FVM Analysis For Comparision The Performance Of Different Profile Of Fins – A Review

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Abstract- *fins are more demanding to cool electronic equipment, stationary engines and many engineering applications, so we need the optimized designs with minimum material and the maximum rate of heat transfer. But due to many factors such as material, fluid velocity, cross section, the climatic condition affects the heat transfer rate of the fin; the main control variable generally available to the designer is geometry of fin array.The main of aim of this work is to study various researches done in past to improve heat transfer rate fins by changing its geometry, climate condition and material, spacing between the fins and its configuration.*

Keywords- Heat Transfer, Fins, Nano Fluid, Computational Fluid Dynamic.

I. INTRODUCTION

Fins are used as an extended surface to increase the heat transfer rate in a wide range of engineering applications, and offer a practical approach without use of an excessive amount of primary surface area for achieving a large total heat transfer surface area. It is commonly used for heat management in electrical appliances, cooling of Internal Combustion engine, such as fins in a car radiator. So it is important factor to analysis the behavior of the fin in respect to temperature distribution for optimize the effectiveness. In natural cooling rectangular horizontal fins array chimney flow pattern is developed due to the density difference. This flow pattern creates a stagnant area near the central region of the bottom. That portion does not contribute much to the dissipation of heat, central part of the fins flat become ineffective due to already heated air comes in contact with it so that part is removed becomes notch to avoid wastage of material

II. LITERATURE REVIEW

Some of the important paper related to analysis of heat transfer rate of fins have been reviewed and discussed here.

SM Wange, RM Metkar (2013) [1] they did both the experimental analysis and computational analysis of inverted notched fin (in the central part of the bottom fin) dissipation heat by convection natural and also to compare the results between the method and observed that the heat transfer coefficient values are higher in inverted notch fin arrays giving better performance than normal fins arrays. They also concluded that the experimental and computational analysis results comparisons are well matched.

Hardik Rathod D. et al (2013) [2], they have studied various documents relating to the transfer of heat through extended surfaces (fins) and the effect on the heat transfer coefficient changing section, the conditions climate, materials, etc. for now the best geometry and material for the fins for better engine cooling and concluded that the shape of the fins and the cross-sectional area affect the heat transfer coefficient. In vehicles at high speed thicker blades offer better efficiency. Increased thickness resulted in swirls being created which contributed to increase the heat transfer. A large number of fins with less thickness may be preferred in high-speed vehicles thick fins with less numbers as it helps induce more turbulence and also the heat transfer coefficient depends on the space, time, flow conditions and fluid properties. If there are changes in environmental conditions, there are changes in the transfer co-efficient heat.

Jung Tae Sung Kang, Kook Hwan (2013) [3] they have studied the characteristics of convective heat flux and were numerically investigated for a typical sink installed vertically from heat and installed horizontally in a free convection using ANSYS CFX software. They performed comparative experiments to reveal the quantitative effect of the installation direction of the cooling performance. The results were analyzed using the correlation dimension with the Nusselt number and the Rayleigh number and compared with the well-known theories. Finally, they found that the heat sink of the cooling power installed vertically is about 10 ~ 15% better than that of a natural convection.

Raaid Jassem R., (2013) [4] they have made an experimental study to investigate heat transfer by natural convection in a rectangular perforated fin plates and used five fins for the job the first non-perforated fin and other perforated by different shaping the fins the perforation by different shapes (circle, square, triangle, hexagon), but these holes have the same cross-sectional area of 113 mm2 .These perforations distributed over three columns and six rows and they founded from the experimentation that the greatest value of the RAF at triangular perforation and the smallest value occurred in circular perforation. In addition, the triangular perforation gives better values of heat transfer coefficient and then the circular, square, hexagonal and non- perforation respectively.

Shivdas S. Kharche and Hemant S. Farkade (2012) [5] presented a comparison between the heat transfer rate through un-notched and notched fins using copper as a material instead of aluminum . And based on the experimental study concluded that the heat transfer rate in notched fins is more than the fins of un notched. Average heat transfer coefficient without notched fin is 8.3887 W / m2k and for 20% notched fin is nicked fins 9.8139 W / m2K. In addition, the copper gives more heat transfer rate than the aluminum plate. As the area of the notch of the blade increases the heat transfer rate increases. Copper plate gives a better heat transfer rates than the aluminum plate.

Barhatte1 Mr. Chopade (2012) [6] modified by removing the fins portion centre part by cutting a triangular notch and also analyzed the different proportions of notches for comparison and optimization with respect to heat transfer rate and this é an experimental analysis of the result in a range of heights and fin heat dissipation rate, the CFD software was also used to get the result and compare with experimental results. They also studied the heat transfer rate by natural convection from vertical rectangular fins network with triangular notch in the center theoretically and experimentally and founded both experimentally and computationally the heat transfer rate is increased with increasing aspect ratio (height to base ratio) and then decreases after 1.266 and also suggested the same experimental research methodology and analysis of calculation can be used also for different types of notches and fins.

Wadhah Hussein Abdul Razzaq Al Doori (2011) [7] did the study on the optimization of heat transfer by natural convection of rectangular fins of circular perforations experimentally and analytically and found that the perforated flange area of heat transfer surface is a function of the dimensions and geometry of fin-shaped perforation and the temperature drop between the base and the blade tip increases as the diameter of the perforation increases. This is because the thermal resistance of perforated fins decrease as the diameter of the perforation is increased. They finally concluded that the gain in heat dissipation rate to the perforated fin is a strong function of the size of the perforation and the lateral spacing. Decreasing the size of the perforations reduces the temperature drop rate along the perforated fin .Heat transfer coefficient for perforated fin which contains a larger number of perforations higher than the perforated fin containing a small number of perforations.

Barhatte SH et al (2011) [8] analyzed experimentally and computationally that the heat transfer rate through various types of notches in the fin. They used a different notch such as rectangular, circular, triangular and trapezoidal. They also compare without notch and notch network fins providing different heat inputs and kept dimensions of the fin fixed. And based this heat transfer coefficient is the highest for the triangular notch compared to other forms in the investigation of both experimental and computational and they also suggested to work to optimize the size of a single notch.

MJ sable1, SJ Jagtap, PS Patil, PR Baviskar Barve & SB (2010) [9] studied for natural convection adjacent to a vertical plate heated with a multiple V- type partition plates (fins) in the ambient air surrounding. Compared to conventional vertical fins, the works of this partition plate type V not only the extended surface, but also tabulator flow. To improve the heat transfer, V-shaped partition plates (fins) with edges face upstream were attached to two identical vertical plates. They found that among the three different configurations of fins Network heated vertical plate. V-type network design fin outperforms rectangular vertical fin and V-fin array with the bottom space design. Performance was observed to increase even with the increase of the height of the V- plate (fin height).

SD Suryavanshi, NK Sane (2009) [10] made study on heat transfer by natural convection through inverted rectangular notched fin arrays. For the experimental configuration, they used fin flats and spacers are cut from 3 mm and an aluminum foil laminated to a thickness of 1 mm and assembled together to form the required fin network. They use the length of the fin is 150 mm, height 75 mm, 4-13 mm fins spacing, number of 7-15 fins 10-40% notch portion and the heat supplied 50-200 W. they fix the length and height of fin spacing and varying end, number of blades, notch portion, the heat input. They concluded that the value of the heat transfer coefficient increases as the notch region increases and spacing end 6mm.

H. Abdullah Alessa Ayman M. Maqableh and Shatha Ammourah (2009) [11], studied the improvement of heat transfer by natural convection in a horizontal rectangular fin integrated with rectangular perforations aspect ratio of two was examined using the finite element technique. The results of the fin were punched from its solid equivalent. A parametric study for the geometrical dimensions and the thermal properties of the fin and the perforation has been completed. The study examined the gain in the area of the fins and heat transfer coefficients due to perforations. They concluded that, for certain values of dimension of the rectangular perforation, perforated fin enhances heat transfer. The scale of the development is proportional to the thickness of fin and its thermal conductivity. Furthermore, the extent of improvement of the heat dissipation of perforated fins is for the dimensions of the fin, the geometry of the perforation and the fin thermo physical properties. In addition, the gain in heat dissipation rate to the perforated fin is a strong relationship between the two, the size of the perforation and the lateral spacing.

Mr. Shaeri Mr. Yaghoubi, Jafarpur K. (2009) [12] has three-dimensional numerical calculation is made for turbulent fluid flow and heat transfer by convection around a table of solid rectangular and new perforated fins different no. and two different sizes of perforations. Experiments were carried out for the range of Reynolds no. 2000-5000 based on the thickness of the fins and pr = 0.71 and after the main conclusions are drawn.

- Fins with perforations for the recirculation region on the faces of the perforated fins fixed altitude of fin is different from the solid fin, but this region on the upper surface of the fins is almost the same for all types of investigated fins.
- With increasing perforations flow becomes complicated, average friction coefficient decreases and the solid fin has the highest value cf.
- For fin with perforation, reduced drag force. Also drag ratio decreases with increasing Reynolds no.
- Average Nusselt no. decreases with increase in perforations no. Solid fin has the largest average Nusselt no. for each Reynolds No. for practical applications for the following co-relation are proposed.
- The same fine porosity but larger window sizes have higher Nusselt no. than fin with small window.
- Increasing no. of perforations, the temperature difference between the base of the fin tip becomes larger.
- By making the perforations in the window, and in particular with increasing no. of perforations, lighter fins which are more economical, will be achieved. The main advantage of these new types of perforated fins is their low considerable weight.
- For perforated fin of type 2-7 with increasing Re. No. the percentage of heat transfer enhancement compared to solid fin becomes smaller, but the opposite trend is observed.

SS Sane et al. (2008) [13] presented a comparison between the experimental results and the results obtained using CFD (computational fluid dynamics) software and also discussed that the flow pattern of existence of single chimney flow pattern and the effect of the removal of the fin portion, which is not effective in the heat dissipation and observed that the total heat flow and the heat transfer coefficient increases as the notch depth increases, and it founded is a close correspondence between the values of heat transfer coefficients available by using Fluent CFD analysis and experimental results.

Dharma Rao, SV Naidu, B. Govinda Rao and KV Sharma (2007) [14], worked on the problem of heat transfer by laminar natural convection from a network containing a vertical fin and horizontal fin base is theoretically formulated treating the adjacent inner fins as two fin enclosures. The equations governing mass, timing and balance of energy to the fluid in the two fin housing with the heat conduction equations in the fins are solved numerically using the ADI method. The heat transferred to the ambient fluid from the two end fins is also calculated separately. Heat transferred by radiation is considered in the analysis. The numerical results are compared with experimental data available in the literature. The effects of system parameters such as the base temperature, the fin height, fin spacing on the rate of heat transfer fins network are examined. They concluded the following points.

- With the decrease of the fin spacing heat transfer rate increases more strongly.
- Convective heat transfer rate from a fin network increase with increase of the temperature of the fin base network at all fin separation.
- Convective rate of a network of heat transfer fins increase with increasing length of the fin spacing of the fins.
- It is noted that the average Nusselt number increases with the increase of Rayleigh and emissivity for all length of fins.
- Average Nusselt number for short fins more than long fins.

SS Sane et al (2006) [15] did the experimental analysis of heat transfer through without notch and notch fins. They use fin material is aluminum. They use the length of the fin was 150 mm and the fin height 75 mm at a time has been set. They take number of fins 9 and 15 and the notched portion of 10% to 40%. They used three different types of array by varying the depth of the notch. Their aluminum fin flats cut using aluminum sheet shearing feet 2 mm thick. If notched fin slot was machined using a hacksaw and filed. Common apartments were tied together using tie rods. Spacing was adjusted using aluminum spacers. Cartridge Heater rod 14 mm in diameter were used for heating. They provided different inputs to the area of the fins in the 50W to 200W. Find the heat transfer coefficient in each case. They concluded that the total heat flow and the heat transfer coefficient increases as the depth of the notch increases.

According to Yunus A. Çengel (2004) [16] the analysis of fins they consider regular operation without heat generation in thermal conductivity of fins material is constant. The heat transfer coefficient is assumed to be constant over the entire surface of the fin. The value of h is less than its tip because the liquid is surrounded by the solid surface near its base, hence adding too fins on a surface decrease the overall heat transfer coefficient of h when the decrease offsets any gain resulting from increasing the surface.

Krikkis et al. (2002) [17] have investigated the optimization of rectangular and triangular fins and found that, for opening angles between the fin less than 180 °, the optimum properties for the height and the fin thickness are strongly dependent on the emissivity of the fin.

Baskaya et al (2000) [18] did parametric study of heat transfer by natural convection of rectangular horizontal fins networks. They studied the effects of a wide range of geometric parameters such as fin spacing, fin height, fin length and the temperature difference between the fin and its surroundings; Transfer heat from horizontal heat fins. However, no clear conclusions were established because of the different parameters involved. Finally, they concluded that it is not possible to achieve optimum performance in terms of heat transfer overall only focus on one or two parameters. The interactions between all design parameters must be considered. This study showed that each variable has an effect on the overall heat transfer. Overall, it can be concluded that the overall heat transfer is increased with the increase of the height (H) of the vane and the decrease of the length (L) of the fin pa r therefore increase in H / L.

Marlow E. Springer, Thole Karen A. (1998) [19] have described a method for the design of an experimental model of a louvered fin in two-dimensional geometry, scaling by a factor of 20 which allows flow field measurements. They used the geometry of specific component for studying .These experiments had a louver angle of 27 ° and a ratio of fin pitch to louver pitch of 0.76. Simulations using computational fluid dynamics (CFD) both helped design large-scale component model, resulting in a total of 19 louvers rows and identified the region where the flow field could be considered periodical. This document also shows that they have two velocity components in the model measures reduced to at Reynolds numbers Re = 230, 450 and 1016. For the three Reynolds numbers the flow was louver directed instead duct directed. The results indicate that significant differences between the three Reynolds numbers have occurred. While the flow entering the passage of the louvered at Re = 1016 still had remnants of the following two upstream convection component parts, where Re = 230 did not. Speed time-resolved measurements were also made in the wake region of a well component developed for a range of Reynolds numbers. 1000 <Re <1900, there was an identifiable peak frequency velocity fluctuations leading to a constant Strouhal number St = 0.17. Velocity measurements show that the boundary layer on the side of the clean flow gate is slightly thicker than on the upstream side of the gate.

According to Incorporeal FP, DeWitt DP (1996) [20] the term extended surface is commonly used to describe an important special case involving the transfer of heat by conduction in a solid heat transfer by convection from the boundary of a solid. Although there are many different situations that involve such combine convection conduction effect, the most frequent application is where a large area is used to increase the heat transfer rate between the fluid and solid. Such a large area is called is called as fin.

Misumi and Kitamura (1990) [21], reported experimental work on improving the heat transfer by natural convection from vertical plate having a horizontal separation plate and V-plates in the atmosphere of water drop off window They found that the heat transfer in the downstream of the separation plate region is substantially improved when the height of the plate exceeds certain critical values due to the flow of the low temperature fluid into the separation zone. For vertical plate fins with V-shaped, and Misumi Kitamura obtained 40% higher heat transfer coefficient than conventional vertical fins. From the results, they found that the ratio of the heat transfer enhancement is greater than the ratio of the surface enlargement.

Mohammad Mashud, Md. IliasInam, ZinatRahmanArani Afsanul Tanveer and [22] searched a full cylindrical fin and two other cylindrical fins with circular grooves and son on their outer surface are studied experimentally. The supply of heat to the fin varies such that the base temperature is held constant in the steady state. A study of the pressure reduction effect, using the resources available, the room is designed for a 680 mm Hg vacuum. The experimental result shows that for cylindrical fin with circular grooves (depth of 3 5 mm) heat loss is a maximum. The cylindrical grooved approximately1.23times fin loses more heat per unit area with respect to the threaded cylindrical fin, and 2.17 times more heat per unit area, relative to the solid pin fin to a sub atmospheric pressure. When the pressure decreases heat loss and reduces the heat transfer by radiation contribution to total heat loss increases.

Malagouda Patil, Dr. S. A. Alur [2017] [23] Fins are used to increase the rate of heat transfer. Generally, the material used for the application of fins is aluminum alloys. During this project the steady state thermal analysis of rectangular fin with and while not cavities on the fin surfaces by using Ansys worktable 14.0. The temperature distribution and total heat transfer rate through the rectangular fin with and without cavities on the fin surfaces was calculated for various fin materials like Copper, aluminum and Brass. Steady state thermal analysis of rectangular fin and a nominal base temperature condition. Considering rectangular fin of different length conducts heat away from its base at 5000K and transfers it to a surrounding at 3000K through convection. The convection heat transfer constant is 12 W/m2K.Thermal conduction of the fin material is nominal. A relentless temperature condition is applying at the bottom of the fin convective boundary conditions are using at the tip of the fin.

III. CONCLUSION

- The following point worth observed from literature survey is given below given. For certain triangular dimension values, the perforated fin may result heat transfer enhancement. The scale of the development is proportional to the thickness fin and its thermal conductivity.
- The extent of the improvement of the heat dissipation for perforated fins is a complex function of the dimension of the vanes, the geometry of the perforation, and the fin thermo physical properties.
- The gain in heat dissipation speed for perforated flange is a strong relationship between the two, the size of the perforation and the lateral spacing. This ratio reaches a maximum value at a given diameter of perforation and the lateral spacing, which is called the dimension of the optimal perforation and optimal spacing, respectively.
- The perforation blades improves heat dissipation rate and at the same time reduces the costs of the fin.

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