A STUDY ON VARIOUS HEAT TRANSFER ENHANCEMENT TECHNIQUES

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ABSTRACT:- *As there is a higher increase in usage of electronic devices with higher power levels, the removal of heat flux is an irresistible need. There are numerous ways it can be done like conduction, convection (forced and natural) But still they have a drawback of non-uniformity and high pressure drop. So here comes the usage of micro channels with two-layered, stacked and strip fins with the help of constructal theory. Louvered and wavy fins have evolved drastically in its own way to fulfill the heat transfer with minimum drawbacks. Numerous ways have been proposed to enhance heat transfer of higher Reynolds number, but in this we have discussed ways to enhance heat transfer with lower Reynolds number.*

INTRODUCTION

In the last few decades the required attention has been given to heat transfer development in thermal devices because of increased demands by industries to improve efficiency and also to reduce cost of heat exchanger equipment. To fulfill the above need several studies had been done on wavy and louvered fins. To improve the thermal efficiency of wavy fins and louvered fins Constructal theory is used. Constructal design is one of the technique to find the optimal configuration with good thermal performance.

While designing the heat exchanger considerable improvement is also given to material usage and energy factor. Other constraints are size of device, its weight and also manufacture simplicity. To improve heat transfer characteristics wavy and louvered channel is used as one of the Passive method. This configuration can obtain the benefit of enhanced heat transfer but increase in pressure drop is one of critical problems.

CONSTRUCTAL THEORY:

The Constructal law helps in understanding of animate and inanimate designs. This law holds better in defining the universal designs solid structure formulating and organs finite size. Governing the generation of configuration in nature is called constructal theory. The system configuration is free to change in time such that it provides easier access to its currents.

SURVEY ON WAVY FINS:

[1]As for as geometric point of view is concerned natural system that displays a numerous variety of shapes are not perfect that is they are not symmetrical. Constructal law is helpful for engineered system to find configurations that has optimal distribution of imperfection. Zimparov el al. [2] studied the performance of a two stream-parallel flow heat exchanger, in the form of a tree network. It incorporates the relation between effectiveness and Number of heat transfer units (NTU) and also the compared the performance of parallel flow and counter flow configuration. Luo et al. [3] initiated to solve the problem of flow misdistribution they introduced idea of coinciding the Constructal collectors/distributions with mini cross flow heat exchanger to reduce the problem of misdistribution.

Raja et al. [4] with help of constructal theory he analyzed the multi block heat exchanger. Mathematical simulation were carried out at various heat capacity rate ratios on finned and unpinned constructed heat exchanger by keeping the heat transfer area constant. This analysis showed the effectiveness of constructal heat exchanger in both finned and un finned were higher by around 20% compared to conventional cross flow heat exchanger. Luo et al. [5] studied experimentally constructal distributor to develop a binary pattern of pores and flow equidistribution in multi-channel heat exchanger.

With different assembly configuration of constructal distributors thermal performance and pressure drop were determined. To make some relatively better thermal performance and low pressure drop in all tested configuration inlet characteristics was designed with convectional pyramid distributor and outlet configuration is designed with constructal collectors. It shows better performance under experimental conditions.

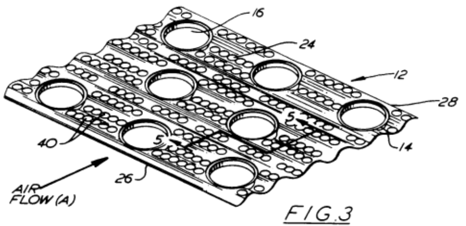


FIG.3

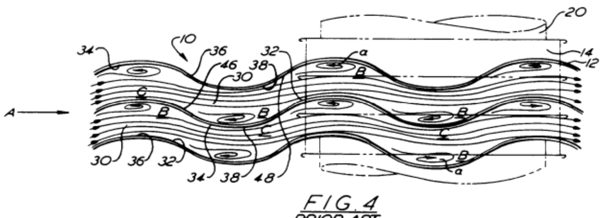


FIG.4
PRIOR ART

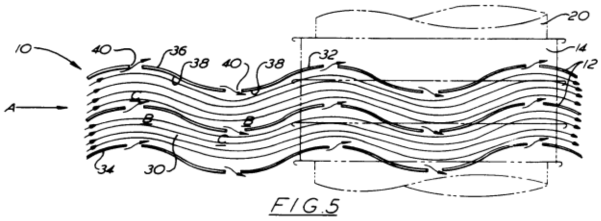


FIG.5

Azad and Amidpour. [6] experimented on optimization of shell and tube heat exchanger to reduce the total cost of the heat exchanger. By this capital cost of heat exchanger is reduced and overall heat transfer coefficient was increased and also the frictional pressure losses were minimized.

Martin et al. [7] introduced a universal computational model for regenerators fed by a hot fluid stream on one side where as the other side indulges with a fluid mixture. Bejan and Lorente. [8] concentrated on flow configuration based on constructal theory. The overall performance is maximized by balancing and arranging the various flow resistant in flow system. Ghaedamini et al.[9] analyzed the svelteness as an important factor which enrolls the bifurcation angle effect on pressure drop and flow distribution. Lee et al.[10] used constructal theory to reduce the global pressure drop in comb like channel network with self-heating and self cooling.

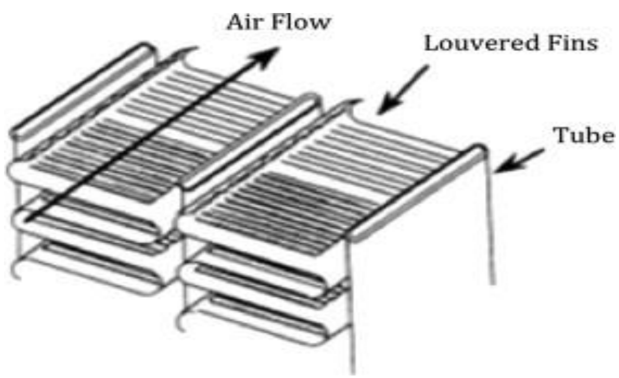
These studies give the idea on numerical study and optimization of corrugated wall channel by constructal law. The final target is to maximize the dimensionless heat transfer and also minimize the pressure drop. Amplitude ratio, wavelength ratio and wall to wall spacing parameters are used to compare the performance of the different geometries for finding the best configuration.

SURVEY ON LOUVERED FINS:

Lorenzini and Moretti have experimented on thermal hydraulic performance on different shaped fins like I and Y shape. After analyzing the results have showed that I fins are comparatively less performance than the Y shaped one. Another person Miguel has used the Constructal theory to prefer better efficiency of solar energy based systems. The flow structure holds good when the diameter and the heights are non-uniform. The performance is be analyzed within a range of 50 to 2000 Re that is they are of low Re and of Laminar flow. After performing the analysis that has stated three characteristics determining the performance. They are lower ratio, angle ratio and lower length ratio. The lower pitch and angle ratio is the main factors that enrolls heat transfer and pressure drop. When there is a increase in 10 degree of lowered angle there is an increase in 26% pressure drop but still maximum heat transfer rate is obtained. The lower length ratio helps in vertex shedding. The main thing recurring here is the steady, incompressible, laminar and 2-Dimensional.

De Jong and Jacobi stated as the lower angle increases the flow becomes more lower directed and has greater pressure drop. Zhang and Tafli have declared that the lower angle is an important variable that defines the thermal performance of the channel. In their study the assumptions made are;

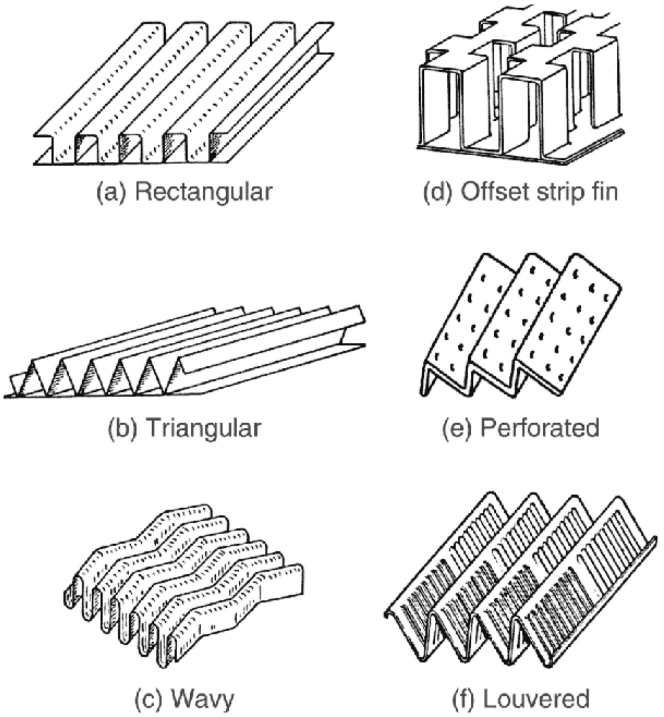
- Heat transfer due to radiation and natural convection is neglected.
- The fluid properties have been assumed constant.
- Incompressible flow has been worked out.



Louvered fins are widely used in fin-tube and flat-tube heat exchanger because their geometric properties and expanding heat transfer areas increase the heat transfer rate. These fins also make a large pressure drop. It can be improved by satisfying the conflicting physical requirement to reduce pressure drop and augment the heat transfer rate. They also selected important parameters and carry out optimization to improve the performance of corrugated louvered fin. Therefore, study of optimal design of louvered fin is necessary to overcome this conflicting physical phenomenon.

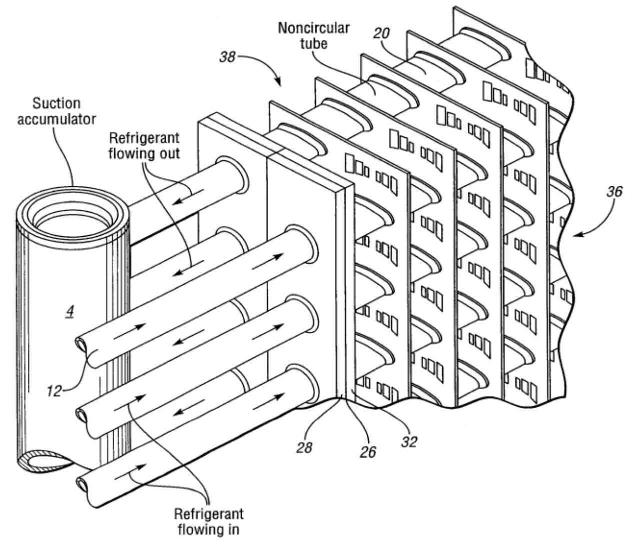
CIRCULAR AND NON CIRCULAR TUBES:

Najla El Gharbi et al analyze this work is to gain insight into the characteristics of heat transfer and fluid flow in different tube bundles arrangements: circular, ellipsoidal and wing shapes. In the recent years, cross flow heat exchangers with non-circular tube have been receiving increased attention. The main purpose of this work is to gain insight into the characteristic of heat exchanger and fluid flow in different tube bundle arrangements\ for heat exchanger taking into account local and bulk entropy generation. This could provide a new wave for engineers to design an optimal network of heat exchangers allowing the enhancement of heat transfer and recovery in industrial applications. In this work, a numerical study has been conducted to investigate the heat transfer and pressure drop characteristics and effectiveness of cross flow heat exchanger employing staggered tube bank with different tube's shapes. There were three studied geometries circular, elliptical and wing shaped. In contrast to the circular tubes which cause severe separation and large wakes that leads to high pressure drop, non-circular tubes of stream lined shapes offer relatively lower pressure drops. The results show also that there is no best geometric shapes valid across all flow conditions i.e., across all Reynolds number with respect to the minimizing of the entropy generation. However results shows that when Re > 15000, the circular shape is clearly worse than other two geometries and for Re>23000 the elliptical shape is best, albeit by only small margin compared to wing shaped tubes.



CIRCULAR AND OVAL TUBE SURVEY:

Ala Hasan et al analyzed the performance of two evaporative cooled heat exchangers. One as plain circular tubes while the other one has plain oval tubes. Both are investigated under similar operating conditions in relation to air flow rates and inlet hot water temperatures. Circular tube is 10 mm outter diameter and oval tube (axes ratio 3.085) is formed from a 18 mm outter diameter circular tube whose perimeter is preserved after forming. It is concluded that the average mass transfer Colburn (J_m) factor for the oval tube is 89 percentages of that of circular tube, while the average friction factor f for oval tube is 46% of that for that circular tube. The ratio (J_m/f) for the oval tube is 1.93-1.96 times of that for that circular tube. The heat mass transfer analogy showed lower values for the mass transfer coefficients estimated from dry heat transfer correlation when compared with wet measurements.



RESULT AND DISCUSSION:

We have devised various analysis to revise the effects of the design parameters on the performance of a louvered and wavy fins. Jf factor is one of the main factor to represent the performance of a louvered fins. With constructal law they have optimally designed the louverd fins. The generalization incur that the parameters like fin pitch, louvered pitch and louvered angle has major influence. Since the effect of change of thickness changes only 0.5% they are been neglected as major influence. The result states that with optimal design improves the jf factor upto 14-32% and maintaining the pressure drop the error range occurs till 3.8% while devising the optimal design.

When the amplitude ratio is increased the heat transfer rate gradually increases to reach the maximum value and after reaching the maximum value even though the amplitude ratio increases the heat transfer rate gradually decrease. This states that the amplitude ratio has no stable influence on heat transfer rate. The dimensionless channel space S is a feature that influences the heat transfer rate. The Reynolds number get increased when the gap between two walls is increased. Thus flow mixing becomes stronger resulting in improving the heat transfer rate. In wavy fins amplitude ratio value approximately 0.7 had a good configuration which enhanced heat transfer rate by 39%.

Enhancement of heat transfer characteristics of shell and tube heat exchanger by thermal analysis on various tube cross sectional shape and tube material reported in this work. In this work numerical study has been conducted investigate heat transfer characteristics of shell and tube heat exchanger by employing staggered tube bank with different tube cross sectional shapes. From analysis of tube shapes, it is clear that the circular cross section is the most efficient cross section among the three cross section circular, elliptical and oval. It is because of circular cross section tube having low turbulence kinetic energy compared with other two. Turbulence kinetic energy values are 0.076 m^2/s^2 for circular cross section, 0.12m^2/s^2 for oval cross section and 0.132m^2/s^2 for elliptical cross section. So it is concluded that the circular shape is efficient. From the study tube material copper has best possible value of heat flux among three materials. So it is clear that copper is the most efficient material among three materials copper, steel and brass. Various characteristics such heat transfer coefficient, effectiveness where calculated from the experimental studies for both parallel and counter flow. It is found that counter flow configuration is efficient then parallel flow configuration.

CONCLUSION:

In accordance with the above studies it is too clear that many factors holds responsible for the performance of heat exchanger and the effectiveness. This was obtained by the formulas of the cumulative effect on all factors over the performance. Insulations may play a major role in increasing the rate of heat transfer if the thickness maintained at the critical thickness. The turbulence may also provide the better effectiveness for a heat exchanger but there exist no direct relation between the turbulence and effectiveness. Conceptual design is discussed to improve the new generation of wavy and louvered fins by using the Constructal theory. The study on Optimal configuration results in increasing the rates of heat transfer by around 26% and decreasing the pressure drop by 54% compared by baseline channel. So there exist many ways in the performance and heat transfer rate can be increased. One method may benefit in one way, but still it can have drawbacks. Hence it is the developer who needs to select the best method according to the requirement.

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