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Heat Transfer Enhancement of Fin and Tube Heat Exchanger Using Vortex Generator

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***Abstract*—In this study we are going to study a numerical analysis conducted to investigate the influence of interrupted surfaces on compact heat exchangers. The performance of CHX'x in terms of heat transfer enhancement and pressure drop can be augmented by incorporating innovative passive techniques. The effect of vortex generators with different number of rows, attack angles and configuration on heat transfer performance and pressure drop will be demonstrate.**

***Keywords*— Heat Exchanger, Fins, Vortex Generator**

I. Introduction

Heat Exchanger: A heat exchanger is a system used to transfer heat between a source and a working fluid. Heat exchangers are used in both cooling and heating processes the fluids may be separated by a solid wall to prevent mixing or they may be in direct contact. They are widely used in space heating, refrigeration, air conditioning, power stations, chemical plants, petrochemical plants, petroleum refineries, natural-gas processing, and sewage treatment. The classic example of a heat exchanger is found in an internal combustion engine in which a circulating fluid known as engine coolant flows through radiator coils and air flows past the coils, which cools the coolant and heats the incoming air. Another example is the heat sink, which is a passive heat exchanger that transfers the heat generated by an electronic or a mechanical device to a fluid medium, often air or a liquid coolant.

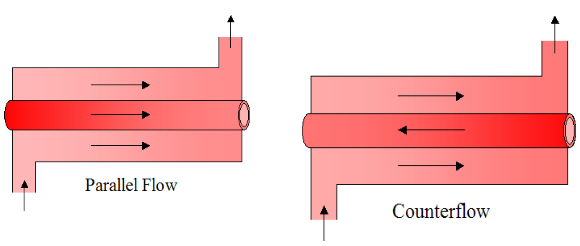

Fig 1. Parallel flow and counter flow heat exchanger arrangement

Fin: In the study of heat transfer, fins are surfaces that extend from an object to increase the rate of heat transfer to or from the environment by increasing convection. The amount of conduction, convection, or radiation of an object determines the amount of heat it transfers. Increasing the temperature gradient between the object and the environment increasing the convection heat transfer coefficient, or increasing the surface area of the object increases the heat transfer. Sometimes it is not feasible or economical to change the first two options. Thus, adding a fin to an object increases the surface area and can sometimes be an economical solution to heat transfer problems.

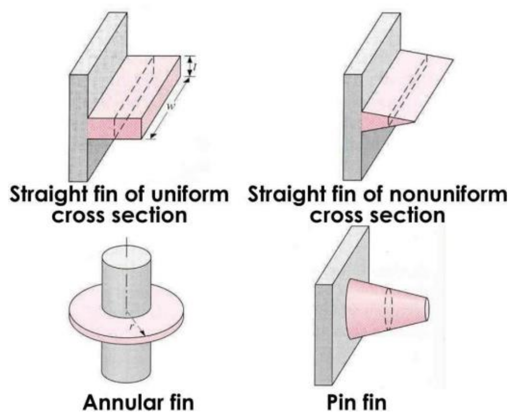

Fig.2 Types of fins

Fin and Tube Heat Exchanger: Fin tube heat exchanger is a heat exchanger consisting of finned tube (also known as finned pipe) with supporting structure and shell. Finned tube is the main heat exchanger. Finned tube is composed of base tube and fin. The combination mode includes expansion joint, high-frequency welding, laser welding and so on .Tube-fin heat exchanger is one of the most efficient heat exchangers. It is widely used in many fields, such aspower, refrigeration and heating, chemical industry, medicine, food and beverage.

Compared with traditional heat exchangers, tube fin heat exchangers have the following characteristics:

The heat transfer area is greatly increased, which is 2-10 times higher than the heat transferareaof the light pipe, and it is more efficient and energy saving.

It can promote the formation of fluid turbulence, and the heat transfer coefficient is 1-2 times higher than that of the light tube. Compact structure; reduce consumption of metal materials, less space and space.

The fins can be different from the base materials, and the selection and utilization of materials are more reasonable and economical.

Long service life, no string liquid, low maintenance cost.

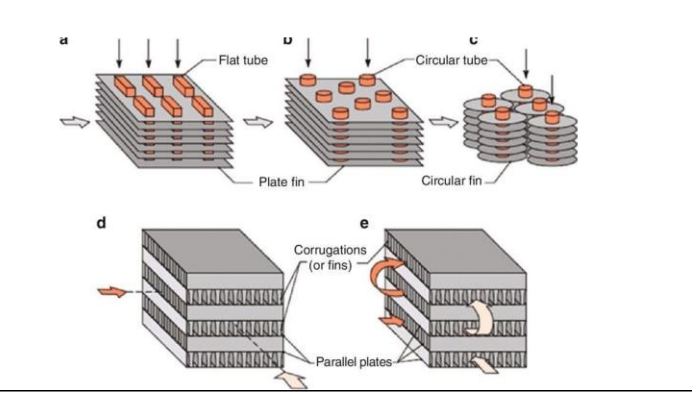

Fig.3 Fin and tube heat exchanger

By definition, a Fin and Tube heat exchanger heat exchanger is a device used to transfer thermal energy between two or more fluids — it allows heat from a liquid or gas fluid to pass to a second liquid or gas without the two fluids mixing together or coming into direct contact. The objective of a Fin and Tube heat exchanger may be to recover or reject heat, or to sterilize, pasteurize, fractionalize, distill, crystallize, or control a fluid or process fluid.

Applications of Fin and Tube Heat Exchanger: Heat Exchanger with finned heating surfaces, so-called finned tube heat exchanger, offers the possibility of heat transfer between gases and liquids significantly space-saving and is more efficient to implement than it is possible with tubes. Volfram finned tube heat exchangers are designed to heat from clean air and gases with high efficiency on liquids or vapors, and vice versa.

Finned tube heat exchangers are often used in power plants as an exhaust gas heat exchanger to increase the efficiency factor. Further applications in power plants are the preheating of combustion air as well as the condensation of

Exhaust steam fromsteam or ORC turbines.

In industrial dryers finned tube heat exchangers will be used for heating of air by hotwater, steam or thermal oil in large quantities.

In many industrial production processes, such as for the air conditioning of buildings, finned tube heat exchangers are used as an air cooler for cooling down or re-cooling of liquids. Due to the problems with Legionella, the high consumption of fresh water, as well as the elaborate water treatment, closed cooling circuits with finned tube heat exchangers will be used instead of cooling towers with open water circuit.

Relevance: In the liquid-to-gas and phase-change heat exchangers, typical to many Heating, Ventilating and Air Conditioning & Refrigeration (HVAC&R) systems, the gas-side thermal resistance contributes heavily to the overall thermal resistance. With increasing energy costs and new regulations aimed at achieving higher efficiency and better environmental protection, heat exchanger performance will continue to play very important role. Achieving overall performance enhancement in the above mentioned heat exchanger geometry is expected to have profound implications on the energy conversion and HVAC&R systems.

Vortex generators (VG) induce streamwise longitudinal vortices in the flow field. Such vortices impart strong swirling action causing destabilization of thermal boundary-layer and in some cases leading to unsteady oscillatory motion. Apart from these well-known mechanisms of heat transfer enhancement, the placement, shape and orientation of the VGs can yield additional augmentation through management of wake structure behind the tubes. The vortex generators have shown great promise in enhancing air/gas-side heat transfer coefficient.

II. Literature Review

Ali Sadeghianjahromi[1] et al carried out detailed review of experimental and numerical researches upon different mechanisms of heat transfer enhancement in fin-and-tube heat exchangers are performed and the relevant influences and operating conditions are thoroughly reviewed. Effects of different geometrical parameters on heat transfer and pressure drop in each mechanism are also discussed in details. Furthermore, comparisons between different mechanisms of heat transfer improvement and some novel compound designs of fin-and-tube heat exchangers are discussed. In addition, some special researches on surface treatment, particle deposition, thermal contact, and fabrication material in fin-and-tube heat exchangers are described. Finally, some developed correlations for calculation of heat transfer and pressure drop characteristics of fin-and-tube heat exchangers with their ranges of validation are classified and compared.

A.A. Gholami[2] et al heat transfer enhancement and pressure loss penalty for fin-and-tube compact heat exchangers with the wavy-up and wavy-down rectangular winglets as special forms of winglet are numerically investigated in a relatively low Reynolds number flow. The rectangular winglets were used with a particular wavy form for the purpose of enhancement of air side heat transfer performance of fin-and-tube compact heat exchangers. The effect of Reynolds numbers from 400 to 800 and angle of attack of 30° of wavy rectangular winglets are also examined. The effects of using the wavy rectangular winglet, conventional rectangular winglet configuration and without winglet as baseline configuration, on the heat transfer characteristics and flow structure are studied and analyzed in detail for the inline tube arrangements. The results showed that the wavy rectangular winglet can significantly improve the heat transfer performance of the fin-and- tube compact heat exchangers with a moderate pressure loss penalty. In addition, the numerical results have shown that the wavy winglet cases have significant effect on the heat transfer performance and also, this augmentation is more important for the case of the wavy-up rectangular winglet configuration. Ashish J Modi, Navnath A. Kalel, Manish K. Rathod[3] et al carried out three dimensional numerical studies is performed to evaluate thermo-hydraulic performance of fin and tube heat exchangers equipped with rectangular winglet vortex generators with circular punched holes from 400 to 2000. Various cases of rectangular winglet vortex generators without and with circular punched holes (1, 2, 4 and 6 holes) are considered. The pairs of rectangular winglet vortex generator are placed in common flow down orientation behind the circular tubes to improve wake management. The effects of number of punched holes is compared with non-VG baseline case and rectangular winglet vortex generator without hole for flow structure and thermos-hydraulic performance of fin and hole tube heat exchangers with four inline circular tube arrangement. The effect of number of punched holes is compared with performance criterions which include Nusselt number, pressure drop, friction factor, Colburn factor, London area goodness factor. Effects of number of punched hole on the performance of rectangular winglet vortex generator is also evaluated using dimensionless number as performance evaluation criteria. It is observed that rectangular winglet vortex generator with circular punched holes remarkably improve the thermos-hydraulic performance of fin and tube type heat exchangers. The punched hole exhibits reduction in the flow resistance for all cases with slight reduction in Nusselt number. Rectangular winglet vortex generator with 6 holes shows better performance as compared to other cases. Nusselt number for rectangular winglet vortex generator with 6 holes increases about 45.95% and 57.37% at Reynolds number 400 and 2000 respectively.. However friction factor is decreased by about 13.81%. Thus from the point of views of London area goodness factor. Rectangular winglet vortex generator with 6 holes found better than considered cases in rectangular winglet vortex generator.

Anupam Sinha [4] et al the heat exchanger is approximated as a periodic rectangular channel with heated walls and three rows of built-in tubes placed at an appropriate interval. Two different orientations of the tubes in the heat exchanger are considered here-one with inline arrangement of three tubes and the other with staggered arrangement of three tube rows. Further, the angles of attack in each orientation are varied. The heat transfer characteristics of the heat exchangers of the vortex generators located near the tube have been compared among the cases with varied angles of attack and orientation of tubes. The Navier-stokes and energy equation along with the appropriate boundary conditions are solved using the ANSYS FLUENT 14.5 solver. Performance parameters in terms of Nusselt number, vorticity and quality factor (a ratio between the Colburn factors to apparent friction factor, also refer to as area goodness factor with slight modification) were evaluated. The result shows the significant improvement in the heat transfer performance due to nozzle-like flow passages created by the winglet pair and the region behind the circular tube which promotes accelerating flow. There is an increasing trend of above for the in-line row of tubes; whereas with the staggered row of tubes, there is a slight deviation of this trend. Due to the alternate CFD-CFU orientation of the VG, the performance

Amit Arora[5]et al carried out For compact sizing of finned-tube heat exchangers, improving the gas-side thermal conductance is essential, which is attempted by integrating longitudinal vortex generators. As geometry of the vortex generators is one of the principal design parameters, main thrust of this investigation is to identify their energy-efficient geometric design(s). Since spatial positioning of the generators as well as its attack angle have a strong bearing on the energy-efficiency of the said design, therefore, both are accounted over the entire effective range for a comprehensive and conclusive investigation. For the selection of best geometric designs, regression based phenomenological models are developed, and the selection is conducted based on a detailed thermo-hydraulic trade-off. After identifying the optimal design(s), a study is conducted to assess their robustness by making them perform under varying operating conditions. Although phenomenological models suffice the purpose of design optimization, they do not explain the physics of thermo-hydraulic augmentation. Therefore, a study investigating the effect of geometric variation on the flow and thermal characteristics is also conducted. Since tube wakes in plain finned-tube heat exchangers make a significant heat transfer area virtually unavailable for the stipulated task, a study discussing the effect of generator’s geometry on the thermal management of wake affected surfaces is also reported. It is observed that heat transfer augmentation over the surfaces wetted by the baseline wakes has a dominant role to play whenever energy-efficient compact sizing of the heat exchanger is desirable. For a selected position of generators in the tube aft region, the highest Colburn j-factor augmentation over the wake-affected fin equals 207.1 % at the specified Reynolds number.

Prashant Saini a, Atul Dhar a, Satvasheel Powar et al carried out Vortex generation is a potential passive technology for increasing the heat transfer rate in the air side of fin and tube heat exchangers (FTHEs). This study proposes novel configurations of a curved trapezoidal winglet vortex generator (CTWVG) with and without circular holes to improve heat transfer in FTHEs. As per the literature, the streamlined form of the trapezoidal winglet demonstrates high heat transfer enhancement with low flow loss and pressure drop. But still, different design configurations are possible to augment the heat transfer characteristics of CTWVG further. The current study investigates the novel configurations of CTWVG (i.e., CTWVG without hole, CTWVG with 1 hole, CTWVG with 2 holes, CTWVG with 3 holes and CTWVG with 6 holes). A three-dimensional computational model is utilized to evaluate the thermal-hydraulic efficiency of FTHEs fitted with CTWVGs with or without circular holes for Reynolds numbers ranging from 400 to 2000. A common flow-down configuration of the CTWVG with circular tubes array is used to reduce the wake region. The thermo-hydraulic performance and flow structure of FTHE with four inline circular tube configurations are compared without VG and CTWVG with or without holes. Pressure drop (ΔP), Nusselt number (Nu), friction factor (f), Colburn factor (j), and London area goodness factor (j/f) are used for the thermal-hydraulic performance comparison. Results show that the number of punched holes has an impact on the FTHE performance, which is measured using a dimensionless number as performance evaluation criteria (i.e., (j/jo)/(f/fo)). CTWVGs with circular punched holes significantly increase the FTHE's thermo-hydraulic performance. The results indicate that the flow resistance is reduced in all cases (i.e., VG with no holes, VG with 6 holes, VG with 3 holes, VG with 2 holes, and VG with 1 hole) with a minor decrease in the Nusselt number. The CTWVG with six holes performs better than other CTWVG configurations. At Reynolds numbers 400 and 2000, the Nusselt number for CTWVG with six holes enhanced by 75.25% and 40.10%; pressure drop increased by 107.88% and 125.51%, respectively. On the other hand, friction is reduced by a factor of 8.1% in CTWVG with 6 holes compared to CTWVG without holes. The CTWVG with six holes performs better than other CTWVG configurations reported in the literature [48,54]. HTPF has increased by 30.96% (compared to rectangular winglet [48]) and 27.69% (compared to curved rectangular winglet [54]) with respect to values reported in the literature. The London area goodness factor (LAGF) has been increased by 275% compared to Modi et al.

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[5] Ashish J. Modi, Manish K. Rathod et al carried out The presence of vortices in a flow field significantly impacts heat transmission. The effect of a modified rectangular winglet vortex generator on heat transfer and pressure drop performance for a fin-tube heat exchanger (FTHE) is experimentally explored in this work. Design and fabrication of full- scale prototype of an FTHE are carried out. Two types of rectangular winglet vortex generators (RWVGs), i.e., Flat RWVG and RWVG with a circular punched hole are installed into the FTHE for experimentation purposes. The experimental studies are conducted with Reynolds numbers ranging from 8000 to 25,000. The experimental results show that the use of RWVG in FTHE provided a much greater heat transfer coefficient than FTHE without RWVGs with an increase in pressure loss penalty. For better wake management, the RWVG are installed behind the circular tubes in a common flow down (CFD) arrangement. The comparative study is carried out to explore thermo-fluid performance of fin-and-tube heat exchanger with two inline circular tube arrangements for all considered cases of RWVGs. By varying the tube wall temperature (i.e., 65, 75, and 85 °C), thermo-hydraulic performance criteria such as Nusselt number (Nu), friction factor (f), and thermal performance factor (η) are compared. Lower tube surface temperature gave the highest enhancement in heat transfer performance with a lower friction factor. However, the thermal performance factor (η) for the RWVG with a circular punched hole is about 1.04–3.2%, 1.3–5.4% and 2.3–10.52% higher than RWVG-Flat for the tube wall temperature 65 °C, 75 °C, and 85 °C, respectively.

Ahmet Ümit Tepe et al carried out Existence of the vortices in a flow field strongly affects the heat transfer. In this study, effect of newly proposed punched triangular ramp vortex generator (PRVG) on heat transfer performance for a fin-tube heat exchanger was investigated numerically. Normalized ramp height (H/d=0.196 and 0.161) and ramp angle (αr=20° and 35°) were examined as the geometric parameter. Numerical computations were carried out under turbulent flow conditions ($5000 \leq Re \leq 20000$). RANS equations were solved using ANSYS Fluent by using SST k-ω turbulence model. Nusselt (Nu) number, friction factor and Performance Evaluation Criterion (PEC) were comprehensively examined quantitatively. Flow characteristics were also investigated for elucidating the underlying physics of enhancement heat transfer by the PRVG winglet. Results were compared with the flat smooth fin surface (baseline case). Results showed that overall heat transfer on the entire channel wall increases up to 43.66% for Re=5000 by H/d=0.196 and αr=35°. The influence of ramp angle on thermo-hydraulic performance was more significant compared to ramp height. Furthermore, PEC results showed that the most feasible geometric design of PRVG winglet for the fin-tube heat exchanger is H/d=0.161 and αr=20°. Furthermore, decreasing flow speed in the channel increases the effectiveness of the vortex generator according to PEC results.

Yeongtaek Oh, Kuisoon Kim et al carried out The thermal and fluid-flow characteristics of the rectangular-winglet, delta-winglet-upstream (DWU), and delta- winglet-downstream (DWD) curved vortex generators (CVGs) are computationally analyzed in this study. Polar coordinates based on the tube center are considered to define the CVG positions, thereby facilitating a parametric study of the effects of the position angle and radial distance of CVGs. The resulting heat-transfer enhancement, pressure loss, and flow patterns have been analyzed in detail. When CVGs are placed at =30°, mixed vortices are generated, thereby improving the heat-transfer performance of the fin. In contrast, placing the CVGs near the rear of the tube reduces the wake size and increases heat transfer behind the tube. Furthermore, a secondary flow is induced enhancing the fine heat-transfer performance. However, the most of results obtained in this study reveal that CVGs are not superior to conventional VGs. Further, the realization of optimum heat- transfer performance using CVGs mandates certain position and geometry requirements to be satisfied. For example, as observed in this study, the DWU CVGs (r=105°, /=1.25) and DWD CVGs (&=30°, r/=1.5) exhibit the highest heat-transfer performance improvements of 5.2% and 7.5%, respectively, compared to conventional VGs. However, this enhancement in heat-transfer performance is realized at the cost of a relatively small pressure loss.

Xie Jinlong a, Lee Hsiao Mun et al carried out In this study, the flow and heat transfer characteristics of newly configured curved-rectangular vortex generators (VGs) in a compact fin-tube heat exchanger were numerically investigated. The proposed VGs were designed to be directly printed rather than being punched out from the plate fin surfaces. The influences of VGs on the overall flow structure and thermal mixing, and near-wall flow and thermal features were characterised in detail. The mechanisms of heat transfer enhancement were explored in terms of the secondary flow and field synergy theories. Results indicate two main mechanisms for the suppression of recirculation flows by applying VGs. The lowered local synergy angle rather than the enhanced local secondary flow intensity is the immediate mechanism for the enhanced heat transfer performance. Parametric analysis indicates that increasing VG height and radius increases both Nusselt number (Nu) and friction factor (f). An optimal VG configuration for the thermo-hydraulic performance is identified at the VG height ratio of 0.8 and radius ratio of 1.55, by which the obtained performance evaluation criterion (PEC) is about 1.3–1.5 times as that of the baseline over the tested Re range. Correlations are further developed to predict the Nu, f and PEC for future preliminary design purposes. Mohd Zeeshan, Sujit Nath , Dipankar Bhanja , Aabir Das et al carried out In the present work, a numerical investigation has been performed to find out the best emplacement of rectangular winglet pairs (RWPs) for the improvement of the heat transfer and flow characteristics of a fin and tube compact heat exchanger at low Reynolds number ranges from 500 to 900. The RWPs are placed at two different locations i.e., adjacent to the tubes and behind the tubes namely, common-flow-up (CFU) and common-flow-down (CFD) orientations respectively. The effect of attack angle, span angle and location of RWPs on air-side thermal hydraulic performance is investigated numerically. Area goodness factor and heat transfer rate per unit fan power are considered as the performance evaluation criteria. It is found that with the increase in attack angle and span angle heat transfer rate increases causing an increase in pressure drop penalty as well. Vortex generators behind the tube can reduce the pressure drop but with a significant reduction in heat transfer. Furthermore, MOORA (Multi-objective optimization by ratio analysis) method is employed to obtain the most expedient position and orientation of RWPs.

Pan Chu , Wen-Quan Tao a, Yu-Wen Zhang a b, Tao Xie et al carried out In present work, heat transfer enhancement and pressure loss penalty for fin-and-tube heat exchangers with rectangular winglet pairs (RWPs) were numerically investigated in a relatively low Reynolds number flow. The purpose of this study was to explore the fundamental mechanism between the local flow structure and the heat transfer augmentation. The RWPs were placed with a special orientation for the purpose of enhancement of heat transfer. The numerical study involved three-dimensional flow and conjugate heat transfer in the computational domain, which was set up to model the entire flow channel in the air flow direction. The effects of attack angle of RWPs, row-number of RWPs and placement of RWPs on the heat transfer characteristics and flow structure were examined in detail. It was observed that the longitudinal vortices caused by RWPs and the impingement of RWPs- directed flow on the downstream tube were important reasons of heat transfer enhancement for fin-and-tube heat exchangers with RWPs. It was interesting to find that the pressure loss penalty of the fin-and-tube heat exchangers with RWPs can be reduced by altering the placement of the same number of RWPs from inline array to staggered array without reducing the heat transfer enhancement. The results showed that the rectangular winglet pairs (RWPs) can significantly improve the heat transfer performance of the fin-and-tube heat exchangers with a moderate pressure loss penalty.

The heat exchangers has variety of application like power generation in power plants, heating and air con systems, refrigeration, manufacturing, food processing, chemical processing, car radiators and many others. Heat exchangers are used in thousands of different places.

The majority of the literature explains about the experimental study of different types of heat exchangers as well as different parameters used in heat exchangers. In some of the research papers the experimental study as well as real practical results are mentioned.

There are many researcher who did the experimental study only.

The combined computational and experimental study for different types of heat exchangers were carried out by few researchers. As the heat exchangers used at many places there is huge future scope for it

III. Objectives and Methodology

Objectives of the study and brief methodology to achieve these objectives are summarized below:

1. To enhance the heat transfer rate of fin and tube heat exchanger.
2. To compare various types of vortex generator with different shape and dimensions.

methodology:

Literature review of various types of fins and tube heat exchangers.

For this we have various types of fins as well as different arrangement of tubes. For example for fins there are different types like straight fin with uniform cross section, straight fin with non uniform section, annular fin, pin fin etc. and for fins there are plate fins with circular tubes, plate fin with flat tube, circular fins with circular tube and corrugations.

Finding the research gap

A research gap is an unanswered question or unresolved problem in a field which reflects a lack of existing research in that space.

Formulation of problem statement

A problem statement is a short, clear explanation of an issue or challenge that sums up what you want to change. In this there is chance to increase the efficiency of a heat exchanger with using various types of angle and different sizes of fins.

Formulation of objectives

Objective is the purpose or it is the reason for doing that thing. For this project we have some objectives which are mentioned below.

To enhance the heat transfer rate of fin and tube heat exchanger.

Compare various types of vortex generator with different shape and dimensions

Determining the dimensions of fin and tube heat exchanger. Try to examine different dimensions of fins and position of vortex for getting different types of experiment results.

Selection of vortex generator

We use different types of vortex generators. We use different angles for the selection of vortex generator and used on basis of best results.

Catia models

We made the catia models according to our requirements. We drawn some drawings in cad software and some in catia software according to secifications of drawings.

Simulation of all catia models in Ansys fluent

For the analyzing the experimental results we use ansys software as well as cmm software. The result after simulation are as follows.

Select best model and manufacturing of best model

Select the best model among all the simulation result and manufacture the best model on the basis of simulation result.

Experimentation on best model for various parameters

IV. MODELLING

Basic model using cad catia software:

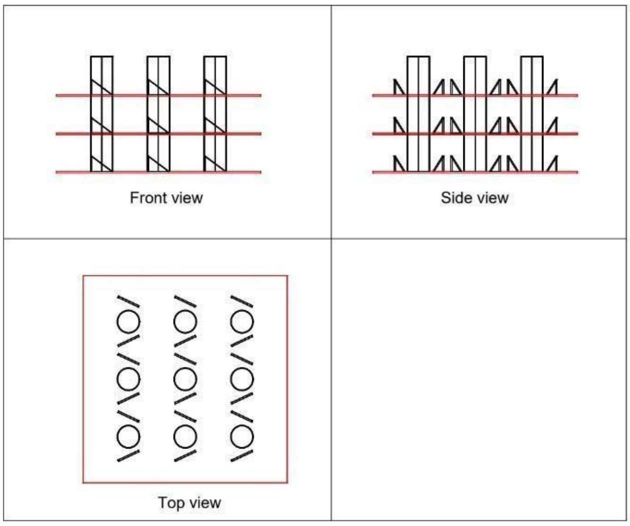

Fig4. fin and tube vortex generator

The fig. 4 is drawn in AutoCad software. The figure is drawn where we will see the front view, top view and right hand side view. The fig. 5 shows the 3D model of fins and tube heat exchanger using vortex generator. The figure consist of nine tubes and three fins and vortex. The arrow shows the the direction of air flow. The following dimensions are used.

Plate dimension: 270mm by 270mm.

Tubes length: 200mm

Tubes inner diameter:28mm

Tubes outer diameter:30mm

Vortex angle:115degree

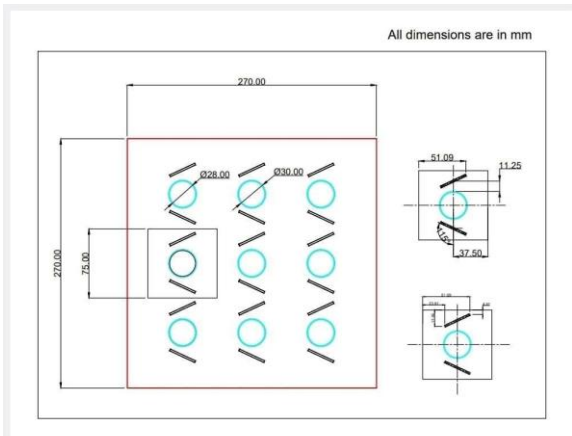

Fig. 5 Fins and tube heat exchanger using dimension

For designing and analyzing we drawn the design parts in catia software. For designing we use various parameters like tubes, fins, vortex etc. The fig is drawn in 3D and then extruded using extrude command. For designing we use 3 plates and 9 tubes. For designing we use delta winglet type vortex generator. To enhance efficiency we use punched plates. For the designing the different parts we use the various dimension for fins, tubes and vortex.

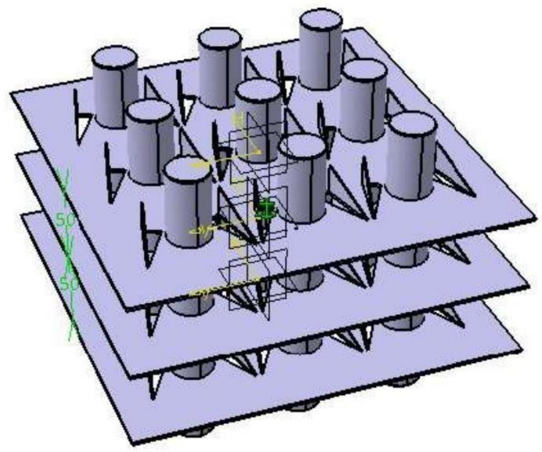

Fig. 6 Fins and tube heat exchanger using catia

V. MODEL SIMULATION

For the analysis purpose we use the ansys software where we can analyze the figures on different parameters. Ansys is a analysis system. Ansys Mechanical is a finite element analysis (FEA) software used to perform structural analysis using advanced solver options, including linear dynamics, nonlinearities, thermal analysis, materials, composites, hydrodynamic, explicit, and more.

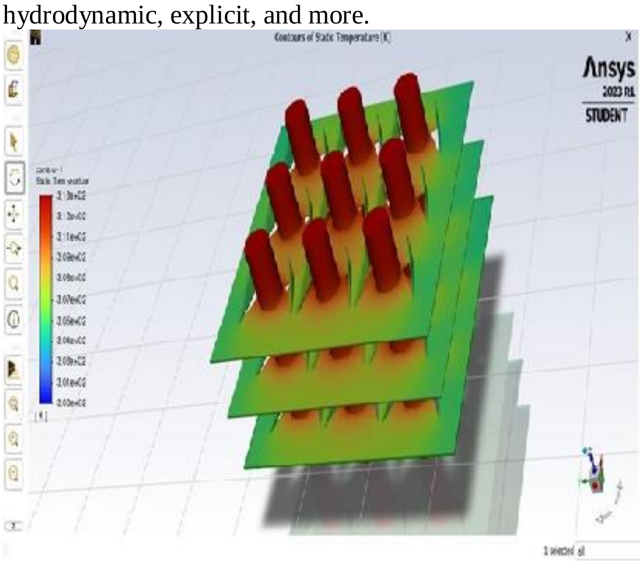

Fig. 7 Ansys Simulation of the model 1

For analysis purpose we use ansys software. First we draw the figure in catia v5. Then for the analysis the figure is uploaded in ansys in ansys we analyze the different parameters. We did simulation using ansys software for the drawn figures according the dimension in the catia v5 software. For that we gave the inlet temperature and according on the basis of inlet temperature we got the outlet temp. As well as we give the air temperature 25 c and we give inlet temperature of water 40 c and we get output temperature of water 27 c. We gave the velocity for air 10m/s and for water we give the velocity 0.5m/s. Also the turbulent intensity 5% and turbulent viscosity ratio is 10.

VI. CONCLUSION AND FUTURE SCOPE

Heat exchanger is one of the essential devices for industrial as well as domestic applications. It is widely used for exchange of fluid state from hot fluid to cold fluid and vice versa. After using the vortex generators the result shows a marked overall increase in performance of heat exchangers. There are many types of vortex generators such as wing type, winglet type, rectangular, triangular etc. From the simulation result it can be concluded that the enhancement of fins and tube exchanger can be done with using different vortex angle as well as different sizes of fins. Temperature and air at inlet and outlet also plays role in the enhancement of heat exchanger. For heat transfer between a gas and a liquid, the thermal resistance of the gas side is much higher than that of the liquid side. Hence finned surfaces are primarily used in the gas side to enhance heat transfer coefficient and surface area of the gas side.

Future work:

Future work can be focus on,

1. The optimization of design including different angles and size of the fin.
2. The aluminium can be used over copper in some applications according to requirement.
3. The enhancement of heat exchanger can be increased using different positions and sizes of vortex generator.

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