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Engine Performance Assessment through Solid Fins with & without Perforations

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Abstract:-- **Now a days machines become a part in human life. Our every moment is in their hands. Updating that machines means updating ourselves. And in such machine, there is no machine without losses and that losses too mostly due to the heat. As you consider mobiles, computers, vehicles everything produces heat and we need to cool down them to work efficiently. How effectively you cool them that much efficiently they work. Majority of cooling systems are incorporated with air cooling. As the water heated in water cooling are cooled by air cooling that itself indicates importance of air cooling. Air cooling have many advantages but the thing is they are a bit costlier. This air cooling is done due to solid fins which are heat exchangers used to increase the flow of air. The advancement in that heat exchange process is perforations on fins. In the present paper the matters deal with effect of size, shape of perforations & their number present on fins on the efficiency of heat exchange. The parameters change due to perforations and the effect of that parameters on the heat exchange which in turn effects engine performance. All the simulation is done with ANSYS 15.0**

I. INTRODUCTION

All most all the electronic materials dissipates large amount of heat and those things need to be cool down for efficient performance. The heat dissipation is very serious issue to overcome due to continuous integration, miniaturization and lightning of equipment. The removal of the excess heat is essential to avoid the damage of burning and overheating of system components. Heat exchangers must be provide to deal with this issue. And that heat transferring can be amplified by increasing heat exchange coefficient or increasing surface area of contact of heat exchangers. As far the league concerns increasing surface area deals with the designing of heat exchangers. Extending surfaces by providing fins with rectangular shaped fins and further advancement in extending surface area is considering the perforations on those solid rectangular fins and also providing pins on the heat exchangers. But here is the thing that makes difference and that thing is the engine weight. So the perforations are a bit better in terms of weight concerns.

Dai(2013) showed that the perforations increase the heat transfer, reduce the pressure drop, that results the reduction of recirculating zones. Dhanwade(2010,14) made simulations by Finite Element Techniques and showed that perforation diameter is function of applied heat flux density. Larger perforations are benefit for low heat flux and high heat flux prefer for small perforation sizes. And the perforations do an ultimate job in the reduction of the fins that is reduced engine weight. Damook(2015) using experimental and numerical methods showed that heat transfer rate increase monotonically with number of perforations, while pressure drop is the only issue opposing here. He conclude that heat transfer rate increasing by 10% , reduce pressure drop by 15% for 5 perforations as per his data analysis. Eve thus shows is perforations increase heat exchange capacity and reduce pressure drop to avoid recirculating zones.

Modelling:

An engine Cylinder has been chosen and modelled in the AutoCAD 2018. Circular perforation in the fins has been made. The figure shows the geometries of the engine with perforated fins of different diameter (2, 4 and 6mm). Respectively figure 1,2,3 and 4 represents the engine cylinder block with without perforations,2mm, 4mm, 6mm diameter circular perforations. Automatic meshing has been adopted for the present work. One can observe the difference between the meshed view of the perforated fin engine and solid fin engine. Meshing is fine in case of perforated fin engine when compared with an engine with solid fin

1.

Without perforations

2.

With 2mm circular perforations

3.

With 4mm circular perforations

4.

With 6mm circular perforations

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Results:

The figures 1,2,3 are the time temperature cooling curve for the engine cylinder made of materials Aluminium, Grey Cast Iron, Structural Steel respectively. And 1a,1b,1c,1d are the time temperature cooling curves for the materials without perforations,2mm,4mm,6mm diameter circular perforations. From the figures it can be clearly identified that the increase of perforations size results in obtaining more minimum temperature for the same period of time. As a result heat exchange increases. Same results obtained for grey cast iron and structural steel in Fig2,Fig 3.

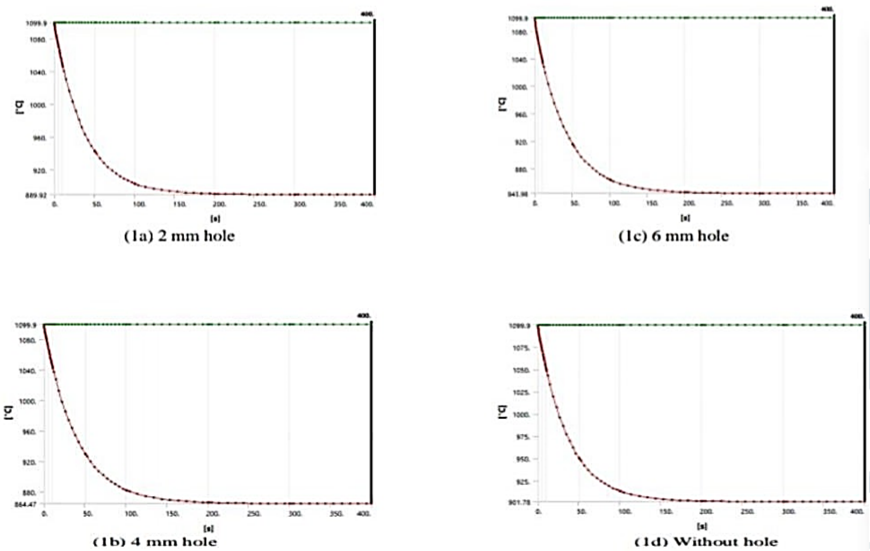

Fig 1: Temperature v/s time curve for Aluminium

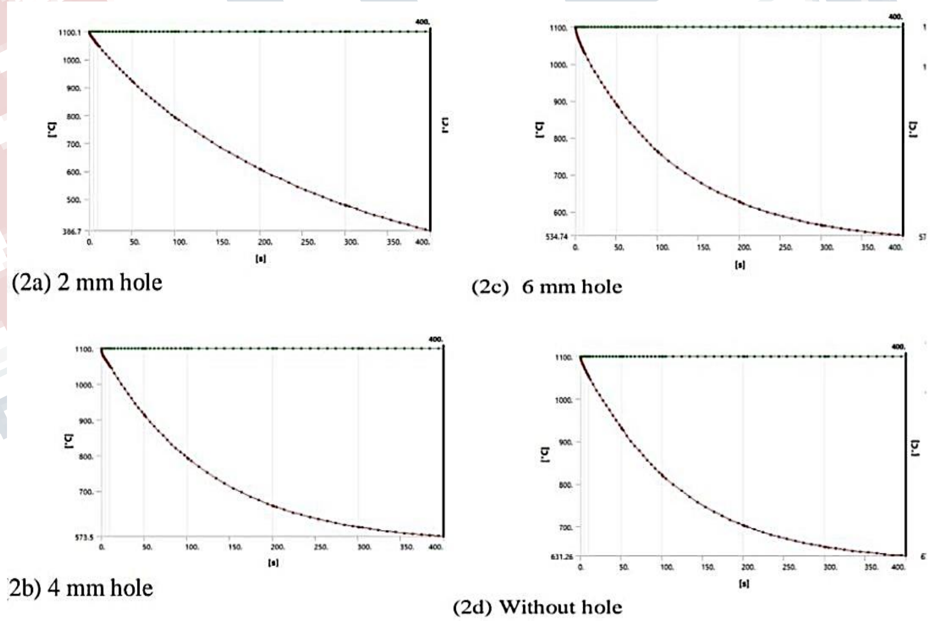

Fig 2: Temperature v/s time curve for Grey Cast Iron

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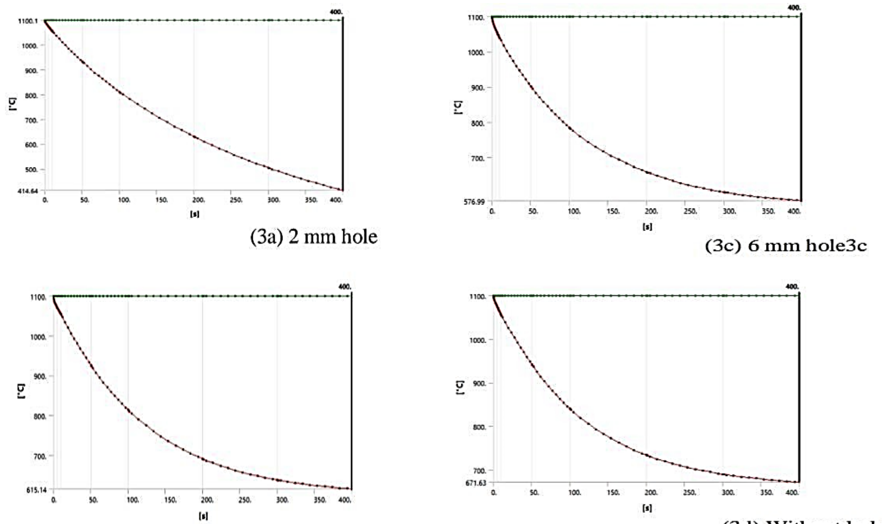

(3a) 2 mm hole (3c) 6 mm hole3c

(3b) 4 mm hole (3d) Without hole

Fig 3: Temperature v/s time curve for Structural steel

Table 1,2 & 3 are represent the heat flux maximum and minimum values & temperature maximum and minimum values for materials Aluminium, Grey Cast Iron, Structural steel with different perforation geometries i.e., without perforations,2mm,4mm,6mm circular perforations. Table 4 represent the weight comparison of the different materials with 2mm perforations and without perforations.

	Aluminium without perforation	Aluminium with 2mm perforation	Aluminium with 4mm perforation	Aluminium with 6mm perforation
Heat Flux _max	1.2417 w/mm^2	2.3031 w/mm^2	7.1225 w/mm^2	4.0490 w/mm^2
Heat Flux _min	0.018402 w/mm^2	0.01617 w/mm^2	0.00412 w/mm^2	0.00314 w/mm^2
Temperature _max	1099.8°C	1099.8°C	1099.8 °C	1099.8°C
Temperature _min	901.78°C	889.92°C	864.47°C	843.98°C

Table 1: Temperature max& min values for Aluminium with different perforation geometries

	Gray Cast Iron without perforation	Gray Cast Iron with 2mm perforation	Gray Cast Iron with 4mm perforation	Gray Cast Iron with 6mm perforation
Heat Flux _max	0.8346w/mm^2	7.7034 w/mm^2	4.4458 w/mm^2	1.90916 w/mm^2
Heat Flux _min	0.01333 w/mm^2	0.00210 w/mm^2	0.00429 w/mm^2	0.00601 w/mm^2
Temperature _max	1099.8°C	1099.8°C	1099.8 °C	1099.8°C
Temperature _min	631.26°C	386.7°C	573.5°C	534.74°C

Table 2: Temperature max& min values for GreyCastIron with different perforation geometries

	Structural Steel without perforation	Structural Steel with 2mm perforation	Structural Steel with 4mm perforation	Structural Steel with 6mm perforation
Heat Flux _max	0.8930w/mm^2	8.5517w/mm^2	4.7054 w/mm^2	2.0589 w/mm^2
Heat Flux _min	0.01409 w/mm^2	0.00246w/mm^2	0.00429 w/mm^2	0.00613 w/mm^2
Temperature _max	1099.8°C	1099.8°C	1099.8 °C	1099.8°C
Temperature _min	671.63°C	414.64°C	615.14°C	576.99°C

Table 3: Temperature max& min values for Structural steel with different perforation geometries

Material	Total weight with 2 mm hole	Total weight without hole
Al	1.5779 Kg	1.6009 Kg
Structure Steel	4.4718 Kg	4.5369 Kg
Gray Cast Iron	4.1015 Kg	4.1612 Kg

Table4: weight comparison for different material with 2mm and without perforations

CONCLUSIONS

By employing perforations on solid fins

- Increased heat transfer by 10%
- Reduction in pressure drop by 15%
- Can obtain minimum temperature
- Reduced weight of engine
- Aluminium alloy is preferred material for heat exchange as it has greater heat exchange coefficient.

REFERENCES:

1. Dhumne, A. B., & Farkade, H. S. (2013). Heat Transfer Analysis of Cylindrical Perforated Fins in Staggered Arrangement, International Journal of Innovative Technology and Exploring Engineering, 2(5), 225-230.

2. Dhanawade, K. H., Sunnapwar, V. K., & Dhanawade, H. S. (2014). Thermal Analysis of Square and Circular Perforated Fin Arrays by Forced Convection, International Journal of Current Engineering and Technology, Special Issue-2, 109-114.

3. Saeri, M. R., & Yaghoubi, M. (2009). Numerical Analysis of Turbulent Convection Heat Transfer from an Array of Perforated Fins, International Journal of Heat and Fluid Flow, 30, 218-228.

4. Shaeri, M. R., & Yaghoubi, M. (2009). Thermal enhancement from heat sinks by using perforated fins, Energy Conversion and Management, 50, 1264-1270.

5. Ismail, M. F., Hasan, M. N., & Saha, S. C. (2014). Numerical Study of Turbulent Fluid Flow nd Heat Transfer in Lateral Perforated Extended Surfaces, Energy, 64, 632-639.

6. Wang, W., Guo, J., Zhang, S., Yang, J., Ding, X., & Zhan, X. (2014). Numerical Study on Hydrodynamic Characteristics of Plate-Fin Heat Exchanger using Porous Media Approach, Computers and Chemical Engineering, 61, 30-37