# A REVIEW ON HEAT TRANSFER ENHANCEMENT METHOD USING DIFFERENT SURFACE PROFILES

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## ABSTRACT

*Recent development in technology has led to demand for high performance lightweight, and compact heat transfer equipment. To provide accommodation with this demand, finned surface are usually used to increase rate of heat transfer. The excessive heat must be dissipated to the surrounding for smooth functioning of system. This is more important in cooling of gas turbine blade, thermal power plants, air conditioning equipment and electrical / electronic component. This component is getting more compacting size, which generates heat continuously. This excessive heat will reduce the life of component. To overcome this problem there is need of effective cooling system. Therefore now a day's industries are utilizing thermal system such as ribs, fins, baffles etc. The turbulence occurred due to these passive techniques are good enough to increase rate of heat transfer. This article is based on comprehensive review of work carried out in this technology.*

***Keyword: Heat Transfer Rate, Reynolds Number, Surface Profiles, Surface Roughness.***

## I INTRODUCTION

Large amount of heat is generated in many engineering application. This generated heat caused overheating problem, leading to failure of the system. Thus this heat must be dissipated effectively. Artificial roughness on a surface has been widely accepted as an effective technique to enhance the heat transfer rate. Surface roughness elements are also used to improve the convective heat transfer. There are some other methods to increase heat transfer rate as follows.

## II HEAT TRANSFER ENHANCEMENT TECHNIQUES

Heat transfer enhancement technique refers to the improvement of thermo hydraulic performance of heat exchanger. Existing augmentation techniques can broadly divide into three different categories.

### 2.1 Active Technique

These techniques are more complex from the use and design point of view as the method requires some external power input to cause the desired modification and improvement in the rate of heat transfer. It finds limited application because of the need of external power in many practical applications. Various active techniques such as mechanical aids, fluid vibrations, surface vibrations, jet impingement.

### 2.2 Passive Technique

These techniques generally use surface geometrical modification to the flow channel by incorporating inserts, ribs or additional device. They promote higher heat transfer coefficient by disturbing the existing flow behavior which also leads to increase in the pressure drop. Heat transfer enhancement by this technique can be achieved by using rough surface, extended surface, and treated surface.

### 2.3 Compound Technique

This method is based on combination of active and passive method. A compound augmentation technique is the one where more than one of the above mentioned techniques is used in combination with the purpose of further improving the thermo-hydraulic performance of a heat exchanger.

## III REVIEW OF SOME RESEARCHERS

**MayankUniyalet al., [1]**in this paper with the help passive techniques researchers had studied on forced convection for plain and dimpled surfaces to improve the heat transfer rate by comparing the two different fin surfaces with same dimensions. It has practical application for cooling of turbine airfoils. Experiments were done between plain and dimpled surface which were come on to conclusion that dimpled fin have more heat transfer coefficient than plain fin.

**KenichiroTakeishi et al., [2]** in this paper experiment was carried out on rectangular duct for convective heat transfer and pressure loss for enhancing the heat transfer coefficient. For improving the cooling efficiency the inclined pin-fin were used for enhancing the heat transfer coefficient and fin shape. In this experiment four kinds of pin-fin arrangement were tested. It was concluded that by using the 45 degree incline fin heat exchanger factor can be improve.

**Shivdas S. Kharche et al., [3]** in this paper by using the natural convection heat transfer through fin was experimentally studied to increase the heat transfer rate. The objective of this paper was to compare the effect of heat transfer coefficient for notch and without fins. This paper mainly focuses on heat transfer rate of copper fin for greater heat transfer which is needed to increase rate of modernization and extent use of copper is tested. It was observe that, the heat transfer rate in notched fins is more than the un-notched fins. It was concluded that the average heat transfer coefficient for without notched fin is 8.3887 W/m2K and for 20% notched fins it is 9.8139 W/m2K. It was concluded that the copper plate gives better heat transfer rate than aluminum plate.

**Paisarn Naphon et al., [4**] their aim was to experimentally investigated heat transfer and pressure drop in the different angles of corrugated upper and lower plates. The experimentation was carried out for Reynolds number in the range of 2000 to 9000 and heat flux 0.5 to 1.2Kw/$m^2$. Experiments were conducted with various heat flux as well as flow rate of air. It was conclude that the heat transfer rate was higher as the air mass flow rate increases. Heat transfer obtained with the corrugated channel was3.5 times higher than smooth channel, and pressure drop was 5 to 6 times greater than smooth channel.

**S. Liu et al., [5]** this paper reviews experimentally and numerically studies of passive method such as twisted tape, wire coil, swirl generator and ribs etc., to enhance the thermal efficiency in heat exchanger. Researcher had studied in detail about the twisted tape, wire coil, baffles, inserts and ribs. They conclude that, twisted tape inserts perform better in laminar flow. Wire coil inserts gives better performance than the other inserts. Ribs, conical nozzle were more efficient in turbulent than laminar flow.

**P. Eiamsa-ard et al., [6]** studied the heat transfer enhancement and friction factor in the tubes inserted with rectangular-winged twisted-tapes as working fluid water. The wing-depth ratio was varied from 0.1 to 0.3 while the tape twist ratio was kept constant at y/W = 4. Twisted tapes were used as swirl generators. Experiments were held at uniform heat flux condition for Reynolds number between 5500 and 20,200. In this experiment the modified twisted tapes used with rectangular-wings and alternate-axes. Effects of the wing depth ratio (d/W= 0.1, 0.2 and 0.3) on the heat transfer, pressure drop and thermal performance factor characteristics were also examined. It was conclude that, the proper design of the twisted tapes provides an increased heat transfer rate with a reasonable pressure drop and the use of rectangular winged twisted-tapes is more promising than the use of twistedtapes with alternate axis for energy saving purpose. In comparison with experimental data, the heat transfer rate in the heat exchanger tube can be enhanced by insertion of rectangular winged twisted tapes. Experimentally readings shows that, the thermal performance factors of the tubes equipped with rectangular winged twisted tapes considerably increase with decreasing Reynolds number and increasing wing-depth ratio.

**Giovanni Tanda et al [7]** researchers had studied heat transfer in rectangular channel with transverse and V-shaped broken ribs. Experiment was conducted with uniform heat flux and ribs having rectangular or square section as a working fluid air. In this paper continuous and broken ribs were also considered. In this V- shaped ribs with an angle $45^0$ and $60^0$ are taken for comparing, and to observewhich one is better performing. It was found that, a transverse broken rib gives higher heat transfer augmentation under same mass flow rate. Broken or $60^0$ V- shaped ribs give higher heat transfer coefficient.

**SooWhanAhn et al., [8]** researcher investigated the heat transfer and friction factor characteristics inside a rectangular duct. One side roughed with five different shape of rectangular duct. In this study, the effects of rib shape geometries as well as Reynolds numbers were examined. The rib height-to-duct hydraulic diameter, pitch-to-height ratio, and aspect ratio of channel width to height are fixed at e/De=0.0476, P/e=8, and W/H=2.33. They used five different shape of rib such as square, triangular, circular, arc and semicircular, these ribs were sequentially installed on bottom wall of duct. Heat transfer coefficient and centerline friction factors on the bottom ribbed wall were measured. In this experiment, Reynolds number was varied between 10,000 and 70,000. It was found that, the square rib have highest value of friction factor, while triangular type of rib have a substantially higher heat transfer performance than any other one.

**MonsakPimsarn et al., [9]** in this paper the researcher investigated heat transfer in rectangular duct with Z shaped ribs. These ribs were set on the rectangular duct at 30°, 45° and 60° and flat rib was set at 90° relative to the air flow direction. They observed that, Ribs and fins improved heat transfer rate, but there was high friction head loss also, the ribs and fins obstructed the fluid flow and increased friction loss. These types of ribs created turbulence flow, vortex flow and impinging on heat transfer surface for increasing thermal performance. This paper focused on the development of Z- shaped rib for varying angle with three values (α= 30°, 45° and 60°).Experimental trial were performed in turbulent channel flows in a range of Reynolds number from 5000 - 23,000. The constant heat flux was provided to top surface only, and air is used as fluid flow. It was found that, the 45° Z-ribs can increase thermal efficiency which is more than that of smooth channel. It was observed that, the Nusselt number tends to increase with increasing Reynolds number. The $60^0$ Z-shaped rib provided highest increase in heat transfer enhancement.

**Prashanta Dutta et al., [10]**in these study researchersinvestigated the local heat transfer characteristics and the associated frictional head loss in a rectangular channel with inclined solid and perforated baffles. Combination of two baffles of same overall size was used in this experiment. Solid and perforated baffles of same overall size were studied. The leading edges of the baffle plates are kept sharp to reduce the flow disturbance by the protruding edge. The upstream baffle was attached to the top heated surface. Position and shape of other baffle are varied for enhanced heat transfer. Reynolds number for this experimental study is varied between 12,000 and 41,000. The heat transfer coefficient calculations were done on the heated top surface, while the bottom and side surfaces are unheated. In comparison with experimental data, it was found that, the overall heat transfer coefficient is much higher with two inclined baffles than that with a single baffle. For two inclined baffle the frictional head loss is much higher than that for a single baffle arrangement.

## IV CONCLUSION

From this review, various ways of enhancing the Heat transfer rate by generating the swirl flow of various surfaces such as surface roughness, flat and wavy endwall, corrugated surface, ribs. The most efficient way to dissipate the heat effectively is by improving the surface roughness and use of Ribs. This can be done by using different surface as we can increase in different applications.

## REFERENCES

[1] Mayank Uniyal, Anirudh Gupta, “Experimental And Numerical Study On Forced Convenction For Plained And Dimpled Surface In A Long Triangular Fin Bar”, International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181.

[2] Kenichiro Takeishiet,Yoshiaki Miyake,Yusuke Motoda,Yutaka Oda, “Convective Heat Transfer and Pressure Loss in Rectangular Ducts With Inclined Pin-Fin on a Wavy Endwall”, Journal of Engineering for Gas Turbines and Power.

[3]Shivdas S. Kharche, Hemant S. Farkade, "Heat Transfer Analysis through Fin Array by Using Natural Convection", International Journal of Emerging Technology and Advanced Engineering (ISSN 2250-2459, Volume 2, Issue 4, April 2012).

[4]Paisarn Naphon,Somchai Wongwises, "Heat transfer characteristics and pressure drop in channel with V corrugated upper and lower plates", Energy Conversion and Management 48 (2007) 1516–1524.

[5] S. Liu, M. Sakr, "A comprehensive review on passive heat transfer enhancements in pipe exchangers", Renewable and Sustainable Energy Reviews 19 (2013) 64–81.

[6] P. Eiamsa-ard,S. Eiamsa-ard and C. Thianpong "Influences of Twisted-Tape with Parallel Rectangular-Wing on Thermal Performance of a Heat Exchanger".

[7] Giovanni Tanda, "Heat transfer in rectangular channels with transverse andV-shaped broken ribs", International Journal of Heat and Mass Transfer 47 (2004) 229–243.

[8] SooWhanAhn and Kang PH Son, "An Investigation on Friction Factors and Heat Transfer Coefficients in a Rectangular Duct with Surface Roughness", KSME International Journal, VoL 16 No.4, pp. 549-556, 2002.

[9] MonsakPimsarn, Pongjet Promvonge and Parkpoom Sriromreun et al, "Augmented Heat Transfer in Rectangular Duct with Angled Z-Shaped Ribs".

[10] Prashanta Dutta and Akram Hossain, "Internal cooling augmentation in rectangular channel using two inclined baffles", International Journal of Heat and Fluid Flow 26 (2005) 223–232.