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Experimental study 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 [12], Correlation used for finding various heat transfer parameters having Reynolds number less than 200 [6]. Experimental setup was manufactured using calculated parameters of design. The effects of the materials Brass and Copper SPFHE 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, lf=5mm for hot fluid and H=9.5mm, t=0.2mm, s=, lf=5mm for Cold fluid) same for both materials. 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

Heat exchangers are devices used to transfer heat between two or more fluid streams having different temperatures. There are many applications of heat exchanger used in industries like power generation, chemical processing, electronics cooling, air-Conditioning, refrigeration and automotive applications. In this work we have examined the results obtained in serrated plate fin heat exchanger for different materials. Heat transfer parameters like Reynolds number, Colburn factor and Fanning friction factor were discussed. In addition, we had examined relation of above heat transfer parameter for different materials and revealed by various graphs.

The flowing fluids in Cross flow serrated type plate fin heat exchanger are hot fluid as oil and Cold fluid as air. Copper and Brass materials were selected for conducting the trials on serrated type plate fin heat exchanger. The Comparative study for these two materials along with heat transfer parameters were carried out. Copper SPFHE have more heat transfer and less friction drop as Compare to brass at various temperatures. So from results select Copper material than brass for more efficiency. After successful Completion of this work it has been decided that Copper material is more efficient than brass material. Also it is seen that as the flow rate of Cold air increases the heat transfer parameter Colburn factor j increases, hence improved heat transfer rate is achieved.

Experimental set up

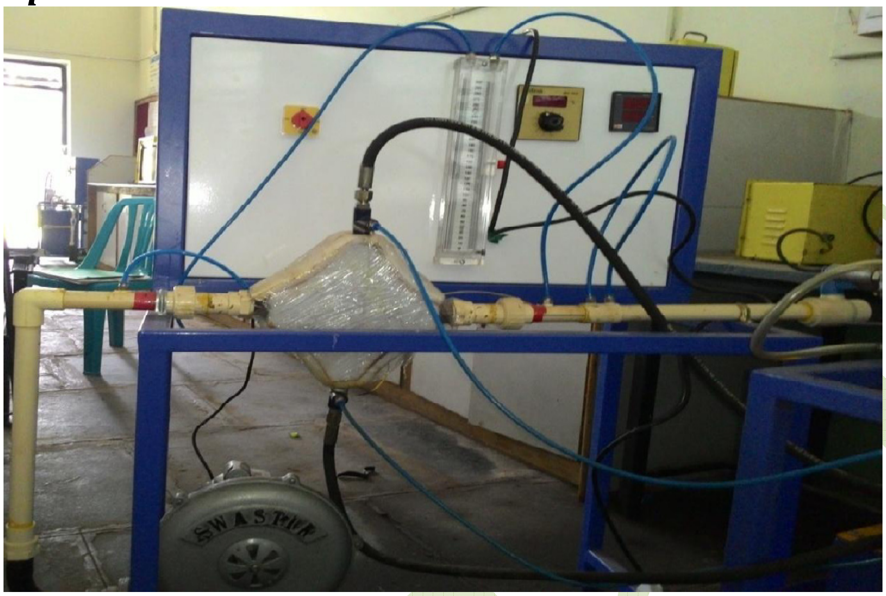
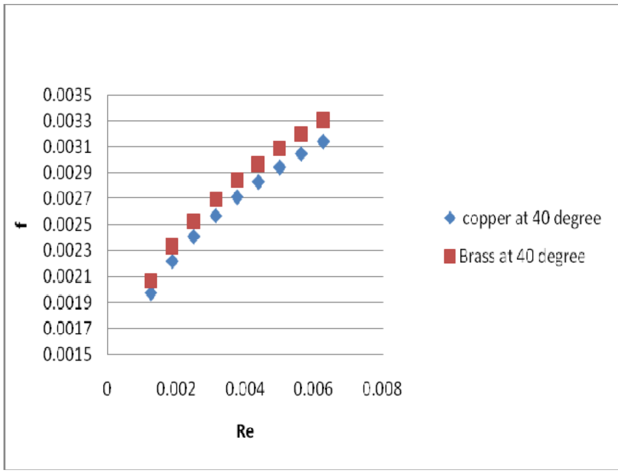


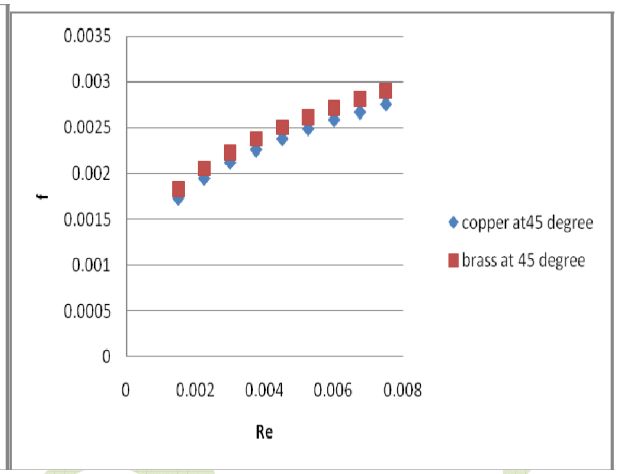
Photo 1 Experimental Setup

Photo 2 Copper SPFHE, Brass SPFHE

Photo 3 Brass SPFHE

Result and Discussions

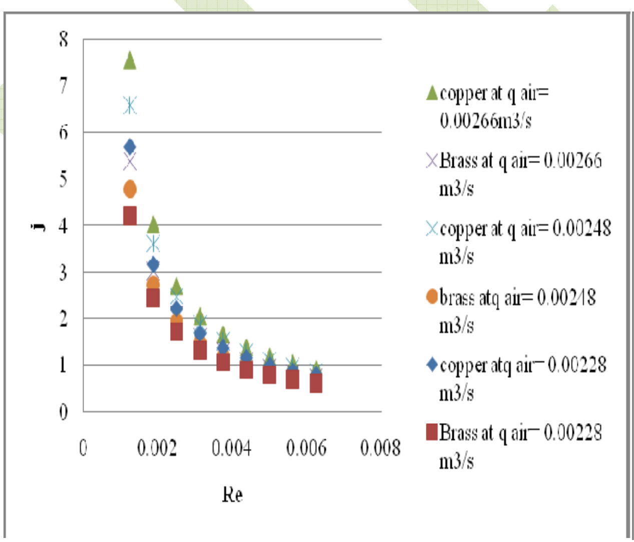


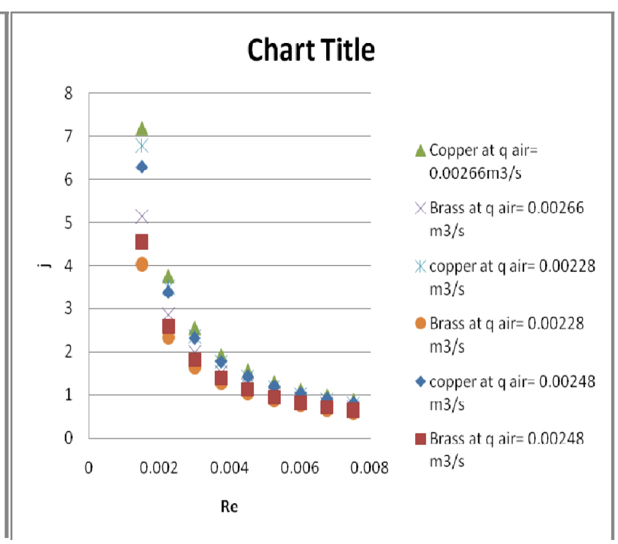


Graph1 graph2

Graph.1 show variation of friction factor with Reynolds number for Copper PFHE and Brass PFHE at various temperatures (400C) And Air Flow rates (0.00266m3/s, 0.00248m3/s, 0.00228m3/s). As found, the friction factor increases with increasing Reynolds No. Because as flow rate increases pressure drop also increases. And friction factor proportional to pressure drop. It is observed that the friction factor increases with increasing Reynolds number. Hence as the F increases, the pressure drops also increases accordingly. It is observed that Brass PFHE shows more friction factor as compare to copper PFHE for same flow rate. Experimental results shows friction factor for Brass PFHE are 5% larger than the copper PFHE.

Graph.2 show variation of friction factor with Reynolds number for Copper PFHE and Brass PFHE at various temperatures (450C) And Air Flow rates (0.00266m3/s, 0.00248m3/s, 0.00228m3/s). As found, the friction factor increases with increasing Reynolds No. Because as flow rate increases pressure drop also increases. And friction factor proportional to pressure drop. It is observed that the friction factor increases with increasing Reynolds number. Hence as the F increases, the pressure drop also increases accordingly. It is observed that Brass PFHE shows more friction factor as compare to copper PFHE for same flow rate. Experimental results shows friction factor for Brass PFHE are 6% larger than the copper PFHE.





Graph3 graph4

In Graph 3 it is observed that the Colburn factor decreases with increasing Reynolds number. As the Re increases, the temperature drop also decreases accordingly. It is observed that Copper PFHE at (q air= 0.00266m3/s, Hot oil at 400C) shows higher Colburn factor, means higher heat transfer. Brass PFHE at (q air= 0.00228m3/s, Hot oil at 400C) shows lower Colburn factor, means low heat transfer. Experimental results shows that for copper PFHE at q air 0.00266 m3/s shows 10 %-16 % greater heat transfer than the Brass PFHE at same conditions .

In Graph 4 it is observed that the Colburn factor decreases with increasing Reynolds number. As the Re increases, the temperature drop also decreases accordingly. It is observed that Copper PFHE at (q air= 0.00266m3/s, Hot oil at 450C) shows higher Colburn factor, means higher heat transfer. Brass PFHE at (q air= 0.00228m3/s, Hot oil at 450C) shows lower Colburn factor, means low heat transfer. Experimental results shows that for copper PFHE at q air 0.00266 m3/s shows 8 %-10 % greater heat transfer than the Brass PFHE at same conditions .

Conclusions

In this study, the heat transfer Colburn factor j and friction factor f of serrated fins in Copper and Brass 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, lf=5mm for hot fluid and H=9.5mm, t=0.2mm, s=, lf=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. Key findings of this study were:

(1) An experimental model is established in this study, which can predict the flow and heat transfer characteristics at low Reynolds number for Copper and Brass materials.

(2) The Colburn factor j decreases and friction factor f increases with increasing Reynolds number.

(3) At the same Reynolds number both, the Colburn factor j and friction factor f are larger for Copper SPFHE than Brass SPFHE.

(4) Friction factor f is temperature independent in SPFHE.

(5) It is observed that Copper SPFHE at (qair= 0.00266 m3/s, Hot oil at 400C) shows higher Colburn factor as compared with other flow rate (qair= 0.00248 m3/s, qair= 0.00228 m3/s), so more heat transfer is obtained at larger flow rate of cold fluid.

(6) Copper SPFHE have more heat transfer and less friction drop as compare to brass at various temperatures. So from results select copper material than brass for more efficiency.

(7) There is a significant offset between trends of serrated fins by obtained existing the empirical correlations and experimental data at Re < 200.

References

1. W.M. Kays, A.L. London, "Compact Heat Exchanger", third ed. MacGraw-Hill Book Company, NY,(1984), pp. 1-10

2. ArashSaidi and BengtSunde, "A Numerical Investigation of Heat Transfer Enhancement in Offset Strip Fin Heat Exchangers in Self-Sustained Oscillatory Flows" Ân Heat transfer enhancement 699 International Journal of Numerical Methods for Heat & Fluid Flow, Vol. 11 No. 7, (2001), pp. 99-716.

3. John M. Brutz,J. Craig Dutton,Anthony M. Jacobi, "Enhancement of Air-Side Heat Transfer in Offset-Strip Fin Arrays Using Unsteady Forcing International Refrigeration and Air Conditioning", Conference School of Mechanical Engineering, (2004), pp.1-9

4. Hu Chen a, Jianming Gong a, LuyangGeng a, Shan-Tung Tu, "Finite Element Prediction of Residual Stresses and Thermal Distortion in a Brazed Plate-Fin Structure", FM2005 – Multiscale Damage Related to Environment Assisted Cracking, | (2005), pp. 145-153.

5. Akhilesh v. bapat and satish g. kandlika, “Thermohydraulic Performance Analysis of Offset Strip Fin Microchannel Heat Exchangers” Proceedings of ASME ICNMM2006 4th International Conference on Nanochannels, Microchannels and Minichannels, (2006), pp. 1-7.
6. Huisheng Zhang, ShilieWeng and Ming Su Huisheng Zhang, ShilieWeng and Ming Su, “Compact Heat Exchange Reformer Used for High Temperature Fuel Cell Systems”, Basics Design Applications, ISBN: 978-953-51-0278-6,(2007), pp. 221-249.
7. HaoPeng, Xiang Ling, “Numerical Modeling and Experimental Verification of Flow and Heat Transfer Over Serrated Fins at Low Reynolds Number”, Experimental Thermal and Fluid Science 32, (2008), pp. 1039–1048.
8. ShadiMahjoob, KambizVafai, “A synthesis of fluid and thermal transport models for metal foam heat exchangers” International Journal of Heat and Mass Transfer 51, (2008), pp 3701–3711
9. NihadDukhan, Pragnesh Patel, “Equivalent particle diameter and length scale for pressure drop in porous metals” Experimental Thermal and Fluid Science 32, (2008). pp 1059–1067
10. Celso Yukio Nakashima, Miguel Henrique Teruel, “Rectangular Offset Strip-Fin Heat Exchanger Lumped Parameters Dynamic Model”, 3rd CTA-DLR Workshop on Data Analysis & Flight Control, Brazil, (2009), pp.1-10.
11. M. Yousefi , A.N. Darus , H. Mohammadi, “An imperialist competitive algorithm for optimal design of plate-fin heat exchangers”, International Journal of Heat and Mass Transfer 55, (2012), pp 3178–3185.
12. Saad A. El-Sayed, Sayed A. EL-Sayed and Mohamed M. Saadoun, “Experimental Study of Heat Transfer to Flowing Air inside a Circular Tube with Longitudinal Continuous and Interrupted Fins” Journal of Electronics Cooling and Thermal Control, 2012, 2, pp 1-16
13. Juan Li, HaoPeng, Xiang Ling, “Numerical study and experimental verification of transverse direction type serrated fins and field synergy principle analysis”, Applied Thermal Engineering 54, (2013), pp. 328-335.
14. Dr. AlkaBaniAgrawal, “Offset-Strip Fin Heat Exchangers a Conceptual Review Study”, International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 Vol. 3, Issue 1, (2013), pp.1306-1312.