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A Review: Fin and Tube Heat Exchanger Performance with different Fin Pattern

S D Katkade*, J H Bhangale, D D Palande
*ME Student Mechanical Engineering Dept, MCERC, Nasik, India
Associate Prof. & HOD Mechanical Engineering Dept, MCERC, Nasik, India
Associate Prof. , Mechanical Engineering Dept, MCERC, Nasik, India

Abstract

Various methods are used to increase rate of heat transfer without affecting much the overall performance of the system. These techniques are used in heat exchangers. Heat exchangers are used in various applications in day to day life. Some of the applications of heat exchangers are-in process industries, thermal Power plants, air-conditioning equipments, refrigerators, radiators for space vehicles, automobiles etc. The present paper is a review of the various methods used to increase the heat transfer performance by using different types of fins. The performance of different fin types is evaluated at different Reynolds number, fin pitch, number of tube rows etc.

Keywords: heat exchanger, fins, friction factor, pressure drop.

Introduction

Heat exchanger is a basic component in industrial system involving the process of heat transfer Improved design fins are used as a effective way to improve the performance of heat exchanger. Heat exchangers are widely used in air-conditioning, refrigeration, processing industry. Compact heat exchangers are also used in automobile industries, radiators, evaporators, condensers, and charge air coolers. In these applications, the heat transfer performance is normally limited by the thermal resistance on the air side of the heat exchangers. Fins are also used in cooling of electronic components and gas turbine blades. In these applications, fins are used in simple designs such as rectangular, triangular, parabolic, annular, and pin rod fins or complicated designs such as spiral fins.

The objective of this study is to investigate the characteristics of air-side heat transfer for fin-tube heat exchangers with different types of fins. The j-factors of the spiral-type circular fin-tube heat exchangers were measured by varying the fin pitch, number of tube rows, and fin alignment. In addition, the present study aims to propose air-side heat transfer correlations(j-factors) for spiral-type circular fin tube heat exchangers based on a very reliable database as a function of the Reynolds number, number of tube rows, and dimensionless fin pitch normalized by the hydraulic diameter.

Review of work carried out

L.H. Tang, M. Zeng, Q.W. Wang[1] have investigated characteristics of air-side heat transfer and friction of five kinds of fin-and-tube heat exchangers (crimped spiral fin, plain fin, slit fin, fin with delta-wing longitudinal vortex generators and mixed fin), with the 12 number of rows and the diameter of tubes 18 mm ,with Reynolds number ranging from 4000-10000. It was found that crimped spiral fin shows the excellent results for heat transfer compared to other fins.

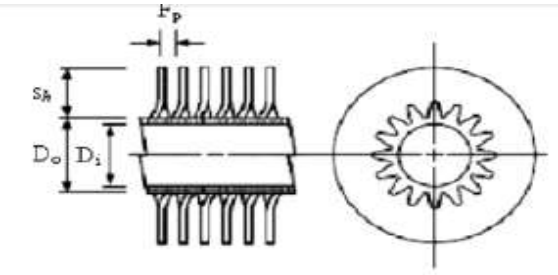

Fig 1.Crimped spiral fin[1]

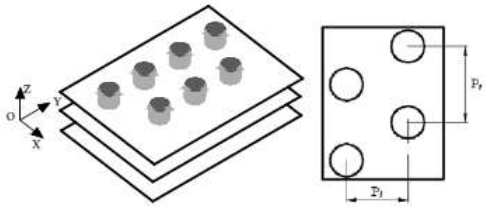

Fig 2.Plain fin[1]

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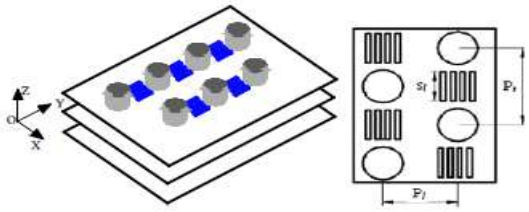

Fig 3.Slit fin[1]

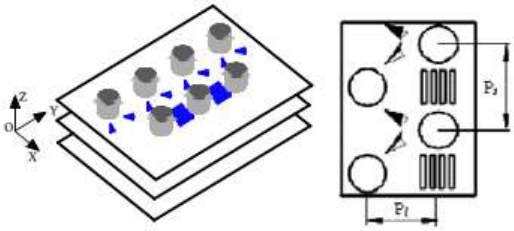

Fig 4.Mixed fin[1]

Mao-Yu Wen, Ching-Yen Ho[2] studied three fins i.e. plate fin, wavy fin, and compounded fin in a wind tunnel. The heat transfer coefficient, the pressure drop of the air side, the Colburn factor (j), and fanning friction factor (f) against air velocity (1–3 m/s) and Reynolds number varying between 2000-6000 have been discussed. From the results we can say that the pressure drop, heat transfer coefficient, f factor and j factor of wavy fin increases compared to flat fin. The results also shows that in the compounded fin all the factors increases as compared to wavy fin. Therefore it strongly suggest the use of compounded fin.

.Parinya Pongsoi, Patcharapit Promoppatum, Santi Pikulkajorn, Somchai Wongwises[3] reports on Effect of fin pitches on the air-side performance of L-footed spiral fin-and-tube heat exchangers. The purpose of this experiment was to investigate the effects of fin pitch on the air-side heat transfer performance and frictional characteristics of L-footed spiral fin and tube heat exchangers with Reynolds number varying from 4000-15000. Ambient air and hot water are used as a working fluid on the air- and the tube-side, respectively. However, fin pitch does have an influential effect on the average heat transfer rate, pressure drop, and friction factor according to this investigation.

A. Nuntaphan, T. Kiatsiriroat, C.C. Wang [4] reports on air side performance at low Reynolds number of cross-flow heat exchanger using crimped spiral fins. A total of 23 cross-flow heat exchangers having crimped spiral configurations is studied with the effect of tube diameter, fin spacing, transverse tube pitch, and tube arrangements. For the inline arrangement, the pressure drop increases with the rise of tube diameter with decrease in the associated heat transfer coefficient. The considerable increase of pressure drop with heat transfer coefficients decreases for the inline arrangement with increase in fin height. However, for the staggered arrangement, the effect of the fin height on the pressure drop is much smaller than that of the inline arrangement due to the major contribution to the total pressure drops from the blockage of the airflow from staggered arrangement. Effect of the fin spacing on the air side performance is strongly related to the transverse tube pitch for both inline and staggered arrangements.

Parinya Pongsoi,Santi Pikulkajorn,Chi-Chuan Wang , Somchai Wongwises [5] this paper describes the effect of fin pitches on the air-side performance of crimped spiral fin-and-tube heat exchangers with a multipass parallel and counter cross-flow configuration. This study investigates the effect of fin pitches and fin materials on the air-side performance of crimped fin-and-tube heat exchangers in the range of high Reynolds numbers varying between 4000 to 13000.. The test samples are made from copper and aluminium with different fin pitches. The experimental results reveal that the fin pitch casts insignificant effect on the heat transfer characteristics (Colburn j factor). However, a detectable rise of the friction factor is seen when the fin pitch is increased to fin pitch = 6.2 mm. On the other hand, the effect of fin material on the airside performance is negligible.

Parinya Pongsoi, Santi Pikulkajorn, Chi-Chuan Wang, Somchai Wongwises [6] this paper reports on effect of number of tube rows on the air-side performance of crimped spiral fin-and-tube heat exchanger with a multipass parallel and counter cross-flow configuration. The air-side performance of crimped spiral fin and tube heat exchangers with Reynolds number varying from 3000–13,000 is investigated in this study. The test samples are made from copper and aluminium with different number of tube rows (2, 3, 4 and 5). The effects of number of tube rows and fin material on the heat transfer and friction characteristics are studied. The results show that no significant effect for either number of tube rows or fin materials on the heat transfer performance is found at high Reynolds number.

Thirapat Kuvannarat, Chi-Chuan Wang, Somchai Wongwises [7] effect of fin thickness on the air-side performance of wavy fin-and-tube heat exchangers under dehumidifying conditions was reported in this study. A total of 10 samples were tested with associated fin thickness of 0.115 mm and 0.25 mm,

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respectively. For a heat exchanger with two rows and fin pitch of 1.41 mm. The heat transfer coefficients is about 5–50% and pressure drop 5-20% higher for fin thickness of 0.25 mm than those for fin thickness of 0.115 mm.

Chi-Chuan Wang, Jane-Sunn Liaw, Bing-Chwen Yang [8] investigated the airside performance of herringbone wavy fin-and-tube heat exchangers data with larger diameter tube This study examines the airside performance of the wavy fin-and-tube heat exchangers having a larger diameter tube of 16.59 mm with the tube row ranging from 1 to 16. The performance drop is especially pronounced at the low Reynolds number region. Actually more than 85% drop of heat transfer performance is seen for Fin pitch of 1.7 mm as the row number is increased from 1 to 16. The effect of fin pitch on the airside performance is comparatively small for N = 1 or N = 2. However, a notable drop of heat transfer performance is seen when the number of tube row is increased and normally higher heat transfer and frictional performance is associated with that of the larger fin pitch.

Han-Taw Chen, Wei-Lun Hsu [9] reports on estimation of heat transfer coefficient on the fin of annular-finned tube heat exchangers in natural convection for various fin spacing. The heat transfer coefficient value increases and fin efficiency decreases with increasing the fin spacing . The fin temperature departs from the ideal isothermal situation and decreases more rapidly away from the circular center with increasing the fin spacing.

Conclusion

From this review we came to know that there is wide applicability of different types of fins in fin and tube heat exchanger. Crimped spiral fin shows the highest heat transfer at high Reynolds number. Compounded fin shows the highest pressure drop compared with plain and wavy fin. However, fin pitch does have an influential effect on the average heat transfer rate, pressure drop, and friction factor.

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