Review of Heat Transfer Parameters of Serrated Plate Fin Heat Exchanger for Different Materials

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Abstract

The heat transfer and flow friction characteristics of plate fin surfaces are presented in terms of the Colburn factor j and the Fanning friction factor f verses Reynolds number Re, the relationships being different for different surfaces. The laminar flow model predicts j and f values at low Reynolds number; the data is throughout the range of interest. Velocity, and temperature fields have been computed and j and f factors determined over appropriate range of Reynolds number and geometric dimensions. For this work I have designed heat exchanger according to procedure of design of serrated plate fin heat exchanger [11], correlation used for finding various heat transfer parameters having Reynolds number less than 200 [6]. Experimental setup was manufactured using calculated parameters of design. On this setup readings were taken by varying flow rate of hot oil, at constant air for different temperatures of selected materials. After getting readings calculations were done for heat transfer parameters like Reynolds number, Colburn factor and Fanning friction factor.

Introduction

Plate fin heat exchangers are widely used in automobile, aerospace, cryogenic and chemical industries. They are characterized by high effectiveness, compactness (high surface area density), low weight and moderate cost. Although these exchangers have been extensively used around the world for several decades, the technologies related to their design and manufacture remain confined to a few companies in developed countries. Recently efforts are being made in India towards the development of small plate fin heat exchangers for cryogenic and aerospace applications. Following is the literature survey.

Kayset et al. [1] demonstrated both the model and modeling method will be useful and valuable for other heat exchanger reformer designs and optimization; it can also provide a reference for the design of the control system in the future.

Saidi et al. [2] carried out numerical analysis of the instantaneous flow and heat transfer for offset strip fin geometries in self sustained oscillatory flow. The creation processes of the temperature and velocity fluctuations have been studied and the dissimilarity between these has been proved.

Brutz et al. [3] discussed flow visualization experiments demonstrate that when the array is subjected to harmonic forcing at specific frequencies and amplitudes, flow instabilities appear within the array, and these flow instabilities are qualitatively similar to natural flow instabilities that have been previously shown to enhance heat transfer.

Chen et al. [4] discussed residual stresses and thermal distortion that were generated during the brazing process of nickel-base brazed stainless steel plate-fin structures. The distortion and the residual stresses predicted by FEM are reported. The influence of residual stresses on the crack initiation and propagation of brazed joint are also discussed.

Bapat et al. [5] developed flow theory and it was first applied to the offset strip fin heat exchangers analyzed. The same theory was then applied to the micro channel geometry with strip-fins studied and the heat transfer and friction factor are compared.

Peng et al. [6] investigated the heat transfer Colburn factor j and friction factor f of serrated fins in aluminum air oil plate fin heat exchangers (PFHE) for both experimentally and numerically. Also presented and discussed a detailed description of the local and average heat transfer characteristics of the fins.

From above literature it is concluded that

1) From the above literature review it is concluded that many researchers have worked on heat transfer Colburn factor j and friction factor f and Reynolds number.

2) From the above literature review it is concluded that some of researchers worked on compact heat exchange reformer for high temperature fuel cell systems and numerical analysis of the instantaneous flow and heat transfer for offset strip fin geometries.

3) From the above literature review it is concluded that very less Researchers are working on heat transfer Colburn factor j and friction factor f and Reynolds number for different materials.

4) From the above literature review it is concluded that there is no recent work on heat transfer Colburn factor j and friction factor f and Reynolds number for different materials at the same time on one experimental setup. Also there is no such comparison about effect of two materials on heat transfer parameters.

In this study, the heat transfer parameters like Colburn factor j and the friction factor f characteristics of the serrated plate fin heat exchanger are investigated by experimental method for copper and brass SPFHE. Because few experimental data have been presented for Reynolds number lower than 200, all the tests limit the heat transfer and pressure drop analysis to Re < 200. The experimental results compared for copper and brass SPFHE.

Objectives:

1. To design and manufacture the serrated plate fin type heat exchanger and built up proposed experimental set up.
2. Theoretically find out heat transfer performance by Colburn factor j, Reynolds number, Prandtl number, Stanton number etc.
3. To find out heat transfer Colburn factor j, Reynolds no. etc by experimental method with variation of oil flow rate and temperature at constant air flow rate for different materials.
4. To compare the heat transfer parameters for different materials.
5. To suggest the better material for various Reynolds number.

ii) Theoretical work:-

1) Literature review will be studied of different Researcher's works.

2) Design of serrated type fin heat exchanger.

3) Calculation of heat transfer performance by Colburn factor j, Reynolds number etc. using proper formulae's.

iii) Experimental set-up:

1) To manufacture of serrated type fin heat exchanger and test setup.

2) To find out temperatures and flow rates for different materials.

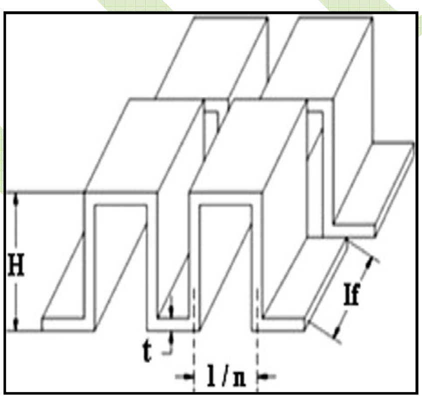

Fig.1 Serrated Fins

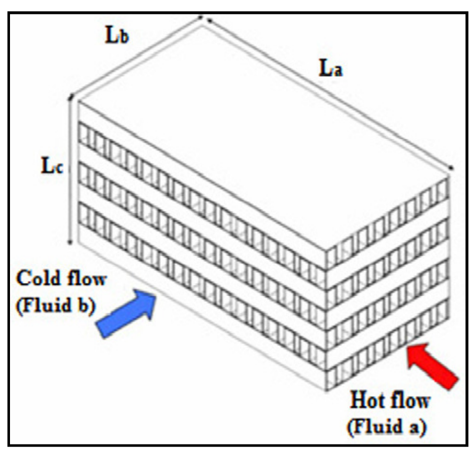

Fig. 2 Serrated Plate Fin Heat Exchanger (SPFHE) - For Air-Oil Cross Flow

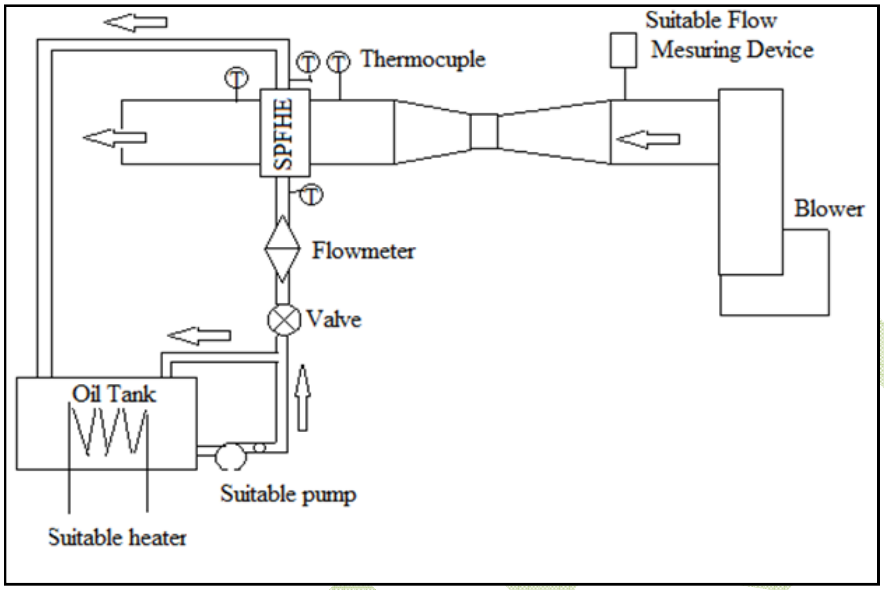

Fig. 3 Proposed experimental setup

Conclusion

In this study, the heat transfer Colburn factor j and friction factor f of serrated fins in Copper and Aluminum air–oil serrated plate-fin heat exchangers (SPFHE) were investigated experimentally. The effects of the materials on the heat transfer enhancement and friction factor behaviors in laminar flow regimes (Re < 200) are described. The fin dimension of serrated type plate fin heat exchanger SPFHE (H=3mm, t=0.2mm, s=2.5, l_f=5mm for hot fluid and H=9.5mm, t=0.2mm, s=, l_f=5mm for cold fluid) same for both materials. The test was carried out at different temperatures and flow rates of hot fluid at constant flow rate of cold fluid.

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