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Design and Fabrication of Compact Heat Ex-Changer for Multiple Purpose Usage

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Abstract: **In many industrial applications compact heat exchangers role became important because to enhance of heat transfer rate and for better performance. Further the compact heat exchangers are being considered for heavy duties to increase more heat transfer by involving the phase change processes at boiling and also condensation. In mean while understanding the thermal-hydraulic characteristics of flow passages for compact heat exchangers the phase change vitally important. But for those compact heat exchangers, which have long been used for boiling and condensation duties, the design procedures are based on local two-phase characteristics. As new type of compact heat exchanger with modified design and with enhancement are capable of handling single phase as well as phase change duties. These new exchangers are being increasingly used in single-phase applications, and at the same time, they are also being considered for two-phase duties. In this present paper describes the design and fabrication of fin based compact heat exchanger for industrial applications as well as automobile industry. In this context, a review on performance of compact heat exchangers with different configurations is presented. The enhanced heat transfer techniques for compact heat exchangers in various applications**

Key words: **Fin Type Heat Exchanger; Compact Heat Exchanger; Multipurpose;**

I. INTRODUCTION

Compact heat exchangers which have been used for phase change application for long time. Plate-fin heat exchangers used in cryogenic industry belong to this category, where the exchangers have long been used for boiling and condensing duties, along with the single phase vapor and liquid applications. Compact finned-tube exchangers of various designs have been used in air to two-phase service for many years in refrigeration and air-conditioning applications. Two of the often stated barriers are the availability of reliable and independent methods and correlations for thermal-hydraulic characteristics of the compact heat exchanger passages, and the availability of independent software tools for the design of compact heat exchangers.

II. LITERATURE REVIEW

Heat exchangers constitute the most important components of many industrial processes and equipment's covering a wide range of engineering applications. Increasing awareness for the effective utilization of energy resources, minimizing operating cost and maintenance free operation have led to the development of efficient heat exchangers like compact heat exchangers.

R.K Shah[2006] in his elaborate discussion over the classification of heat exchangers has defined the "compact heat exchangers" as one having a surface area density of more than 700 m2/m3. Such compactness is achieved by providing the extended surfaces i.e. fin on the flow passages which work as the secondary heat transfer area.

Heat exchangers are used to transfer heat from one media to another. It is most commonly used in space heating such as in the home, refrigeration, power plants and even in air conditioning. It is also used in the radiator in a car using an antifreeze engine cooling fluid. Heat exchangers are classified according to their flow arrangements where there are the parallel flow, and the counter flow. Aside from this, heat exchangers also have different types depending on their purpose and how that heat is exchanged. But the fact is that there are heat exchangers even in the circulation system of fishes and whales. The veins of these animals are intertwined such that one side is carrying cold blood and the other has cold blood. As a result, these species can prevent heat loss especially when they are swimming in cold water. In some whales, the heat exchanger can be found in their tongues. When it comes to the manufacturing industry, heat exchangers are used both for cooling and heating.

Holman (2002), Ozisik (1985), Rohsenow et al. (1998), Kreith and Bohn (2000), and Incropera and Dewitt (2001). Several useful books have been published on the Heat exchangers in large scale industrial processes are usually custom made to suit the process, depending on the type of fluid used, the phase, temperature, pressure, chemical composition and other thermodynamic properties.

Patankar and Prakash [1981&2013] presented a two dimensional analysis for the flow and heat transfer in an interrupted plate passage which is an idealization of the OSFs heat exchanger. The main aim of the study is investigating the effect of plate thickness in a non-dimensional form t/H on heat transfer and pressure drop in OSF channels because the impingement region resulting from thick plate on the leading edge and recirculating region behind

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the trailing edge are absent if the plate thickness is neglected.

(Sparrow, et al. 1977). In calculation method was based on the periodically fully developed flow through one periodic module since the flow in OSF channels attains a periodic fully developed behavior after a short entrance region, which may extend to about 5 (at the most 10) ranks of plates. Steady and laminar flow was assumed by them between Reynolds numbers 100 to 2000.

Heat exchangers characteristics, types and emerging applications, edition: 2016 (2)by James K. Cooper, pp.pp. 1-22

Explained the efforts have been made to produce more efficient heat exchangers by employing various methods of heat transfer enhancement. Increase in heat exchanger performance can lead to more economical design of heat exchanger which can be help to make energy, material & cost savings related to a heat exchange process. Compact heat exchangers (CHEs) technologies are expected to be one of the solutions for new generation heat exchanger. The main motivation of this topic is to present a short review of advanced heat exchangers for thermal design and manufacturing perspective.

III. PROBLEM STATEMENT

Two of the often stated barriers are the availability of reliable and independent methods and correlations for thermal-hydraulic characteristics of the compact heat exchanger passages, and the availability of independent tools for the design of compact heat exchangers. The design is considered on multiple applications and with enhancement the heat exchanger is fabricated. By considering the literature review there is a need to develop in compact heat exchangers with good performance as well as easy fabrication process for multiple applications. The need for development of heat exchanger by considering industrial applications to fulfil requirement with less occupation area due to industrial globalization. Researches needed to develop as a consideration and this is an attempt of developing fin type heat exchanger with better performance.

IV. OBJECTIVES

1) To determine the single phase and two-phase operating regimes are heat flux through the channel wall and coolant flow rate with subjected to Primary parameters.

2) To enhance the heat transfer rate

3) To improve the heat transfer system size - reduction.

Limitations

1. Fabrication and development of heat exchanger with case study requirement only studied in the paper.

2. Materials methods fin types only discussed in the paper.

3. Fluids and performance analysis carried out in the next phase of research.

Materials and Design Specifications

Fin material- SS 316

Base plates- SS -non corrosive

Wavy fins are uninterrupted fin surfaces with cross-sectional shapes similar to those of plain fins, but with cyclic lateral shifts perpendicular to the flow direction. The resulting wave form provides effective interruptions which cause the flow direction to change periodically and induces a complex flow field. Consequently, the boundary layer separates and reattaches periodically around the trough regions to promote enhanced heat transfer; increased pressure drop penalty is also accompanied. Actually the Heat transfer is enhanced due to creation of Goertler vortices. These counter-rotating vortices form while the fluid passes over the concave wave surfaces, and produce a corkscrew-like flow pattern.

Datasheet for Plate Heat Exchanger (Compact)

Design data	
Item no.	**1**
Quantity	**1**
Plate quantity	**20nos**
Thickness/material	**0.5mm / ss304**
Inlet nozzle	**Nps 1”-sch 40, pipe**
Outlet nozzle	**Nps 1”-sch 40, pipe**
Design pressure bar.g	**6**
Hydrotest bar.g	**8**
Design temp ^{o}c	**200**
Mdmt ^{o}c	**-20**

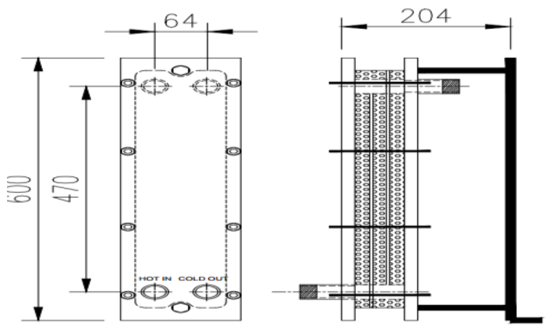

Fig shows the fabrication drawing of heat exchanger

Developing requirements from the company

The followings are the requirements to design the heat exchanger for case study.

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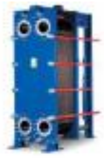
FLUID DATA AND PROPERTIES		HOT SIDE		COLD SIDE	
Fluid Designation and Allocation		PROCESS WATER		CHILLED WATER	
		Channel 1		Channel 2	
		Entering	Leaving	Entering	Leaving
Temperature	°C	80	20	5	65
Operating Pressure	bar	8		5	
Fluid Flow rate, Total	Kg/h	1000	1000	1000	1000
Density	Kg/m 3	999	995	994	997
Specific Heat	Kj/(kg C)	4.18	4.18	4.18	4.18
Dynamic Viscosity	CP	1	1	1	1
Thermal Conductivity	W/(m.K)	0.002	0.002	0.002	0.002
Fouling	M2.K /W				
PERFORMANCE DATA					
Pressure Drop	bar	0.5		0.5	
LMTD	C	15.05			
Heat Transferred	KW	70			
HT Area Required – Cleaned Surface	m2	1.05			
HT Area Required – Fouled Surface	m2	1.09			
HT Area Provided	m2	1.2			

1. HOT side flow rate considered 1 m3/hr in design.
2. Total heat load per hour is 70KW.
3. Unit is open able on both the sides, the fixing of covers will be done by STD clamps or bolt material.

Heating Element

It is basically having a shell and tube type of configuration in which incoming cold side fluid i.e. air enters the equipment and leaves the heater through the series of baffles. Our heater contains seventeen number of aluminium baffles through which a five set of heating tube passes. Load of heater is 1575 W, power source 220/230 V, single phase 50Hz AC Supply.

V. RESULTS OF FABRICATION



Dimensions of space requirements- actual size 600x240x200 as per requirement is developed with cross flow parameters using cross flow fins added inside to increase viability of the heat exchanger to becoming compact type.

Figure 5.1shows inlet and outlet with fins and the fastening ability to make it as compact as possible to fulfil the required position for test setup as required

Figure 5.2shows fins arrangement and beading arrangement with fins of cross flows wave type without disturbing the flow .

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Figure 5.3 shows the compact heat exchanger final fabrication assembly and the area enhancement for further application research of performance testing analysis with different fluids, flow rates and different pressures.

VI. CONCLUSIONS

In order to further accelerate the use of compact heat exchangers for phase change duties some of the suggested areas of further research work are as follows.

1. More two-phase flow pattern studies are required for the compact heat exchanger passages, especially for cross corrugated channels of plate heat exchangers. This information would be useful for developing flow pattern specific models for compact heat exchangers.

2. Use of modern measurement techniques such as liquid crystal thermography etc to establish the heat transfer coefficient variation. These studies should be focussed on obtaining better predictive methods for time averaged local heat transfer coefficients

3. It is observed that the data collected for single small diameter channels tends to be at higher mass fluxes than those for normal diameter tubes. This makes it difficult to compare the performance of the tubes of different diameters.

VII. FUTURE SCOPE

Heat exchanger optimization is an important field and full of challenges. The task of optimization may be considered as a design process, in which any possible candidates will be evaluated based on requirements. Savings of materials or energy, as well as capital cost and operating cost, are common objectives for industrial applications of heat exchangers. On the other hand, heat exchanger design involves complex processes, including selection of geometrical parameters and operating (dynamic) parameters for the design, cost estimation and optimization. This fabrication of CHE further tested for the fluids to optimize performance criteria.

VIII. REFERENCES

[1] Z. Michalewicz, D.B. Fogel, How to solve it: modern heuristics, Springer, New York, 2000.

[2] Q.W. Wang, G.N. Xie, B.T. Peng, M. Zeng, Experimental study and Genetic-Algorithm-based Correlation on shell-side heat transfer and flow performance of three different types of shell-and-tube heat exchangers, ASME Journal of Heat Transfer, 129 (2007), in press.

[3] M. Mishra, P.K. Das, S. Saranqi, Optimum design of crossflow plate– fin heat exchangers through genetic algorithm, International Journal of Heat Exchangers 5 (2004) 379–401.

[4] I. Ozkol, G. Komurgoz, Determination of the optimum geometry of the heat exchanger body via a genetic algorithm, Numerical Heat Transfer, Part A 48 (2005) 283–296.

[5] G.N. Xie, Q.W. Wang, Geometrical optimization of plate–fin heat exchanger using genetic algorithms, Proceedings of the Chinese Society for Electical Engineering 26 (2006) 53–57.

[6] R.K. Shah, Advances in science and technology of compact heat exchangers, Heat Transfer Engineering 27 (2006).

[7] Shah R. K. and Sekulic D. P. Fundamentals of Heat Exchangers, John Willey & Sons Inc., pp 10-13

[8] Patankar S. V. and Prakash C. 1981 An Analysis of Plate Thickness on Laminar flow International Journal of Heat and Mass Transfer, vol. 24, Nov. 1981, p. 1801-1810

IX. BOOKS

[1]. Holman (2002), Ozisik (1985), Rohsenow et al. (1998), Kreith and Bohn (2000), and Incropera and Dewitt (2001)

[2]. https://www.researchgate.net/publication/309489017_Compact_Heat_Exchangers_Development

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