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Design of Various Types of Fins on a Vertical Aluminium Plate Under Natural Convection Heat Transfer Condition for Experimental Investigation and Computational Fluid Dynamic Analysis

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ABSTRACT
Heat transfer is a process by which internal energy from one substance transfers to another substance. Heat transfer, the movement of thermal energy from one place to another, can occur through three main mechanisms: conduction, convection, and radiation. Heat transfer also is important in our daily lives. In this paper, the study of various fins on a plate is done and a sample analysis of heat flow is done in order to predict the heat flow.

Keyword: Heat Transfer, Fins, Natural Convection

LITERATURE REVIEW
Hashem Shatnaw aimed to develop a solar thermal power generation mechanism which was comparable to the conventional power generation methods. It was found that better efficiency can be provided by building short-finned tubes that will minimize thermal losses and also by allowing the solar tower receiver to work well in high temperatures. JTI (Jubail Technical Institute) built the experimental model to investigate the HT properties of solar receivers. After doing the tests, the author concluded that the pressure drop is directly proportional to the Reynolds number and inversely proportional to hydraulic diameter. The author also came to a conclusion that there is a positive correlation between the Nusselt number and the Reynolds number which means that 7 when Reynolds number rises, the Nusselt number rises with it. B. J. Gireesha & G. Sowmya in their work, HT Analysis of an Inclined Porous Fin using Differential Transform Method. In this the author has used the Darcy model to solve the problem and derive its conclusion. The second order nonlinear ordinary differential equation has been consequent as the governing equation. A crucial analytical approach known as the Differential Transform Method has been used to solve the dimensionless problem. The conclusions they got after the experiments were: An

ascending value of the thermo-geometric parameter and radiative parameter decreases the temperature profile; the greater values of the porosity parameter, results, in a rise in HT rate. The angle of inclination has a significant impact on the fin thermal performance, furthermore, the fin efficiency is also affected by the porosity parameter, thermo-geometric parameter as well as radiative parameter and to solve fin problem with greater accuracy Differential Transform Method is one of the effective methods. Yeongtaek Oh, Kuisoon Kim in their work, studied the performance characteristics of geometry and effects of the position of curved vortex generators on fin-tube heat exchangers (HE). In their research, three types of curved winglet VGs were placed in HE (fin tube) and investigation happened using 3-dimensional numerical calculations. A polar coordinate-centered based system of each tube was used to describe the position of the curved winglet VGs. The conclusions he got from the experiments are that the position angle: (a) is a critical parameter in determining the performance of HT of a HE with CVGs. (b) The effect of R on Nu/Nu0 varied based on the angle and (c) the structure of the CVGs. When an angle of 30◦ was set for all CVGs, Nu/Nu0 value increased and so did the value of R. The tube vortices generated and CVGs mixed at = 30, significantly improved the overall performance on HT of the fin-tube HE. Flow guidance and secondary flow effects were varied on the shape of the CVGs when they were positioned at the back of the tube. It has been confirmed that CVGs can improve the performance of HT of a fin tube HE. Abdullah Mansur Aldosr studied using a new type of liquid coolant, G13 ethylene glycol, to cool oblique fins. Within the LCP, the oblique fin structures were found to be in line. Experimentally, the effects of systems and three different flow speeds were investigated. Ethylene glycol and purified water are used as coolants in all cases. The current experiment revealed that using 75 percent purified water and 25 percent G13 ethylene glycol at a flow rate of 0.7 GPM is the best way to run the cold pad. To obtain a better understanding of the influence of the internal fins on the melting process, the researcher Dinggen utilized a two-relaxation time lattice to study natural convection melting in a cubic cavity with internal fins, taking into consideration the instances of double fins and tree-shaped fins in addition, all simulations are run in parallel to increase computing efficiency. NVIDIA's CUDA was used to create simulations. The numerical findings showed that the fin arrangement had a substantial impact on the melting efficiency in the cubic cavity. When equal length fins with different angles are employed, it is shown that the design has the most influence on the first half of the melting process, while the uneven melting produced by convection in the second half cannot be effectively prevented. Furthermore, u = 0 and d = 15 are the optimal angles for melting performance when compared to other circumstances. Furthermore, it is observed that the impact of a single tree-shaped fin is spread across the cavity, and there is no large continuous zone of an inclined interface generated by natural convection. As a result, it was discovered that adding the thinner and longer tree-shaped fins to the LHTES unit greatly enhanced the absorption of latent heat energy, increasing the rate of sensible heat storage. Mohamed studied the numerical investigation of the thermal and hydraulic performance of fin and flat tube HE with various aspect ratios (AR). The author provided a comprehensive three-dimensional numerical analysis of hydraulic and thermal efficiency. This research looks at a wide range of fin and tube HE configurations and operating circumstances. The results of these tests are as follows: The HE with a flat tube provides improved hydraulic performance compare to the circular tube due to the decreased pressure drop. For inlet air velocity less than 1.4 m/s, the HE with a lower flat-tube aspect ratio produced a higher HT coefficient; for inlet air velocity of more than 1.4 m/s, the HE with a higher flat-tube AR produced a higher HT coefficient. When a flat tube with an AR of 0.33 was used in place of a circular tube (AR = 1), the value of goodness factor (j/f) increased by 28.52 percent and 42 percent and value of

Re became 75 and 525 respectively. The HT per unit fan power (Q/Pf) was higher in the HE with a lower flat-tube AR. Based on the j/f area and the HT per unit fan power (Q/Pf) it was found that flat tube should have a minimum AR equal to 0.33 which is the ideal tube shape with the highest thermal-hydraulic efficiency and the ability to decrease the size of the fin and tube HE. Dnyaneshwar investigated the effects of pin fin arrangement and its HT characteristics on heat sink performance. This research used conjugate HT physics to analyse the stability and flow regimes (unsteady) in a 3-D environment. A heated plate was used to compare a method of a vertical fins 3-dimensional model with and without perforations mounted on a hexahedron for examining the degree of HT enhancement under natural convection, as well as a comparison of various shapes of perforations such as circular, rectangle, triangular, and hexagonal It saves money by sacrificing a small amount of heat transmission rate and reducing the system's weight. The author concludes that hybrid pin fins are less effective than splayed pin fins. Samer H. Atawneh used metaheuristic algorithms to LaHood to optimize the thermal performance of longitudinal porous fins with a square cross-section using the entropy generation model. Mathematical models were developed for HT and the optimization of a longitudinal fin square profile. The values of the governing parameters were optimized using FFA, PSO, and hybrid algorithms for the lowest average entropy generation rate. According to the results of these studies, the hybrid FFA-PSO was found to be more efficient than either FFA or PSO algorithms in terms of convergence speed and computational efforts. The worldwide best values for both fin tip conditions are observed to be very close. Soleymani Performance analysis of hotspots using geometrical and operational parameters of a microchannel pin-fin hybrid heat sink. After doing numerical studies and Ansys analysis, the authors concluded that the HT increases when the angle of the NACA 0024 airfoil pin fin is increased or if the geometry is changed from a NACA 0024 airfoil pin fin to a rounded pin fin (rectangle). It is also noticed that the thermal resistance decreases when the angle of the NACA 0024 airfoil pin fin is increased or if the geometry is changed from a NACA 0024 airfoil pin fin to a rounded rectangle pin fin. When there is an increase in NACA 0024 airfoil pin fin angle, the drop in pressure increases. The required pumping power increases when the NACA 0024 airfoil pin fin angle is increased or if the geometry is changedfrom a NACA 0024 airfoil pin fin to a rounded rectangle pin fin. The thermal performance of the micro pin fin has been studied experimentally by Singh et al. [10]. The observations made by the author were that the increase in the height of the fin or decrease in the spacing between the fins leads to a decrease in the thermal resistance and higher pressure drop. An increase in the height of the fin or decrease in the spacing between the fins increased the thermal performance and the temperature-reducing capacity of the heat sinks. The temperature reducing capacity and thermal management of the micro heat sink are more dependent on the height of the pin fin compared to the spacing between the fins. An increase in the height of the fin or decrease in the spacing between the fins increases the Nusselt number. It was also found that micro square pin-fin heat sinks more effectively reduced the temperature of high-density power chips. The study of the HT by fins was done by Tong using fluent software to methodically investigate the effect of the HT fins' length and angle on heat distribution and water flow in PEMFCs. It was observed that fins could efficiently improve the HE effect of the TMS of PEMFC. It was also found that the performance of the TMS was significantly impacted by the fin angle and the length of the fin. The influence of fin angle on TMS performance was significantly more than that of fin length. The TMS's performance was directly related to the fin angle and fin length. Wright experimentally investigated the different types of fins based on geometry and found that the HT increased when using airfoil-shaped fins. It was also observed that the HT was directly proportional to the area covered by the airfoil-shaped fins. Densely packing of the fins increased the convective HT significantly, but there was also a considerable pressure drop. The airfoil-shaped fins are much more efficient compared to the conventional round pin fins. Padmanabhan in their work, investigated the temperature distribution of fin profiles using analytical and CFD analysis. In the article, the authors have used two different types of fins to check which of the one is more suitable under the given circumstances where CFD analysis took place in four-engine stroke temperature where the compression stroke temperature is 867.42 K, expansion stroke temperature is 1387.34 K, and exhaust stroke temperature is 610.212 K. With the CFD and analytical analysis the authors compared both the values and found out that both the values were comparable and were close to each other. They were also able to figure out the advantage of using triangular geometry, which is, the amount of material it utilizes is significantly less, which makes it even more economical when compared with rectangular fin. The HT rate was also found more in rectangular fin than in triangular fin. When the temperature drop was taken into accord, it was found that the rectangular fin was higher than that of triangular fin geometry.

TYPES OF FINS USED

1. Rectangular Fins.
2. Triangular Fins.
3. Right angled Triangle Fins (Delta).
4. Semi Circular Fins.

CALCULATION OF FINS DIMENSIONS

One Fin area = 10 cm2 (For all fins)

1. Rectangular Fins:

Length = 20mm = 2cm Width = 3mm = 0.3cm Height = 50mm = 5cm Number of fins = 15 Nos Total Fin area = 10 * 15 = 150 cm^2

2. Triangular Fins:

Base = 40mm = 4cm Height = 50mm = 5cm Width = 3mm = 0.3cm Number of fins = 15 Nos Total Fin area = 10 * 15 = 150 cm^2

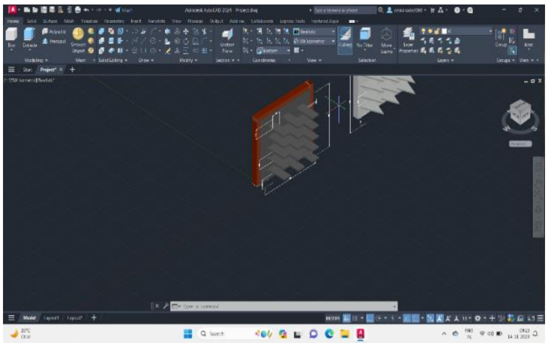
3. Right Angled Triangle (Delta):

Base = 40mm = 4cm Height = 50mm = 5cm Width = 3mm = 0.3cm Number of fins = 15 Nos Total Fin area = 10 * 15 = 150 cm^2

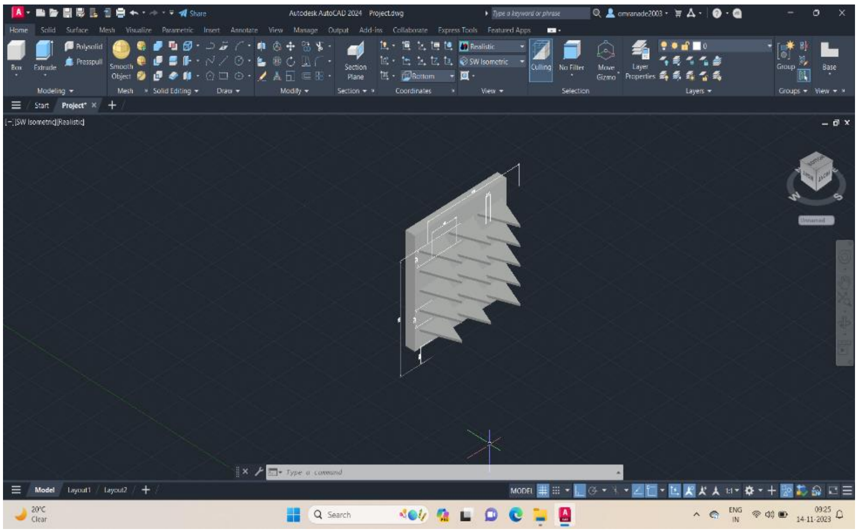
4. Semi-Circular Fins:

Radius = 25.2mm = 2.52cm Thickness = 3mm Number of fins = 30 Nos Area = 10cm2 Total Fin area = 150cm^2

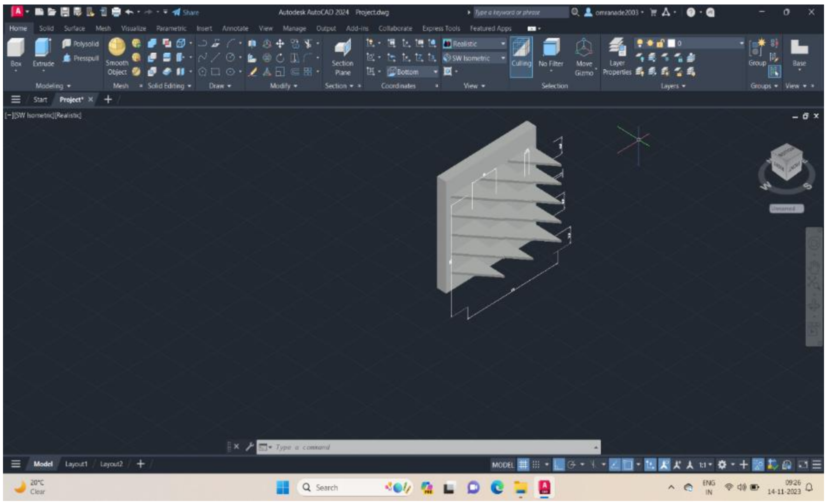
Rectangular Fins



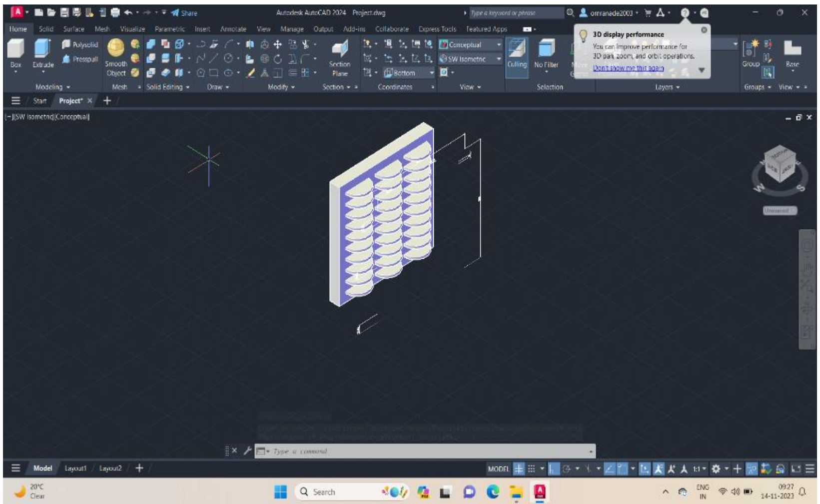
Triangular Fins



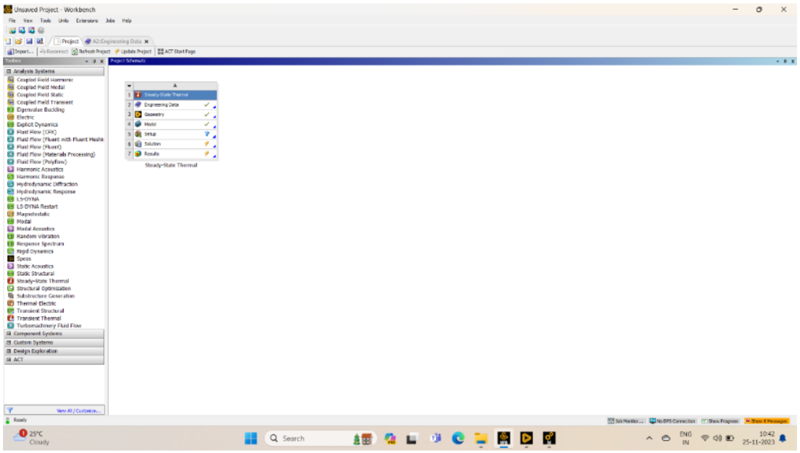
Right Angled Triangled Fins (Delta)

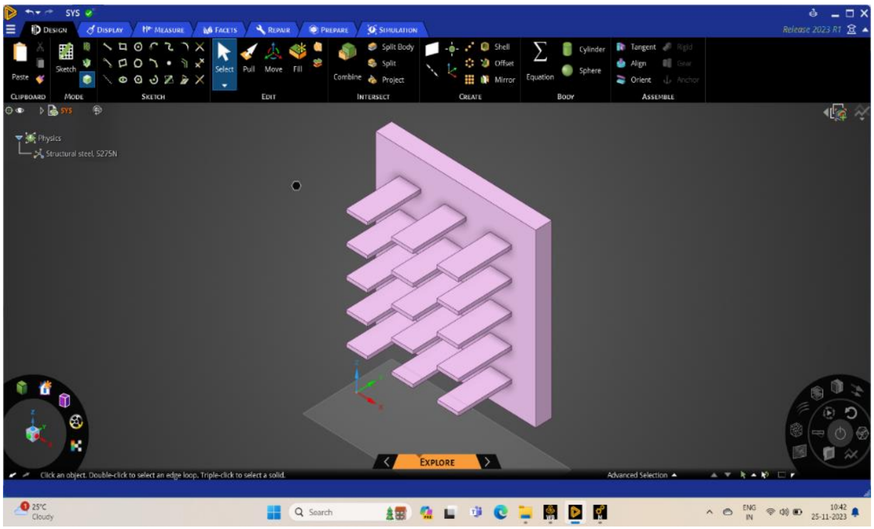


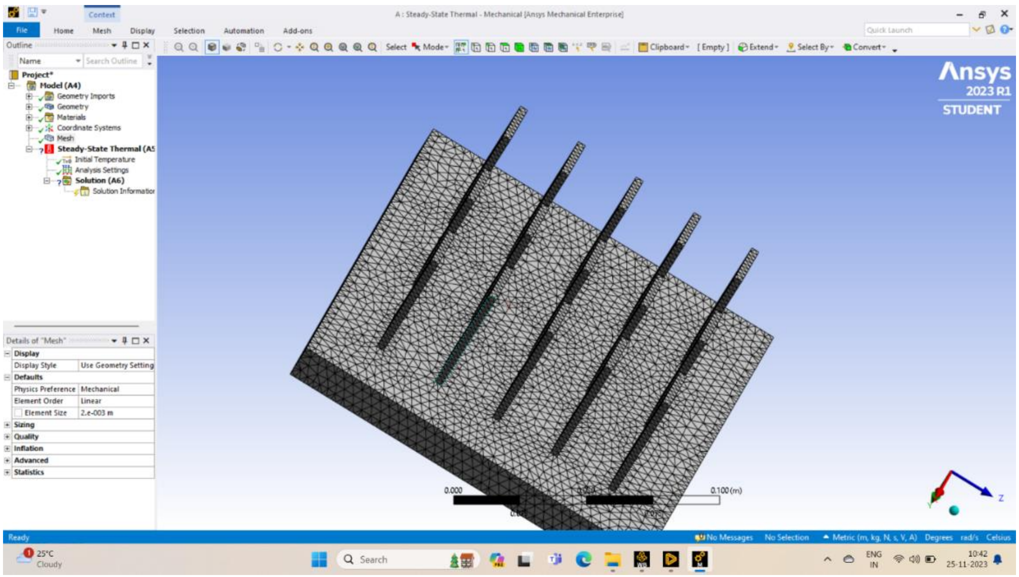
Semi Circular Fins

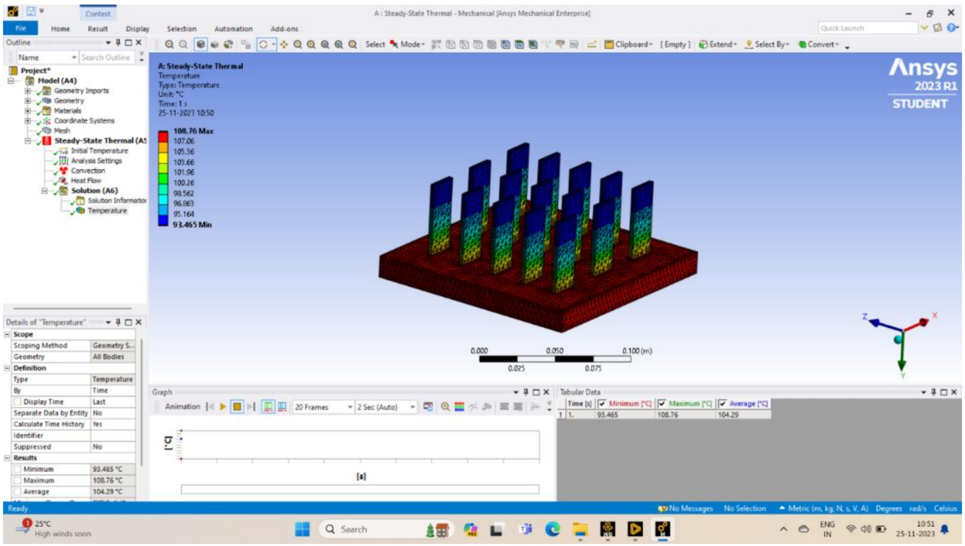


CFD AND IT'S OUTPUT









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