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An Effect of Different Aluminium Fins and Internal Grooving of Air Cooled Counter to Cross Flow Heat Exchanger – A Review

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ABSTRACT

A heat exchangers are device which heat exchanges among two or more fluids. Heat exchanger are using for the heating and cooling systems in domestic and industrial operations. When heat exchanger devices are used in any operation than some heat losses in atmosphere. We studied different research paper and analyzed the performance parameter of heat exchangers. After studied of different research paper, I found new idea to get better the thermal performances of counter to cross flow by using air cooled heat exchanger[ACHE] process. Constrained geometry structures are counter to cross flow using air cooled heat exchangers process. In air cooled heat exchanger[ACHE] process are using spiral grooved GI concentric tube and rectangular copper fins. Hot water will be flow in spiral grooved GI tube and rectangular aluminium fins will be fitted on tube. A fan will be fitted perpendicular to the tube which expand cold air through the fan on tube. When the hot fluid will be flow in tube then internally spiral groove shaped of tube due to high turbulence in fluid. Rectangular aluminium fins will be fitted on the GI tube and heat will be exchanged. When the hot fluids will be flow in GI concentric tube inlet to outlet then the air expanded on tube due to heat exchanges. Where will be copper fins fitted on the annular tube due to increases the rate of the heat transfer. Such as the hot fluid inlet in annulus where are aluminium fins are fitted on the tube due to the rate of the heat transfer are also to be increases. The fans will blow the air on tube due to hot fluid will be decreases the temperature outlet of tube. We willbe temperature difference found input and output of the hot fluid.

Keywords: Air Cooled Heat Exchanger, Internal grooved tubes, Rectangular Aluminium fins

1. INTRODUCTION

A heat exchanger is a heat-transfer devise that is used for transfer of internal thermal energy between two or more fluids available at different temperatures. In most heat exchangers, the fluids are separated by a heat-transfer surface, and ideally they do not mix. Heat exchangers are used in the process, power, petroleum, transportation, air conditioning, refrigeration, cryogenic, heat recovery, alternate fuels, and other industries. Common examples of heat exchangers familiar to us in day-to-day use are automobile radiators, condensers, evaporators, air preheaters, and oil coolers. Heat exchangers could be classified in many different ways. A heat exchanger consists of heat transfer elements such as a core or matrix containing the heat transfer surface, and fluid distribution elements such as headers, manifolds, tanks, inlet and outlet nozzles or pipes, or seals. Usually, there are no moving parts in a heat exchanger; however, there are exceptions, such as a rotary regenerative exchanger (in which the matrix is mechanically driven to rotate at some design speed) or a scraped surface heat exchanger.

A heat exchanger consists of heat-exchanging elements such as a core or matrix containing the heat-transfer surface, and fluid distribution elements such as headers or tanks, inlet and outlet nozzles or pipes, etc. Usually, there are no moving parts in the heat exchanger; however, there are exceptions, such as a rotary regenerator in which the matrix is driven to rotate at some design speed. The heat- transfer surface is in direct contact with fluids through which heat is transferred by conduction. The portion of the surface that separates the fluids is referred to as the primary or direct contact surface. To increase heat-transfer area, secondary surfaces known as fins may be attached to the primary surface**.** Some of the noteworthy contribution in the field of heat exchanger is presented in this section which gives us the idea of further research by finding a suitable research gap among the latest research work

Tubes

Round tubes in various shapes are used in shell-and-tube exchangers. Most common are the tube bundles with straight and U-tubes used in process and power industry exchangers. However, sine-wave bend, J-shape, L-shape or hockey sticks, and inverted hockey sticks are used in advanced nuclear exchangers to accommodate large thermal expansion of the tubes. Some of the enhanced tube geometries used in shell-and-tube exchangers are Serpentine, helical, and bayonet are other tube shapesthat are used in shell-and-tube exchangers.

Types of air cooled heat exchanger [ACHE]:

- Induced draft ACHE
- Forced draft ACHE
- Natural draft ACHE

- **Forced draft ACHE** - In air cooled heat exchanger the fan is situated underneath theprocedure pack and air is constrained through the tubes.

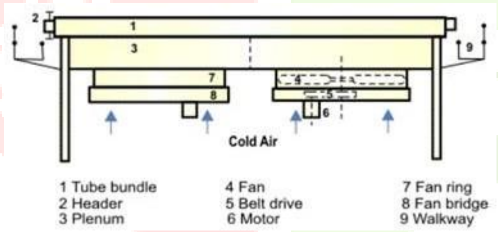


FIG.1- Forced Draft ACHE

- **Induced draft ACHE -** In air cooled heat exchanger the fan is situated over the procedure pack andair is pulled, or prompted, through the tubes

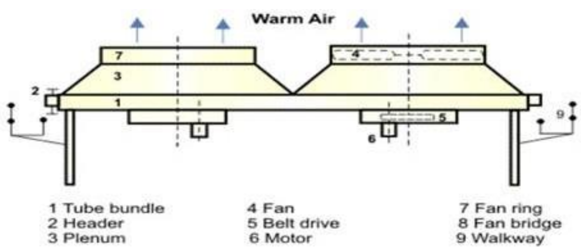


FIG.2-Induced Draft ACHE

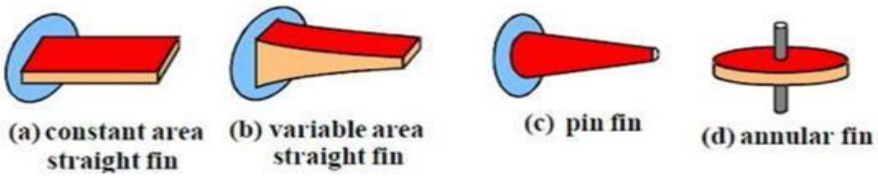
- **Natural draft ACHE-** Natural draft air cooled heat exchanger are synonymous. There are no used fans to drive air. In the natural draft air drive through the tubes group. Its logic are comparableto induced draft.

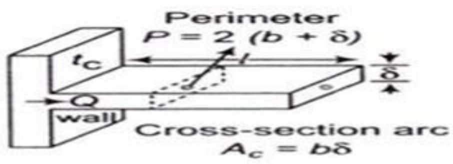
FINS

These exchangers may be classified as conventional and specialized tube-fin exchangers. In a conventional tube-fin exchanger, heat transfer between the two fluids takes place by conduction through the tube wall. However, in a heat pipe exchanger (a specialized type of tube-fin exchanger), tubes with both ends closed act as a separating wall, and heat transfer between the two fluids takes place through this ''separating wall'' (heat pipe) by conduction, and evaporation and condensation of the heat pipe fluid. Let us first describe conventional tube-fin exchangers and then heat pipe exchangers**.**

In a tube-fin exchanger, round and rectangular tubes are most common, although elliptical tubes are also used. Fins are generally used on the outside, but they may be used on the inside of the tubes in some applications. They are attached to the tubes by a tight mechanical fit, tension winding, adhesive bonding, soldering, brazing, welding, or extrusion**.**

There are various type of fin:





Rectangular Fin Diagram

Such as there are various type of the fins but we will be used constant area straight fin[rectangular fin] because its surface are equal due to heat transfer are equal at every point of the fins surface due to enhances the rate of heat transfer of the surface. Such as rectangular fins will be used in air cooled heat exchanger because rectangular fins material will be copper due to its thermal conductivity are high. In air cooled heat exchanger when hot fluid will be flow in GI tube than the rectangular copper fins are brazing on the GI tube due to rectangular copper fins will be the heat transfer rates will beincreased on the surface of tubes .

LITERATURE REVIEW

Asif Afzal, Mohammed Samee et al. [1] Presents an experimental setup for optimal spacing between the external grooved heat exchanger tube. In this work author presents three different grooved tubes with different spacing (pitches) one of the tube is plain in design on the other hand other two of them having pitches of 10 mm and 15 mm after considering all three design for the heat transfer analysis on the basis of result obtained we conclude the with increase of air velocity (Re) the tube surface temperature with grooves and without grooves gets significantly reduced with respect to plain tube. On the other hand the nusselt number in grooved tube is found to either same or lower than the plain tube due to flow velocity reduction at the surface. There also exists an optimum spacing between the heated vertical parallel tubes at which heat transfer rate reaches its maximum value.

C. Nithiyesh Kumar1 and M. Ilangkumaran et al. [2] The present study provides the experimental investigation of thermal performance and exergy analysis in an internally grooved (IG) tube fitted with triangular cut twisted tape insert consisting of alternate wings (TCTT). The analysis is carried out with TCTT for different twist ratio, y = 3.5, 5.3 and 6.5 with attack angle, β = 45° and 90°. The investigations were performed in turbulent regime, with Reynolds number ranging from 3000 to 14,000. The thermal and energy efficiencies were used to evaluate the overall performance of the heat exchanger, by considering energy gain and energy lost. The experimental results reveal that, both the thermal efficiency and energy efficiency of the IG tube equipped with TCTT were found to be increased up to1.12 and 1.85 times, respectively, than those that with plain twisted tape (PTT). The integration of IG tube with TCTT creates synergy effect, which increases the overall performance compared to single ones. This is due to the effect of swirl flow induced by TT, along with vortices generated by wings, which results in thinner boundary layer and increased heat transfer.in the study we also find that the Nu increases with increase in Reynolds number and the average value of Nu for IG tube with TCTT is higher than that for plain IG tube by about 46.1%.

Zhisong Li et al. [3] In this work author proposed a new heat pipe structure, replacing the conventional axial-grooved or sintered wicks with spiral coil and simple piping container. The proposed heat pipe structure is introduced for its design and operational mechanism. With the help of two test articles fabricated preliminary experiments were carried out to investigate the heat transfer performance with different wire diameters and compare with a charged container without coil wick. We also find that the spiral coil successfully functioned as a capillary wick. When talking about the local transverse temperature difference, it existed in the heat pipe due to gravity influence and for evaporation, the coil wick of 0.5 mm wire diameter performed much better than the 0.4 mm wire, The proposed arterial heat pipe with coil wick of 0.5 mm wire realized high effective thermal conductivity of the same order of magnitude with an AGHP. Considering its satisfactory heat transfer performance and advantageous design for integrating with the spacecraft structures, this novel wick structure deserves more attentionsin future research and applications.

Pengxiao Li, Peng Liu et al. [4] In the present study, the heat transfer and flow performance in turbulent flow of the tube fitted with the drainage inserts are investigated. The results show that the new-type insert can lead the fluid at the core to the tube wall, strengthening the mixing of cold and hot fluid. And the insert also generates the vortex to make perturbation in the fluid domain. The experiment investigates the influence of pitch ratio on the Nusselt number and friction factor. The Nusselt number and friction factor both increase with the decrease of pitch ratio. And the pitch ratio of 3.3 is recommended for the insert. Some numerical results validated by the experimental results are also shown in the study to analyze the influence of slant angle on heat transfer and flow performance. The results indicate that 45◦ is suggested as the best slant angle for the insert. In the study, the heat transfer and flow performance of the tube fitted with drainage inserts in turbulent flow are investigated by both experimental and numerical methods. The experiment studies the influence of pitch ratio on Nu and f, while the simulation studies the influence of slant angle. The flow structure and mechanism of heat transfer enhancement are also analyzed. The new-type inserts can lead the fluid in core flow region to tube wall flow region, and the fluid scours the tube wall with a higher flow rate than mean flow rate. At the meantime, the vortexes are generated and strengthened by the perturbation of inserts to fluid. So the mixing of fluid in the near wall domain and core flow domain is enhanced, leading to a better heat transfer performance but also a larger pressure drop compared with smooth tube.

Pankaj N. Shrirao, Rajeshkumar et al. [5] This work presents an experimental study on the mean Nusselt number, friction factor and thermal enhancement factor characteristics in a circular tube with different types of internal threads of 120 mm pitch under uniform wall heat flux boundary conditions. In the experiments, measured data are taken at Reynolds number in range of 7,000 to 14,000 with air as the test fluid. The experiments were conducted on circular tube with three different types of internal threads viz. acme, buttress and knuckle threads of constant pitch. The heat transfer and friction factor data obtained is compared with the data obtained from a plain circular tube under similar geometric and flow conditions. The variations of heat transfer and pressure loss in the form of Nusselt number (Nu) and friction factor (f) respectively is determined and depicted graphically. It is observed that at all Reynolds number, the Nusselt number and thermal performance increases for a circular tube with buttress threads as compared with a circular tube with acme and knuckle threads. These are because of increase in strength and intensity of vortices ejected from the buttress threads. Subsequently an empirical correlation is also formulated to match with experimental results with ± 8% and ± 9%, variation respectively for Nusselt number and friction factor.

Kadir Bilen a, Murat Cetin et al. [6] An experimental study of surface heat transfer and friction characteristics of a fully developed turbulent air flow in different grooved tubes is reported. Tests were performed for Reynolds number range 10,000 to 38,000 and for different geometric groove shapes (circular, trapezoidal and rectangular). The ratio of tube length-to-diameter is 33. Among the grooved tubes, heat transfer enhancement is obtained up to 63% for circular groove, 58% for trapezoidal groove and 47% for rectangular groove, in comparison with the smooth tube at the highest Reynolds number (Re = 38,000). Correlations of heat transfer and friction coefficient were obtained for different grooved tubes. In evaluation of thermal performance, it is seen that the grooved tubes are thermodynamically advantageous (Ns, a < 1) up to Re = 30,000 for circular and trapezoidal grooves and up to Re = 28,000 for rectangular grooves. It is observed that there is an optimum value of the entropy generation number at about Re = 17,000 for all investigated grooves. We conclude the heat transfer rate increases with increasing Re for all grooves due to causing thinner boundary layer. The variation of friction coefficients of all grooved tubes tends to be closer to each other in the considered range of Re and it is seen that f is almost independent of Re. Nusselt number and friction factor for each grooved tube and smooth tube were correlated as a function of the flow conditions. For the grooved tubes, maximum heat transfer enhancement is obtained up to 63% for circular groove, 58% for trapezoidal groove and 47% for rectangular groove, in comparison with the smooth tube. For the rectangular grooved tube, less increase in heat transfer enhancement is obtained, because it is speculated that the fluid flows resulting in by pass of the flow over the groove and increases the formation of the recirculation region inside therectangular grooves.

P. Bharadwaj, A.D. Khondge et al. [7] From this paper we get insight of pressure drop and constant wall heat flux heat transfer measurements in a 75-start spirally grooved tube with and without twisted tapes and with water as working fluid ($Pr \approx 5.4$) have yielded highly non-linear behaviour of f and Nu with Reynolds number and twist ratio Y. Constant pumping power comparison with smooth tube shows that the spirally grooved tube without twisted tape yields maximum heat transfer enhancement of 400% in the laminar range and 140% in the turbulent range. However, for 2500 < Resm< 9000, reduction in heat transfer is noticed. Similar comparison for spirally grooved tube with twisted tape shows maximum enhancement of 600% in the laminar range and 140% in the turbulent range. However, deterioration in heat transfer is observed at Y = 10.14 (anticlockwise) for 6000 < Resm < 13,000. The measurements have indicated that flow and heat transfer in a spirally grooved tube are influenced by extremely complex interactions between momentum and heat transfer in the vicinity of the grooved wall resulting in highly nonmonotonic and non-linear behavior at $Pr \approx 5.4$.

M. Siddique, A.R. A. Khaled et al. [8] In this paper, the various heat transfer enhancers are described such as extended surfaces including fins and microfins, porous media, large particles suspensions, nanofluids etc. Different research reviewed different methods among of these methods presented in the literature are using joint-fins, fin roots, fin networks, biconvections, permeable fins, porous fins, helical microfins, and using complicated designs of twisted tapes it was found that additional attention should be made towards uncovering the main mechanisms of heat transfer enhancements due to the presence of nano fluids. Moreover, we concluded that perhaps the successful modeling of flow and heat transfer inside porous media, which is a well recognized passive enhancement method, could help in well discovering the mechanism of heat transfer enhancements due to nano fluids. Eventually, many recent works related to passive augmentations of heat transfer using vortex generators, protrusions, and ultra high thermal conductivity composite material have been reviewed. Finally, the estimated maximum levels of the heat transfer enhancement due to each enhancer described in this report.

S Basavarajappa, G Manavendra, S B Prakash et al. [9] In this paper, to enhance the heat transfer various types of fins were used in this review paper. Different fin geometries like rectangular, triangular, trapezoidal fins, Pin fins, wavy fins, offset strip fins, louvered fins and perforated fins are used in order to analyse the heat transfer rate and pressure drop measurement, various parameters like fin pitch, orientation, height and different types grooves used to study heat transfer rate, Pressure drop, Nusselt number friction factor Rayleigh number. Research works on variety of fins showed that, it improves the heat transfer by increasing the exposed area to allow more heat transfer and as well as disturbing the flow to produce turbulence and causing bulk fluid mixing. It was clear that standard wavy and rectangular fins provided better heat transfer but increased in pressure drop.

S Basavarajappa, G Manavendra, S B Prakash et al. [10] In this paper, two internally grooved horizontal tubes are studied one is made up of HCFC22 and other of R410A this study was based on both evaporation and condensation. From the result the effect of heat transfer due to shape difference on internal grooving are reported. The herring-bone grooved heat exchanger shows more effective heat transfer than that of conventional spiral grooved tube for evaporation on the other hand the conventional spiral grooved performs well with respect to herring-bone grooved tube when heat transfer is consider in case of condensation. This paper also predicates the drop of pressure inside a grooved tube with betterheat transfer rate.

3.OBJECTIVES

After study of different research paper, I understood about different types of grooved pipe, fins , air cooled heat exchanger configurations using is presented by different authors. By Bayram Sahin research,

- In this Optimization of intend parameter for heat transfer and friction factors in heat sinks with hollow trapezoidal baffle exploratory investigation,
- The impact of various structure parameters on warmth move and weight drop qualities in a warmth sink furnished with trapezoidal astounds were examined by applying Taguchi trial planstrategy.
- In this research papers experimental investigations on thermal performances of phase changed materials attached with three-dimensional oscillating heat pipe (PCM/3DOHP) for thermal management application analysis by Jie Qu.
- In this paper, two sorts of frameworks (PCM/3D-OHP and PCM/ OHPs framework) for warm administration application have been made and tried during liquefying and cementing process. By author Anna Pacak investigation of power demand calculations to freeze prevention method of counter flows heat exchanger used in energy revival from exhaust air.
- In which state that a hypothetical examination of heat and mass exchange in a counter-stream heat exchanger utilizes for energy retrieval in air taking care unit (AHU) under below zero working conditions is displayed.
- In other follow a line of investigation by author Jian Wang investigate the heat transfer and flow characteristic in fin

copper foam heat sink subjected to jet impingement cooling.

- In this research states that the heat move and weight drop of five sorts of warmth sinks showing to impingement cooling by rectangular space flow and fundamental fan. From the above research paper, various authors explained the operation on different tube and fins material andtube in different grooving profile with different fluid flow**.**

4.EXPECTED OUTCOME

In this paper, a thorough examination is displayed on the Air cooled heat exchanger (ACHE), on reviewing various papers based on internal grooving, different fin designing, external grooving and internal grooving with different fin we analyzed the heat transfer rate of the heat exchanger.

- Many researchers point out the design limitation of a simple internal grooved ACHE hence a lot of work has been carried out on internal grooved based exchanger which become very common topic for experimental as well as simulation based study and this concept getremarkable results as well.
- However in latest literature available of ACHE a new concept of varying pitches based external grooved heat exchanger is also introduced but it need further research. From the reference of 10 International Journal on heat exchanger,
- we understand the common research area of air cooled heat exchanger and also find a research gap in the internal spiral grooving with varies pitch heat exchanger . but very few researcher work on varying pitches of the grooved tube,
- one of the latest paper focused on it but for external grooving hence there is a huge scope of research work on varying pitches based internal grooved ACHE, hence this area of research motivate us to carry out our research further.

REFERENCES

[1] Afzal, A., Mohammed Samee, A.D., Abdul Razak, R.K "Optimum spacing between grooved tubes: An experimental study', Journal of Mechanical Science and Technology, Vol 34, No. 1, January 2020.

[2] Nithiyesh Kumar, C., Ilangkumaran, M., “Experimental study on thermal performance and exergy analysis in an internally grooved tube integrated with triangular cut twisted tapes consisting of alternate wings”, Heat and Mass Transfer, Vol 55, April 2019.

[3] ZhisongLi. “Design and preliminary experiments of a novel heat pipe using a spiral coil as capillary wick”. International Journal of Heat and Mass Transfer Volume 125, November 2018.

[4] Pengxiao Li, Peng Liu, Zhichun Liu, Wei Liu “Experimental and numerical study on the heat transfer and flow performance for the circular tube fitted with drainage inserts”. International Journal of Heat and Mass Transfer Volume 107, April 2017.

[5] Pankaj N. Shrirao, Rajeshkumar U.Sambhe, Pradip R.Bodade, “Convective Heat Transfer Analysis in a Circular Tube with Different Types of Internal Threads of Constant Pitch”. International Journal of Engineering and Advanced Technology (IJEAT), Volume2, Issue-3, February 2013.

[6] Kadir Bilen, Murat Cetin, Hasan Gul, Tuba Balta, “The investigation of groove geometry effect onheat transfer for internally grooved tubes”. Applied Thermal Engineering, Volume 29, Issue 4, March 2009.

[7] P. Bharadwaj, A.D. Khondge, A.W. Date, “Heat transfer and pressure drop in a spirally grooved tube with twisted tape insert” International Journal of Heat and Mass Transfer, Volume 52, Issues 7–8,March 2009.

[8] M. Siddique, A.-R. A. Khaled, N. I. Abdulhafiz, and A. Y. Boukhary, “Recent Advances in Heat Transfer Enhancements: A Review Report”, Hindawi Publishing Corporation, International Journal of Chemical Engineering, Volume 2010, September 2010.

[9] S Basavarajappa, G Manavendra and S B Prakash, “A review on performance study of finned tubeheat exchanger”, Journal of Physics: Conference Series, Vol. 1473, No. 1, February 2020.

[10] M Goto, N Inoue, N Ishiwatari, “Condensation and evaporation heat transfer of R410A insideinternally grooved horizontal tubes, Vol. 24, Issue 7, July 2001.

[11] M. Goto, N. Inoue, R. Yonemoto, “Condensation heat transfer of R410A inside internally groovedhorizontal tubes”, Int. J. Refrig. 26 (2003) 410–416.

[12] V. Zimparov, “Enhancement of heat transfer by a combination of three-start spirally corrugatedtubes with a twisted tape”, Int. J. Heat Mass Transfer 44 (3) (2001) 551–574.

[13] P.G. Vicente, A. Garcia, A. Viedma, “Experimental investigation on heat transfer and frictional characteristics of spirally corrugated tubes in turbulent flow at different Prandtl numbers”, Int. J. Heat Mass Transfer 47 (4) (2004) 671– 681.

[14] P. Naphon, M. Nuchjapo, J. Kurujareon, “Tube side heat transfer coefficient and friction factor characteristics of horizontal tubes with helical rib”, Energy Convers. Manag. 47 (18–19) (2006) 3031–3044.

[15] AGS Roll Groove Specifications for 14-72"/DN350-DN1800 roll groove dimensions, © 2019 Victaulic Company**.**