarly determined by analytical technique design calculation. To arrive at the same conclusions, both theoretical and analytical calculations are used. After that, the theoretically determined plate material is analytically calculated to create the final plate.

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 07 Issue: 04 | April - 2023 Impact Factor: 8.176 ISSN: 2582-3930

4. MODELING AND CALCULATIONS

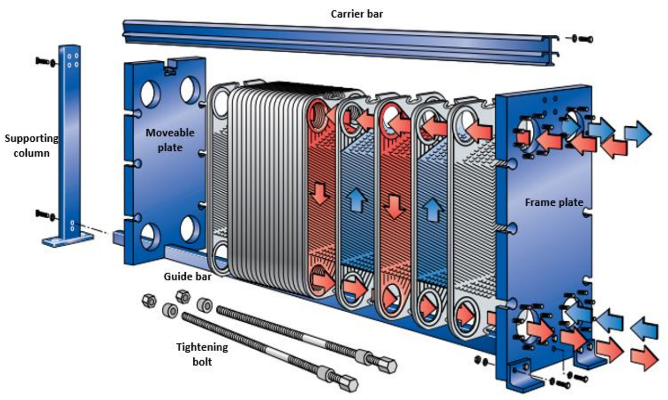

Fig -1: Figure 3D view of Plate Heat Exchanger

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	Temp 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

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.

3. CONCLUSIONS

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.

REFERENCES

[1] R K. Shah and D. P. Sekulic, "Fundamentals of Heat Exchanger Design" Journal of Heat Exchangers, (2003). ISBN-0-471—32117

[2] R.K. Shah, E.C. Subbarao, R.A.Mashelkar, Heat transfer equipment design, hemisphere publishing corporation, USA, 1988 ,pp 231-234, ISBN-0891167293

[3] R.K. Shah and S. G. Kandilkar, "The influence of the number of thermal plates on plate heat exchanger performance", (1989*),* Journal of Heat Transfer, vol.111, pp.300- 313, ISSN 0167-577

[4] Jogi Nikhil G & Lawankar Shailenda M, "Heat Transfer Analysis of Corrugated Plate Heat Exchanger of Different Plate Geometry: A Review' Chemical Engineering Science", *The International Journal of Emerging Technology and Advanced Engineering*, Vol.2, No.10, (2012), pp.110–115.

[5] Durmus A, Benli H, Kurtbas I & Gul H, "Investigation of Heat Transfer in Plate Heat Exchangers Having Different Surface Profiles", *International Journal of Heat and Mass Transfer*, Vol.52, (2009), pp.1451–1457.

[6] Wright AD & Heggs PJ, "Rating Calculation for Plate Heat Exchanger Effectiveness and Pressure Drop Using Existing Performance Data", *Transactions of IChem E*, Vol.80, (2002), pp.309-312.

[7] S.H. Jamshak, M. Dev Anand, S.B. Akshay, S. Arun, J. Prajeev, Prajeesh Prabhakaran "Design and Analysis of a Plate Heat Exchanger in the View of Performance Improvement and Cost Reduction" International Journal of Engineering & Technology Vol.7, (2018), pp.440-446.