Computational Analysis of Triangular Perforated Fins in Staggered Arrangement

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Abstract

The present paper gives the computational analysis of the base plate equipped with triangular cross section fins in staggered manner. This analysis is done for 4 type of ratios, the inter fin spacing distance to side length of fin i.e (Sy/D) 1.208, 1.524, 1.944 and 3.417. in a duct having rectangular cross section area of 250mm x 100mm and a length of 1030 mm and 2 types of fins the solid triangular cross section fins and perforated fins. In the analysis air is forced to enter duct with 5m/s and carry away the heat in all types of arrangement for solid as well as perforated fins the analysis shows that the perforation in the fin has increased the heat transfer of the fin so perforation in the fins is suggested for higher thermal performance.
Keywords: Computational Analysis, Triangular Pin Fins, Force Convection, Staggered Arrangement

I. INTRODUCTION

The heat generated while operating several engineering system may cause severe over heating problems and consequently leads to failure of the systems. So it is imperative to add superior heat transfer elements having smaller mass, more compatible and less expenditure. The heat generated in a system such as diesel engine, heat exchangers in the gas turbine, boiler super-heater tubes, condenser coils, etc. must be dissipated to its surroundings in order to maintain the system functioning at its recommended working temperatures and operating effectively and reliably

II. COMPUTATIONAL ANALYSIS

A. Problem Description:

A tunnel of known dimension with base plate place inside the tunnel at known location is modelled in the Ansys Design Modeler. The fins with base plate is considered in three cases

1) Base plate with Solid Fins: These fins are of 100mm height having no hole
2) Base plate with Perforated Fins:These fins are of 100mm height having a circular hole of 6mm at a 17mm distance from lower base of The base plate.

A tunnel is 1030 mm length at inlet it is conveged and in the middle it has uniform rectangular cross section of 250 mm x 100 mm and in the end it diverges. Arrow B represent flow inlet to tunnel and Arrow A represent flow outlet. Arrow C represent alluminum base plate of 250 mm x 250mm cross section and 6 mm thichness and it has known number of fins and 100mm height having constant electrical heat input of 900w. A flow of air is entering the duct through duct-inlet, passes over the base plate and goes to atmosphere through duct-outlet. The aim of the analysis is to find heat transfer rate, temperature distribution, and stream line patterns across the plate by considering the 5m/s velocity for varios cases of number of fins in staggered arrangement for perforated and solid fins. The location of inlet of duct, outlet of duct, fins and base plate is shown in the below figure.

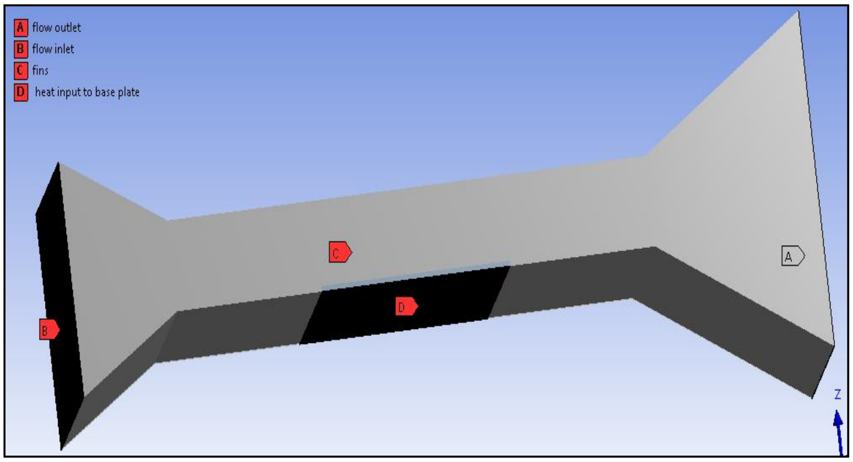

Fig. 1: Workbench Modell of flow Duct and Base plate Assembly

Table -1
Table for Perforated Fins

Sr. No.	*Number of fins*	*Height of fins*
1	*25*	*100mm*
2	*21*	*100mm*
3	*18*	*100mm*
4	*11*	*100mm*

Table – 2
Table for Solid Fin

Sr. No.	*Number of fins*	*Height of fins*
1	*25*	*100mm*
2	*21*	*100mm*
3	*18*	*100mm*
4	*11*	*100mm*

B. Temperature Contour:

The temperature contour for various types of fins is obtained from the ansys software. And this temperature distribution is close to experimental data, it shows that all perforated fins cool fater than solid fins.

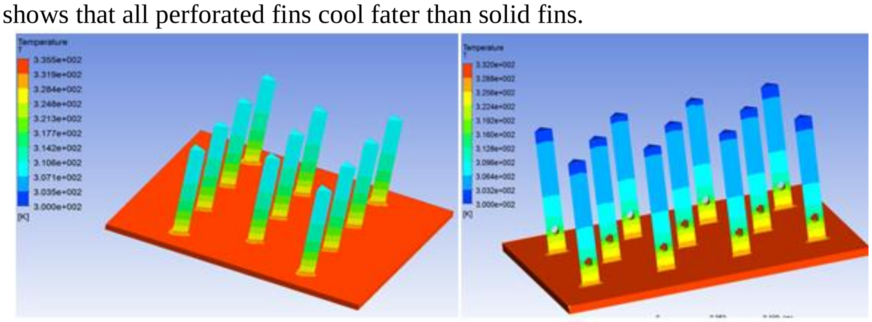

Fig. 2: Temperature Countour for 11 Solid Fins and 11 Perforated Fins

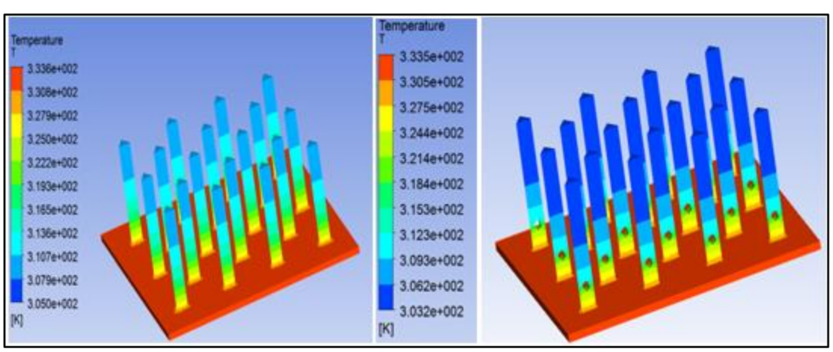

Fig. 3: Temperature Countour for 18 Solid Fins and 18 Perforated Fins

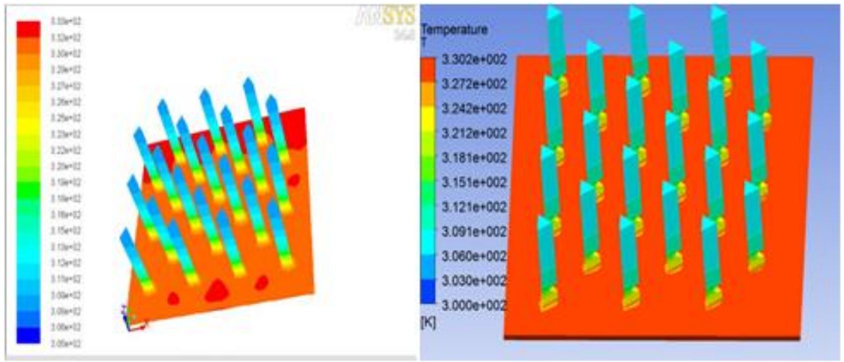

Fig. 4: Temperature Countour For 21 Solid Fins And 21 Perforated Fins

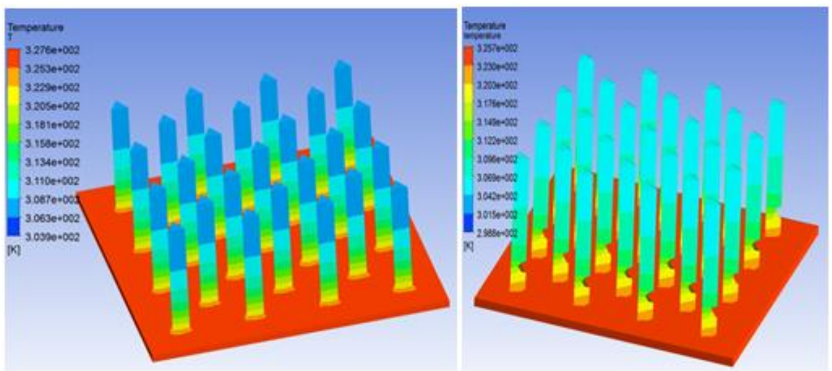

Fig. 5: Temperature Countour for 25 Solid Fins and 25 Perforated Fins

C. Streamline Velocity Contours:

Here velocity streamline contours of all types of fin are shown. It is seen that flow pattern is looking like shape of duct.

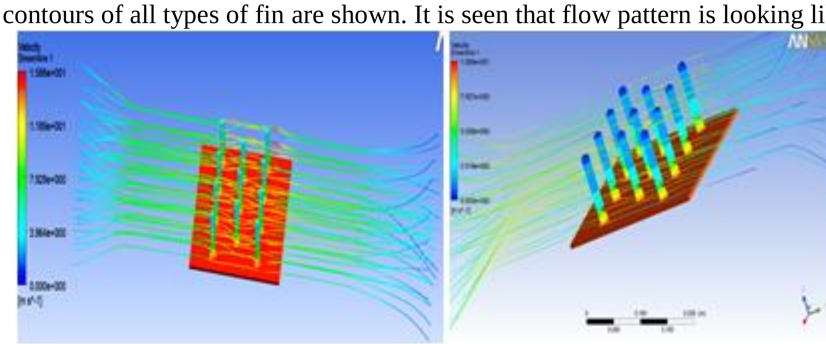

Fig. 6: Streamline Velocity Distribution In 11 Solid Fins And 11 Perforated Fins

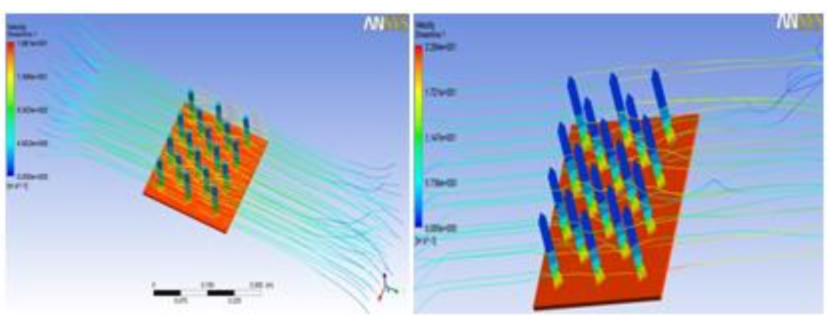

Fig. 7: Streamline Velocity Distribution In 18 Solid Fins And 18 Perforated Fins

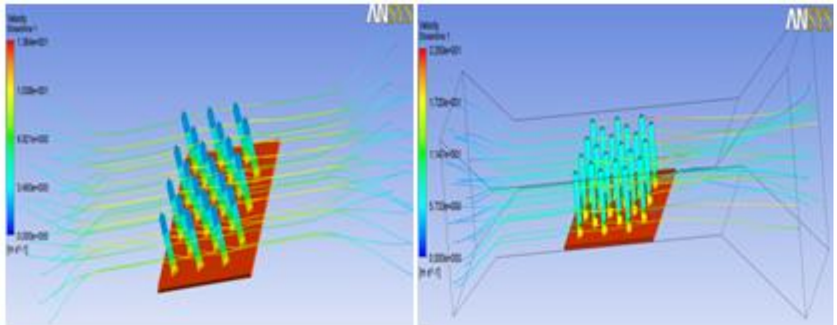

Fig. 8: Streamline Velocity Distribution In 21 Solid Fins And 21 Perforated Fins

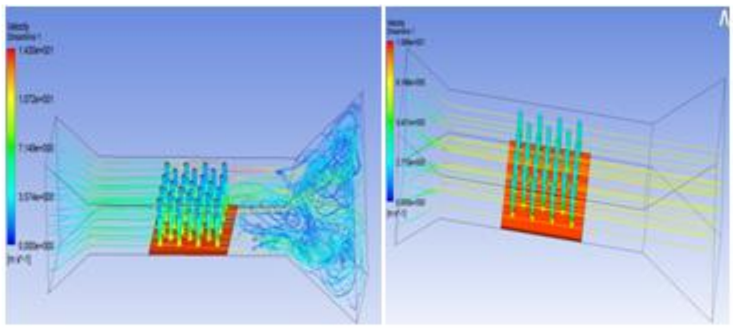

Fig. 9: Streamline Velocity Distribution In 25 Solid Fins And 25 Perforated Fins

III. CONCLUSION

Computational analysis is done four types of arrays and for two types of fins solid as well as perforated fins. In this analysis we are trying see the effect of perforation on the behavior of heat transfer and flow pattern at a velocity of 5 m/s. from the above obtained graph we have reached to following conclusion.

1) For the same heat input of 900w for all types of fins and fin arrangement the lowest steady state base plate temperature is achieved by 25 perforated fins having inter fin spacing ratio i.e (Sy/D)= 1.208 and highest steady state base plate temperature is achieved by 11 solid fins having inter fin spacing ratio i.e (Sy/D)= 3.417
2) The heat transfer rate decreases with increased in inter fin spacing ratio
3) From the temperature distribution of fin we can see that perforated fins cool faster than the solid fins
4) From the streamline velocity distribution we can see that solid fins offer more disturbance to flow than perforated fins and in perforated fins air is forced to flow throw hole consequently the flow becomes smooth and more heat is carried away by the air

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