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Study of Artificial Roughness in Condenser Tube used in Household Refrigerator: A Review

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Abstracts

Enhancement techniques based on artificial roughness are used in numerous applications of condenser such as: the flow regime (Reynolds number), the fluid properties (Prandtl number), with and without fouling, the allowable pressure drop and the existence or absence of natural convection. The use of an enhancement technique may be conditioned by the specific application: for example, wire coils are not applicable in the food industry due to hygiene problems but corrugated and dimpled tubes are being used. In the petrochemical industry, the use of mechanically deformed tubes is not allowed for safety reasons. However, the use of wire coils does not present any problem. In boilers and heat recovery systems, wire coils are frequently used because of their easy removal for cleaning operations.

Keywords: condenser, compressor, hot vapor refrigerant, tubes.

Introduction

This paper presents a review of the condenser tube roughness in refrigerator system. The thermal hydraulic behavior of three types of enhancement technique based on artificial roughness: corrugated tubes, dimpled tubes and wire coils. The comparison has been performed. From the three best specimens selected among the wide range of geometries investigated by the different authors work. Artificial roughness techniques are particularly appropriate for condenser augmentation in this flow regime, as they contribute to disturbing the thermal boundary layer. With regard to the transition from laminar to turbulent flow,

Experimental evidence proves that these techniques promote the advance of transition (4) . As a result of the flow perturbation in the viscous sub-layer, turbulence spots at Reynolds numbers below 2300 lead to early turbulence phenomena. When the transition takes place, the heat transfer rate can be five times higher than the one for the laminar flow in a smooth tube . The use of the best Enhancement technique will bring about an important increase of the heat transfer rate in the transition region, this presenting a high potential in applications with highly viscous fluids, e.g. in the petrochemical and food industries .

The effects of porosity, porous material diameter and thermal conductivity as well as Reynolds number on the heat transfer rate and pressure drop were also investigated .In the present work ,the effect of twist ratio on the performance or behavior of a novel tube insert, namely butterfly insert in an air cooled condenser were investigation. The operational performance butterfly insert tube in condenser.

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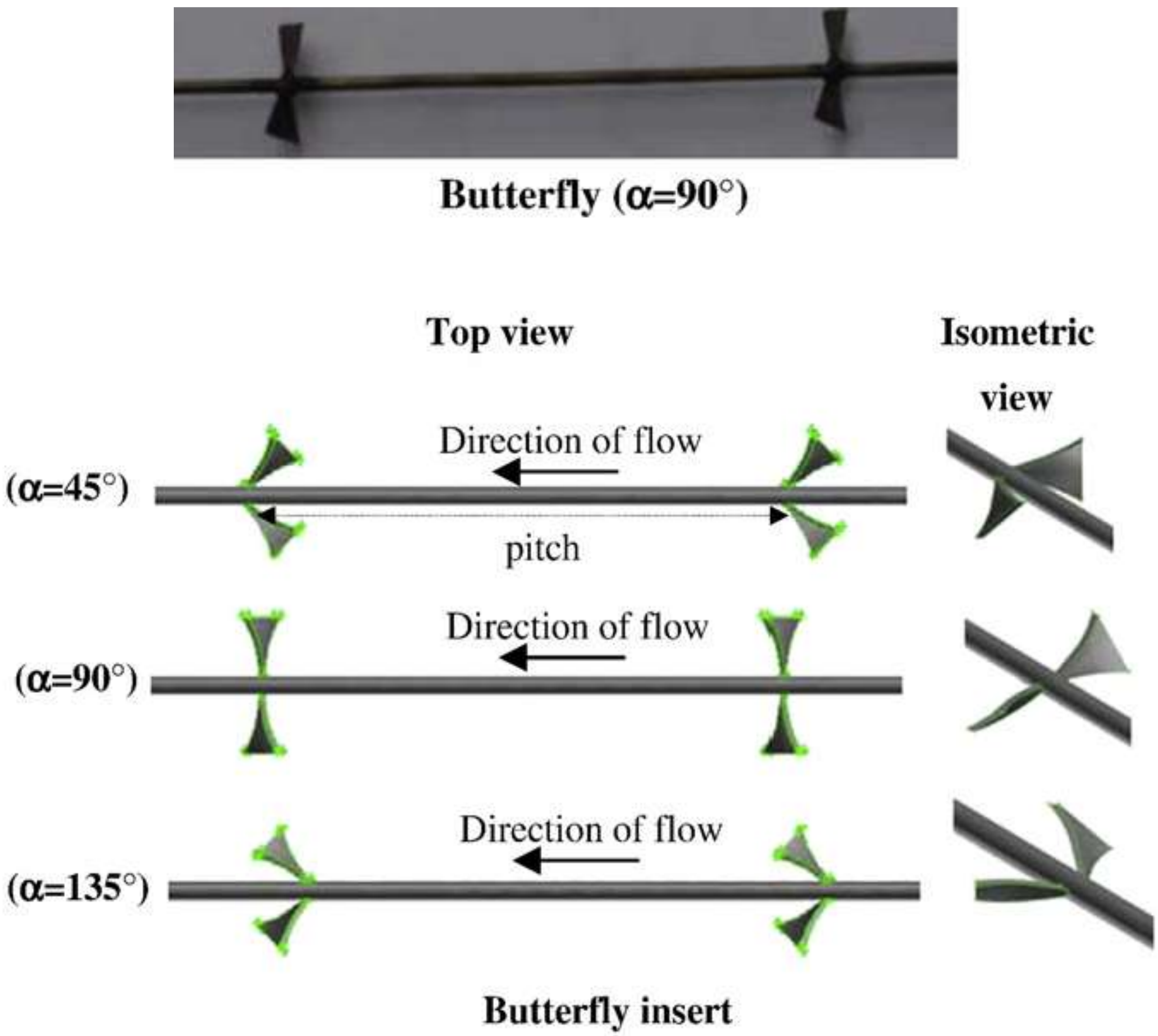

Fig.1 Fan,bent tube, real photo of tube insert and physical model of tube inserts [S.R. Shabanian]

Literature review

The following literature review describes important research results regarding the condenser tube roughness.

1. Pedro G. Vicente et.al :- 19 June 2002:- Experimental study of mixed convection and pressure drop in helically dimpled tubes for laminar and transition flow This paper presents the experimental results carried out in dimpled tubes for laminar and transition flows and completes a previous work of the authors focused on the turbulent region. It was observed that laminar flow heat transfer through horizontal dimpled tubes is produced in mixed convection, where Nusselt number depends on both the natural convection and the entry region Heat transfer enhancement through internally roughened tubes is an interesting technique in order to obtain more compact and efficient heat exchangers. Tubes with artificial roughness obtained by cold rolling the external tube surface are competitive in comparison to performance and cost of other enhanced techniques currently employed in turbulent flow. There are two tube-side artificial roughness methods: two-dimensional roughness (transverse and helical ribs, helically corrugated and wire coil inserts) and three-dimensional roughness (sand-grain roughness, attached particle roughness, ‘‘cross-rifled’’ roughness and helically dimples). Enhanced tubes can be used for many applications such as evaporators, condensers, oil radiators and heat exchangers for sterilizing processes.

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This study is centered on improving heat exchangers used for sterilizing organic fluids, through helically dimpled tubes. In these heat exchangers the organic fluid flows through tubes and is heated by steam or hot water flowing on the outside. Organic fluids usually show high viscosity and internal flow can be either laminar or turbulent at low Reynolds numbers. Therefore the tube-side film coefficient dominates the overall heat transfer coefficient

2. Alberto Garcia et.al Viedma (2006) :- Enhancement of laminar and transitional flow heat transfer in tubes by means of wire coil inserts. This work presents an extensive experimental study on three wire coils of different pitch inserted in a smooth tube in laminar and transition regimes. Isothermal pressure drop tests and heat transfer experiments under uniform heat flux conditions have been carried out. The friction factor increases lie between 5% and 40% in the fully laminar region. The transition from laminar flow to turbulent flow is continuous, without the instabilities and the pressure drop fluctuations that a smooth tube presents. Heat transfer experiments have been performed in the flow ranges: Re ¼ 10–2500; Pr ¼ 200–700 and Ra ¼ 3 _ 106–108. At Reynolds numbers below 200, wire coils do not enhance heat transfer with respect to a smooth tube. For Reynolds numbers between 200 and 1000, wire coils remarkably increase heat transfer. At Reynolds numbers above Re _ 1000–1300, transition from laminar to turbulent flow takes place. At Reynolds number around 1000, wire inserts increase the heat transfer coefficient up to eight times with respect to the smooth tube. A performance comparison between wire coils and twisted tape inserts has shown that wire inserts perform better than twisted tapes in the low Reynolds number range: Re ¼ 700–2500

3. J.P. Meyer et.al (2010) :- Transitional flow inside enhanced tubes for fully developed and developing flow with different types of inlet disturbances: Part I – Adiabatic pressure drops Due to tube enhancements being used to achieve higher process efficiencies, heat exchangers are starting to operate in the transition region of flow. The paucity of data, however, has the implication that no correlation exists for enhanced tube transition flow. This article, being the first of a two-part paper, presents adiabatic friction factor data for four enhanced tubes for fully developed and developing flow in the transition region. Three inlets were used for developing flows, namely square-edged, re-entrant and bell mouth inlets. It was found that, as in the case of smooth tubes, transition was affected by the type of inlet used, with transition being delayed the most for the smoothest inlet .Correlations were developed to predict the fully developed critical Reynolds numbers and friction factors in the transition region. The correlations predicted the critical Reynolds numbers on average to within 1% with a root mean square deviation of less than 8%, while transition friction factors were predicted with a mean absolute error of 6.6%, predicting 89% of the data to within a 150%.

4. S.R. Shabanian et.al ; In 16 December 2010:- CFD and experimental studies on heat transfer enhancement in an air cooler equipped with different tube inserts. This paper reports the experimental and Computational Fluid Dynamics (CFD) modeling studies on heat transfer, friction factor and thermal performance of an air cooled heat exchanger equipped with three types of tube insert including butterfly, classic and jagged twisted tape. In the studied range of Reynolds number the maximum thermal performance factor was obtained by the butterfly insert with an inclined angle of 90°. The results have also revealed that the difference between the heat transfer rates obtained from employing the classic and jagged inserts reduces by decreasing the twist ratio .The CFD predicted results were used to explain the observed results in terms of turbulence intensity. In addition, good agreements between the predicted and measured Nu number as well as friction factor values were obtained

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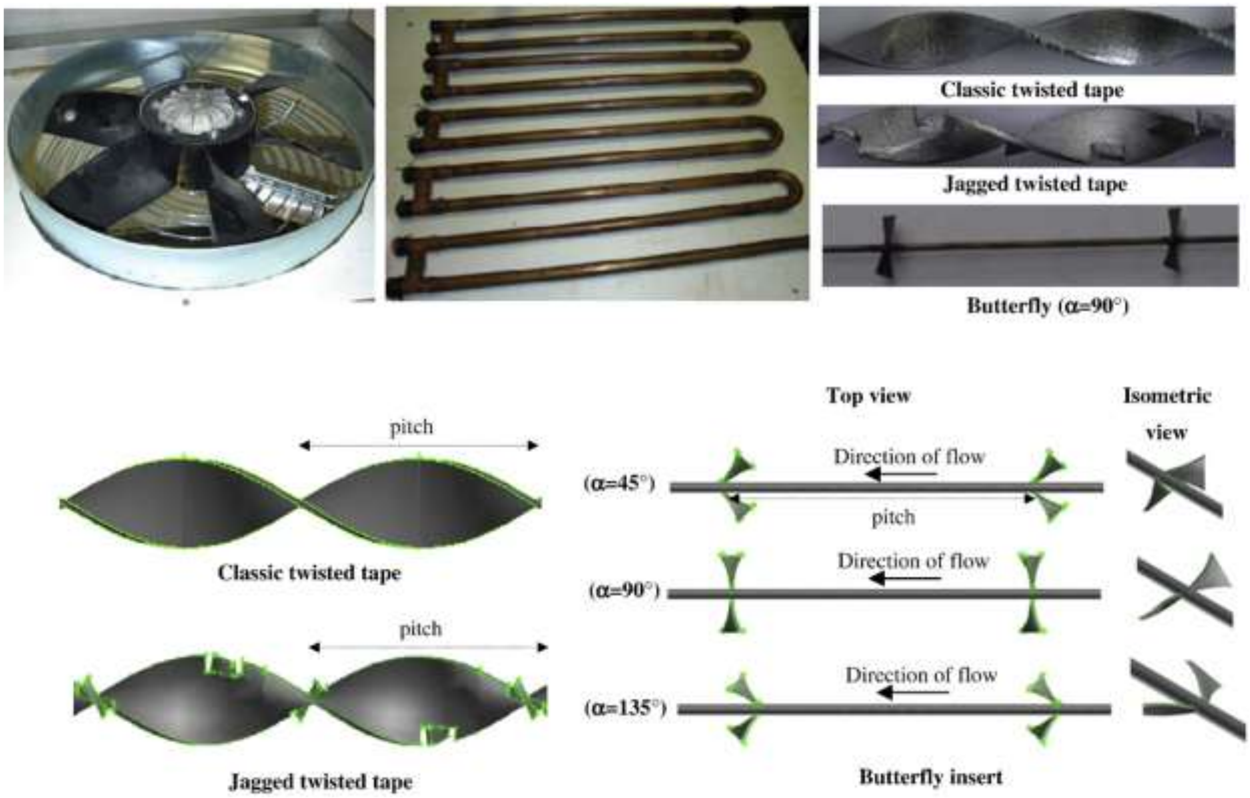

Fig.2 (a) Fan ,bent tube ,real photo of tube inserts and physical model of tube inserts. [S.R. Shabanian]

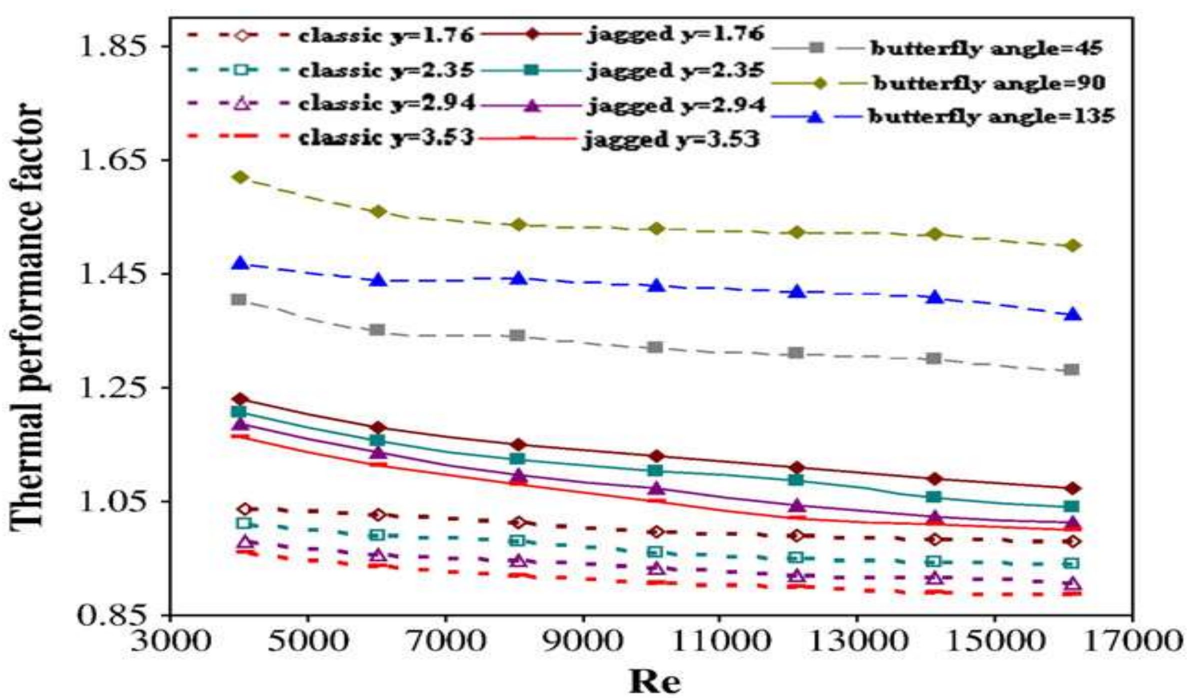

Fig. 2(b) The performance ratio for various tube inserts. [S.R. Shabanian]

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5 .A. García et.al (2011) :-The influence of artificial roughness shape on heat transfer enhancement Corrugated tubes ,dimpled tubes and wire coils -; This work analyzes the thermal hydraulic behavior of three types of enhancement technique based on artificial roughness: corrugated tubes, dimpled tubes and wire coils. The comparison has been performed from the three best specimens selected among the wide range of geometries investigated by the authors in previous works. Heat transfer and pressure drop experimental data in laminar, transition and turbulent regimes are used in this investigation. Results show that the shape of the artificial roughness exerts a greater influence on the pressure drop characteristics than on the heat transfer augmentation. Likewise, this shape strongly affects the advance of the transition to turbulence and its characteristics: smooth or sudden. The study concludes that for Reynolds numbers lower than 200, the use of smooth tubes is recommended. For Reynolds numbers between 200 and 2000, the employment of wire coils is more advantageous, while for Reynolds numbers higher than 2000, the use of corrugated and dimpled tubes is favored over the wire coils because of the lower pressure drop encountered for similar heat transfer coefficient levels.

6. A.W. Fan et.al (2012) :- Parametric study on turbulent heat transfer and flow characteristics in a circular tube fitted with louvered strip inserts -;In the present work, characteristics of heat transfer, flow resistance, and overall thermo-hydraulic performance of turbulent airflow in a circular tube fitted with louvered strip inserts were investigated through numerical simulation. Our main attention was paid to the effects of the slant angle and pitch of the turbulators. The results show that the Nusselt number is augmented by 2.75–4.05 times (Nu = 108.71– 423.87) as that of the smooth tube. The value of performance evaluation criterion (PEC) lies in the range of 1.60–2.05, which demonstrates that the louvered strip insert has a very good overall thermo-hydraulic performance. Moreover, the computational results indicate that larger slant angle and small pitch can effectively enhance the heat transfer rate, but also increase the flow resistance. Furthermore, it is noted that the Nusselt number and friction factor are more sensitive to the slant angle than the inserts pitch.

Comparatively steady and good overall thermo-hydraulic performance can be obtained at a moderate slant angle together with a small pitch. All these data show that the louvered strip is a promising tube insert which would be widely used in heat transfer enhancement of turbulent flow. Shell-and-tube heat-exchangers are extensively used in various industrial fields such as petrochemical industry, power generation, air-conditioning, etc. In those devices, heat is transferred from the hot side to the cold side via the tube walls. In cases of low heat transfer rate, additional approaches are necessary to intensify the heat transfer process. Scientists and engineers around the world have made great contributions to heat transfer augmentation techniques. Usually, these techniques are classified either as passive or active. Their major difference is that direct application of external power is not needed for the passive techniques. Thus, they are more frequently adopted in practical applications. Numerous types of turbulators, such as the twisted tape, helical screw-tape, porous media inserts, etc. belong to the passive techniques .The general mechanism of heat transfer enhancement by using tube inserts is that the turbulators can intensify the swirl flow and reduce the thickness of the thermal boundary layer as well.

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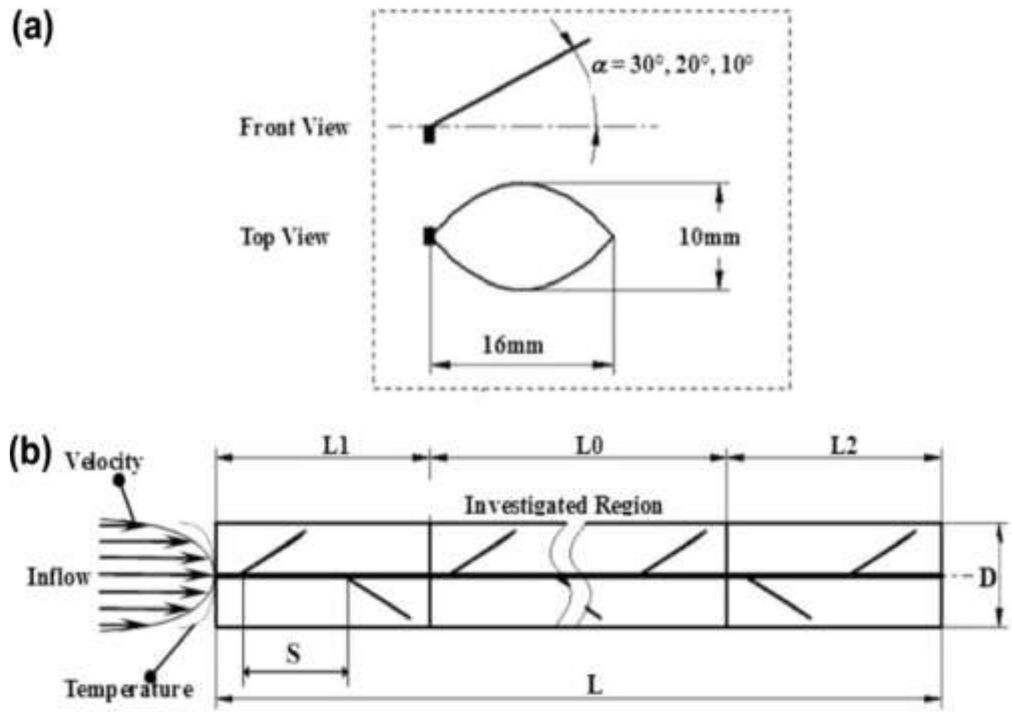

Fig.3 (a) Geometry of the louvered strip insert, and (b) schematic of a circular tube fitted with louvered strip inserts. [A.W. Fan]

7. S. Tabatabaeikia, et.al Heat Transfer Enhancement by Using Different Types of Inserts Heat transfer enhancement has been always a significantly interesting topic in order to develop high efficient, low cost, light weight, and small heat exchangers. The energy cost and environmental issue are also encouraging researchers to achieve better performance than the existing designs. Two of the most effective ways to achieve higher heat transfer rate in heat exchangers are using different kinds of inserts and modifying the heat exchanger tubes. There are different kinds of inserts employed in the heat exchanger tubes such as helical/twisted tapes, coiled wires, ribs/fins/baffles, and winglets.

Conclusion

Heat transfer enhancement has been always a significantly interesting topic in order to develop high efficient, low cost, light weight, and small heat exchangers. The energy cost and environmental issue are also encouraging researchers to achieve better performance than the existing designs. Two of the most effective ways to achieve higher heat transfer rate in heat exchangers are using different kinds of inserts and modifying the heat exchanger tubes. There are different kinds of inserts employed in the heat exchanger tubes such as helical/twisted tapes, coiled wires, ribs/fins/baffles, and winglets. These papers presents an overview about the early studies on the improvement of the performance of thermal systems by using different kinds of inserts. Louvered strip insert had better function in backward flow compared to forward one.

Reference

1. **Pedro G. Vicente , Alberto Garcia, Antonio Viedma** :- 19 June 2002:- Experimental study of mixed convection and pressure drop in helically dimpled tubes for laminar and transition flow
2. **Alberto Garcia a, Juan P. Solano a, Pedro G. Vicente b, Antonio Viedma 2006 :-** Enhancement of laminar and transitional flow heat transfer in tubes by means of wire coil inserts.
3. **J.P. Meyer, J.A. Olivier -2010 :-** Transitional flow inside enhanced tubes for fully developed and developing flow with different types of inlet disturbances.
4. **S.R. Shabanian , M. Rahimi , M. Shahhosseini , A.A. Alsairafi** ; In 16 December 2010:- CFD and experimental studies on heat transfer enhancement in an air cooler equipped with different tube inserts.
5. **A. García , J.P. Solano , P.G. Vicente , A. Viedma** – 25 October 2011 :-The influence of artificial roughness shape on heat transfer enhancement Corrugated tubes ,dimpled tubes and wire coils.

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6. **A.W. Fan , J.J. Deng , A. Nakayama , W. Liu** :- 7 June 2012 :- Parametric study on turbulent heat transfer and flow characteristics in a circular tube fitted with louvered strip inserts .
7. **S. Tabatabaeikia, H. A. Mohammed, N. Nik-Ghazali, and B. Shahizare** 2014: Heat Transfer Enhancement by Using Different Types of Inserts.