

Thermal Analysis Of Engine Cylinder Head By Perforations.

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ABSTRACT

The main objective of this work is to quantify and compare the natural convection heat transfer of fin with various square size of perforation such as 4mm, 5mm and 6mm. The 2 series of 3 square holes on the fin surface to find out the maximum heat transfer rate. This study concluded that the steady state heat transfer rate from fin with the size of 6mm perforation is maximized and same result is validated by using FEA analysis. By providing perforation on fin surface there is reduction in weight and cost of material.

I. INTRODUCTION

Heat Transfer in fins have been the topic of interest of many researcher as the fins have important applications in many fields including heat exchangers, hot water and steam pipes, heaters, refrigerators, chemical processing system and electrical conductors. Optimizing the heat transfer rates result in saving of power supplied and increased efficiency in case of the automobile engines The removal of excessive heat from system components is essential to avoid the damaging effects of burning or overheating.

1.1 Aims and Objectives

Aim:- The aim of present work is to improve heat transfer rate by decreasing area of extended surface by perforating fins of various square size.

Objectives:-

1. To study various types of fins.
2. To study various shapes of perforations on fins such as square, circular, triangular, ellipse, etc.
3. To select square perforations of various sizes for decreasing area of extended surface.
4. To design the fins of various square size perforation for decreasing the area.
5. To analyze the fins of various square size perforation for determining heat flux, temperature distribution.
6. To Increase the efficiency of fins.
7. To Increase fin effectiveness.
8. To reduce the weight.
9. To reduce the material cost.

II. LITERATURE REVIEW

Shivdas S. Kharche&Hemant S. Farkad^[1] investigated the effect of placing notch on the finned surface. Different shapes of notched such as rectangular, triangular etc. has been designed on rectangular fin array By performing the experimentation, it has been observed that average heat transfer coefficient for fin with notched portion results in high heat transfer coefficient value as compared to fin without notched portion.

Raaid R. Jassem^[2] has studied and examines natural convection heat transfer from rectangular fin with different forms of perforations (circle, square, triangle, and hexagon) with having same cross sectional area of 113 mm². He found that fin having triangular perforation has maximum heat transfer rate.

Kumbhar D.G, Dr. N K Sane, Chavan S T^[3] has observed that heat transfer rate increases with perforations as compared to fins of similar dimensions without perforations. It is noted that in case of triangular perforations optimum heat transfer is achieved. they also concluded that heat transfer rate is different for different materials or heat transfer rate changes with change in thermal conductivity.

Rupali v. dhanadhya, abhays.nilawar and yogeshyenarkar^[4] in this author studied and examined the heat transfer augmentation from horizontal rectangular fins with circular perforations under natural convection compared with solid fins and fins with different thickness keeping length constant are also examined in it. A. M. & the other^[5] Studied the natural convection heat transfer from perforated fins. The temperature distribution was examined for an array of rectangular fins (15 fins) with uniform cross-sectional area (100 x 270 mm) embedded with different vertical body perforations that extend through the fin thickness. The patterns of perforations include 18 circular perforations (holes). Experiments were carried out in an experimental facility that was specifically design and constructed for this purpose. The heat transfer rate and the coefficient of heat transfer increases with perforation diameter increased.

R. B. Gurav, J.D.Patil, S.M. Gaikwad, PriteePurohit and A.A. Ramgude(2013)^[6] studies heat transfer increases from a horizontal rectangular fin embedded with elliptical perforation under natural convection compared to non-perforated fin using finite volume method. Rupali V. Dhanadhya, Abhay S. Nilawar and Yogesh L. Yenarkar (2013) studied augmentation of heat transfer from horizontal rectangular fin with circular perforations under natural convection compared with solid fin.

A.H. AlEssa et al,^[7] studied increase in natural convection heat transfer from a horizontal rectangular fin embedded with rectangular perforations of aspect ratio of two with the help of finite element technique. Results obtained by comparing a perforated fin with an identical solid fin, by examining gain in fin area and of heat transfer coefficients due to perforations which are used to judge the influence of fin and perforation factors on increase in heat transfer rate. It is found that heat transfer coefficient of fin surface can be increased by introducing surface roughness and therefore promoting turbulence [8, 9, 10]. Wadah Hussain and Abdul Razzaq Al-Doori (2011) conducted an experiment to study heat transfer by natural convection in a rectangular fin plate with circular perforations as heat sinks.

Kavita H. Dhanawade ,Vivek K. Sunnapwar and Hanamant S. Dhanawade (2014)^[8] experimentally investigated increase in heat transfer over horizontal flat surface with rectangular fin arrays , lateral square and circular perforation by forced convection. Author compared the results obtained from rectangular fin with circular/square perforations with an equivalent rectangular solid fin and found that percentage improvement in temperature of square perforated fin arrays is more than fin arrays of circular perforated fin of same size .B. V. S. S. S. Prasad & A. V. S. S. K. S. Gupta (1998) suggested a method for reducing the weight of a straight rectangular fin by providing a semicircular cut at its tip.

Heat transfer and friction loss characteristics in horizontal rectangular channel having attachments of hollow rectangular profile fins have been studied by U. Akyol and K. Bilen^[9]. Two arrangements in-line and staggered

fin were studied for one fixed span wise ,four different stream wise distances and correlation equations for Nusselt number and friction factor are determined [4]. N. Souidi, A. Bontemps worked on counter current gas liquid flow in narrow rectangular channels simulated by plain fins and perforated fins [5]. Abdulla H.M, AlEssa worked on heat transfer dissipation from horizontal rectangular fin embedded with triangular perforations numerically using finite element technique [6]. Heat dissipation rate of solid fin and perforated fin are calculated and compared.

D. Abdullah H. AlEssa^[10] studied increase in natural convection heat transfer from a rectangular fin with rectangular perforations. Results obtained shows that for different dimensions of rectangular perforations there is an increase in heat dissipation of perforated fin over that of identical solid fin with the increase in perforations.

III. METHODOLOGY

1. Conducting experiments of cylinder block for pulsar 150cc.
2. Reducing surface area of fin by making perforations of 2 series of 4mm, 5mm and 6mm size square.
3. Measure temperatures on fin with and without perforations by using thermocouple rod and thermocouple temperature trainer kit.
4. Assuming the temperature is fully absorbed by the base of the fin; no heat is transferred directly to the environment.
5. Calculate heat dissipation and heat flux from extended surface.
6. Modeling of cylinder block with fins using CREO 3.0.
7. Analyzed the results by using software SOLID WORK for thermal steady state.

IV. EXPERIMENTAL RESULTS:

a. Temperature without perforation on fin

Temp (c°)	Time (min)
45	1.16
67	3.41
89	7.48
111	13.42
139	33.25

b. Temperature with 4mm perforation

Temp (c°)	Time (min)
45	4.31
67	11.9
89	17.4
111	23.31
139	45

c. Temperature with 5mm perforation

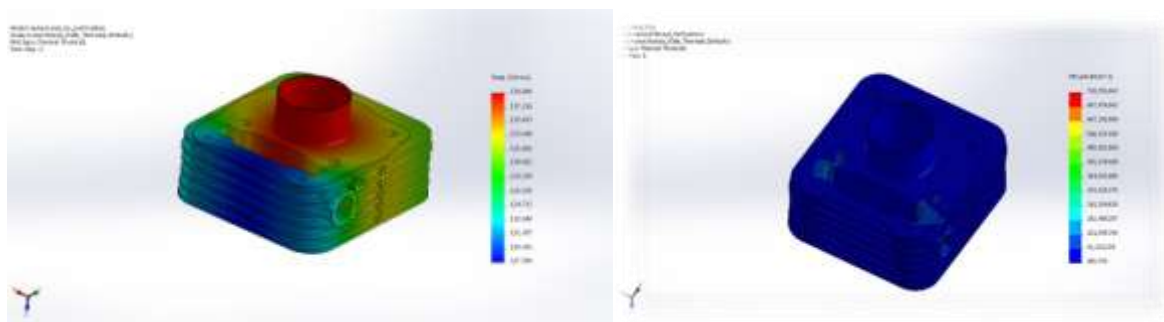
Temp (c°)	Time (min)
45	5.35
67	11.54
89	19.40
111	28.32
115	45

d. Temperature with 6mm perforation:-

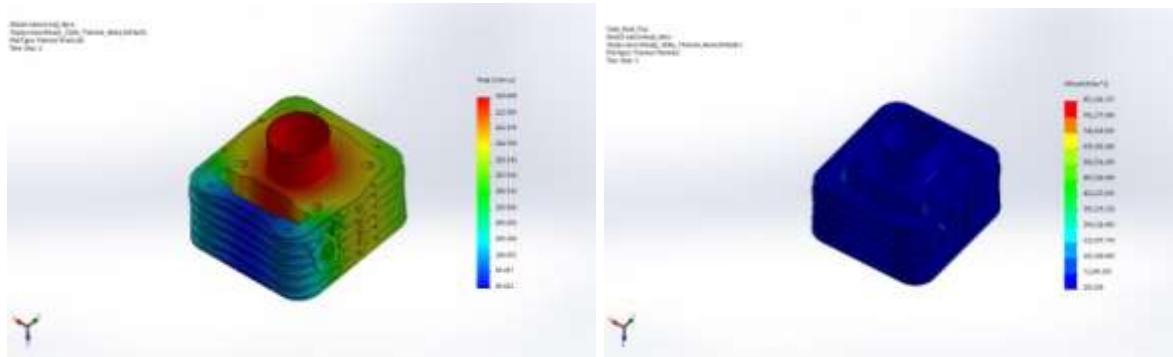
Temp (c°)	Time (min)
45	4.5
67	10.2
89	17.04
111	25.04
120	45

V. VALIDATION USING SOLID WORK

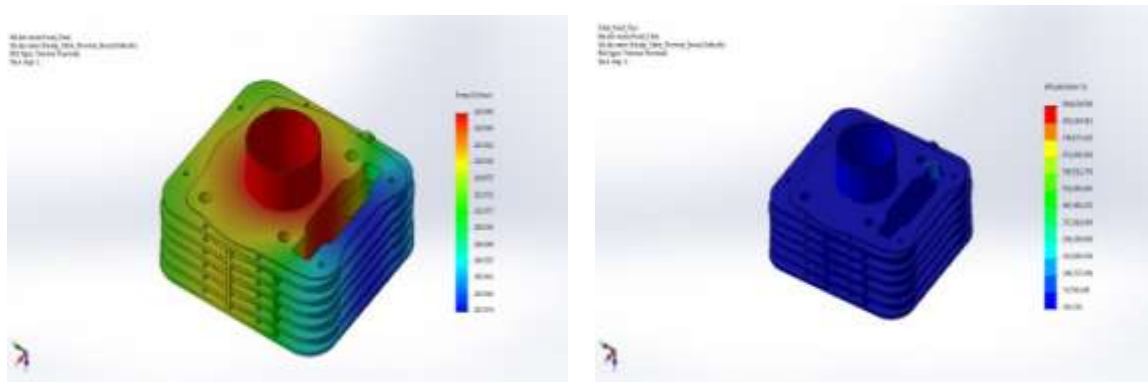
a. Heat Flux For Fins Without Perforation



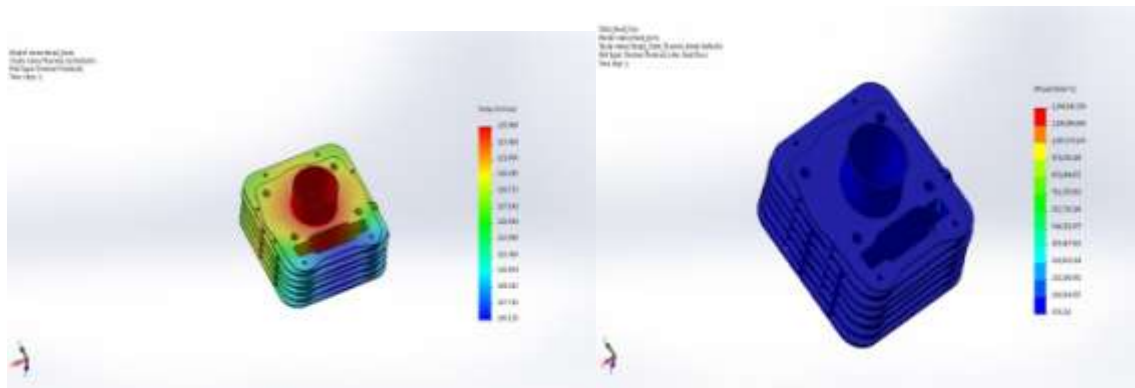
b. Heat Flux For Fins With 4mm square Perforation:-



c. Heat Flux For Fins With 5mm square Perforation

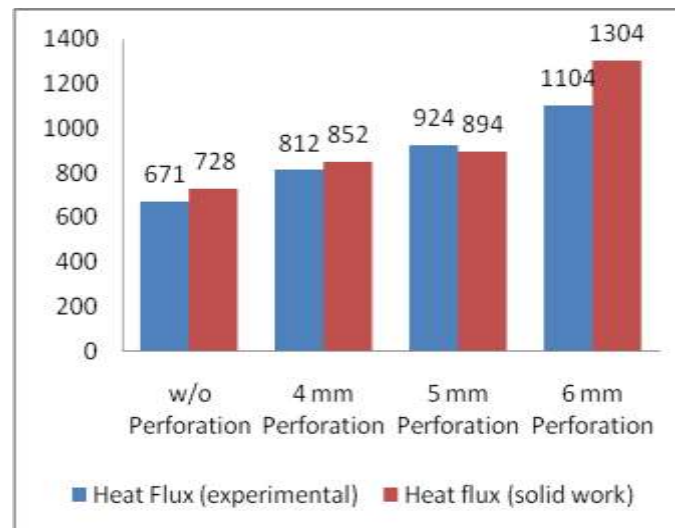


d. Heat Flux For Fins With 6mm square Perforation



VI. RESULTS AND DISCUSSIONS

SrNo	Fin	Expt Temp (°C)	Expt. Heat dissipation (W)	Heat flux (KW/m ²) Experiment	Heat flux KW/m ² (FEA)
1	Without perforation	139	59.09	671.477	728.551
2	4mm perforation	115	58.09	812.361	852.286
3	5mm perforation	120	58.22	924.126	894.634
4	6mm perforation	125	57.43	1104.624	1304.524



Comparison of Heat Flux

Weight Reduction in Percentage

Fin specification	Original mass(kg)	% mass reduction
Without perforation	5.98	—
4mm of perforation	5.964	0.2675
5mm of perforation	5.957	0.3846
6mm of perforation	5.953	0.4515

VII. CONCLUSIONS

An attempt is made to study the effects of various square sizes of perforation on heat transfer rate through fins and after analysis maximum fin size is found to be 6mm compared to 4mm and 5mm perforation. And it is also validated from results with FEA analysis. The perforation of fins enhances the heat dissipation rates and at the same time decreases the expenditure for fin materials. Reduction in weight of material by 0.4515 in 6mm. It also helps for making fin arrays light in weight.

REFERENCES

- [1.] Shivdas S. Kharche, Hemant S. Farkade, “Heat Transfer Analysis Through Fin Array By Using Natural Convection” International Journal of Engineering And technology and Advance Engineering Volume 1 Issue 5 page 318-320,2015
- [2.] Raaid R. Jassem, “Effect The Form Of Perforation On The Heat Transfer In The Perforated Fins” Academic Research International, ISSN:2223-9553, ISSN:2223-9944, Vol.4, N0. 3, May 2013.
- [3.] Kumbhar D.G, Dr. N.K. Sane, Chavan S. TYenarkar “Finite Element Analysis And Experimental Study Of Convective Heat Transfer Augmentation From Horizontal Rectangular Fin By Triangular Perforations” ICAME Issue 2, 187-192, Jun 2013.
- [4.] Rupali V. Dhanadhya, Abhay S. Nilawar And YogeshYenarkar “Therotical Study And Finite Element Analysis Of Convective Heat Transfer From Augmentation From Horizontal Rectangular Fin With Circular Perforation” Ijimperd, Vol. 3, Issue 2, 187-192, Jun 2013.
- [5.] Gurav, R.B., et al., “Finite Volume Analysis Of Convective Heat Transfer Augmentation From Horizontal Rectangular Fin By Elliptical Perforation”. International Journal of Global Technology Initiatives, March 2013
- [6.] Abdullah H. AlEsa, AymanM.Maqableh and ShathaAmmourah, “Enhancement Of Natural Convection Heat Transfer From A Fin By Rectangular Perforations With Aspect Ratio Of Two” International Journal of physical sciences, vol.4(10), pp.540-547, 2009
- [7.] Kavita H. Dhanawade, Vivek K. Sunnapwar, and HanamantS.Dhanawade,” Thermal Analysis of Square and Circular Perforated Fin Arrays by Forced Convection ” International Journal of Current Engineering and Technology E-ISSN 2277 – 4106, P-ISSN 2347 – 5161.
- [8.] AkloyUgur, K Bilen,” “Heat Transfer And Thermal Performance Analysis Of Surface With Hollow Rectangular Fins” Applied thermal engineering 26 (2006) 209-219
- [9.] Abdullah H. AlEsa, AymanM.Maqableh and ShathaAmmourah, “Enhancement Of Natural Convection Heat Transfer From A Fin By Rectangular Perforations With Aspect Ratio Of Two” International Journal of physical sciences,
- [10.] R.K.Rajput S Chand publications “A book on Heat and Mass transfer” first edition pp 203-242.