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EFFECT OF COOLANT IN COMPACT HEAT EXCHANGER PERFORMANCE-A REVIEW

Barmavatu Praveen*[1] & S. Chakradhar Goud[2]
[*1]Research scholar, Shri JJT University, Rajasthan, India
[2]Professor & Principal, Springfields Engineering college, Hyderabad

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ABSTRACT

Compact heat exchangers (CHEs) technologies are expected to be one of the solutions for new generation heat exchanger. The main motivation of this chapter is to present a short review of advanced heat exchangers. These extra heat exchangers may not be located in the most appropriate position and it is not unusual that the water flow is not perpendicular to the heat exchanger core 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 like varying coolants are done. Finally, future development technologies and heat exchangers emerging applications are discussed.

Keywords: *heat transfer enhancement, compact heat exchangers, coolants.*

I. INTRODUCTION

The heat exchangers are found to have a wide range of applications such as aerospace, automotive, power and process applications. Novel heat exchangers solutions are needed to accommodate demand for increased performance with minimum pressure loss, reduced size (volume, envelop dimensions, aspect ratio, weight) and affordable, modular and/or scalable. In fact, the design procedure of heat exchangers is quite complicated, as it needs exact analysis of heat transfer rate, efficiency and pressure drop apart from issues such as long- term performance and the economic aspect of the equipment. Whenever inserts technologies are used for the heat transfer enhancement, along with the improvement in the heat transfer rate, the pressure drop also increases, which induces the higher pumping cost.[3,4]

The heat exchangers are one of the crucial components of machines since to remove the heat from the running system is the major concern, in order to improve the proper functioning. Numerous efforts have been performed by the researchers to overcome this issue by several methods and systems. [1] The typical way to increase heat transfer surface area is using fins on the heat exchangers, which provide a higher surface area per unit volume ratio. The researchers endeavor to develop more efficient heat exchangers but small passage dimensions, non uniformities and geometrical changes make it hard to characterize the heat transfer surface. The applications of the compact heat exchangers can be widely found in industry such as air conditioning, refrigeration, automotive and aerospace. [2]

Human lungs are one of the most compact heat exchangers, having an area density of about 17500 m2/m3, which is equivalent to 0.19 mm diameter tubes. Some microscale heat exchangers under development, having an area density greater than about 15000 m2/m3 or 1 □ m ≤ Dh ≤ 100 □ m, are as compact as the human lung and even more compact [5,6]

II. 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 s tools for the design of compact heat exchangers. The designed based on multiple applications of fabricated heat exchanger. By considering literature review there is a need of developments in compact heat exchangers with good performance as well as easily fabricated for multiple applications. The need of 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.

III. STUDIES FOR INFLUENCE ON COOLANT FLOW AND HEAT TRANSFER:

One of the fundamental research topics about offset strip fin is its geometry. The effect of the geometry on the performance of the fin and heat exchanger is the main concern of the investigators for decades. For this purpose, some researchers kept working on the effect of parameters on the performance of offset strip fin experimentally along the same path developed. [7] The effect of fin geometry is presented for: space, height, length and flow length. In addition to the conventional approach to the fin structure, few researchers try to implement a new aspect to the studies. One of these investigations was reported [8, 9]

IV. EVALUATION OF HEAT TRANSFER ENHANCEMENT

Enhanced surfaces do provide a greater heat transfer coefficient, but they also lead to increased fluid flow friction and pressure drop. Sometimes, the benefits gained from heat transfer enhancement are not great enough to offset the increased friction losses. Clearly, then, the performance goal is to gain maximum enhancement of heat transfer with minimum penalty on pumping power. However, this balance is difficult to quantify in a manner that allows straightforward comparisons between various enhanced surface geometries. Numerous methods have been suggested to accurately evaluate the performance improvement provided by enhancement techniques. This paper provides a broad, but by no means comprehensive, look at some of the proposed procedures for judging and comparing the effectiveness of surfaces that can provide heat transfer enhancement in compact heat exchangers. [10,11]

V. OBJECTIVES

1. To study and review the performance of heat exchangers using coolants
2. To review on heat transfer enhancement of compact heat exchanger

VI. DATA GEOMETRIES

Several plate-fin enhancement geometries have been developed in order to make heat exchangers more efficient and compact. Currently, plate-fin heat exchangers are very common in cryogenic systems and gas-liquefaction plants. Increased demand for smaller and better heat exchange devices will undoubtedly lead to more widespread use of plate-fin heat exchangers in other applications as well.[12]

VII. THERMAL DESIGN DATA

Heat duty =65000 kcal/hr (Input data)
Quantity of water = 50m^3/hr (Assumed)
Quantity of oil = 14.75m^3/hr (Input data)
Water inlet temperature = 33°c (Input data)
Oil outlet temperature = 45°c (Input data)
Allowable pressure drop on water side = 0.6 kg/cm^2 (Input data)
Allowable pressure drop on oil side = 0.6 kg/cm^2 (Input data)
Fouling factor on water side = 0.0004 hr-m^2-°c/kcal
Fouling factor on oil side = 0.0002 hr-m^2-°c/kcal (Input data)
Tube material =Admiralty brass
Thermal conductivity of tube material = 66 BTU/hr-ft^2 ^{0}F (From TEMA)

Number of tubes = 90
Number of tube passes = 2
Length of tube = 3300mm=3.300 m
Outside diameter of the tube = OD=19.05mm=0.01905m
Thickness of tube = 1.650mm=0.00165m
Inside diameter of tube = OD-2*Thk = 15.75mm=0.01575m
Tube type = Plain type
Tube pitch = 25.4mm=0.0254m
Ratio of outside to inside surface area=$A_o/A_i = \pi d_o L/\pi d_i L$ = 1.2095
Number of baffles = 33
Baffle cut =22%
Type of heat exchanger = Shell and tube AEW type heat exchanger (floating rear tube sheet)
Baffle thickness = 6mm=0.006m
Shell inside diameter = 307mm=0.307m
Shell outside diameter =323.8mm=0.3238m
Shell thickness = 8.4mm=0.0084m
Baffle spacing = 86mm=0.086m

Properties of Heat exchanger: [17]

μ_0 = 25.6375cp = 0.0256357 kg/m-sec=92.295 Kg/m-hr
C_{p0} = 0.4663 kcal/kg-°c
K_0 = 0.1295 kcal/m-hr-°c
ρ_0 = 851.85 kg/m^3

Surface characteristic OF CHE [13, 14]

Properties	Air	Base fluid (EG)	Nanoparticle			
			DM	Al_2O_3	SiO_2	TiO_2
ρ(kg/m3)	1.225	1076	3510	3970	2200	4250
Cp (J/kg.K)	1006.43	2664	497.26	765	703	686.2
k (W/m.K)	0.0242	0.261	1000	40	1.2	8.9538
μ(Ns/m2)	0.000017894	0.003036	-	-	-	-

VIII. 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. [15, 16]

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

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