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EXPERIMENTAL INVESTIGATION OF MODIFIED ANNULAR RECTANGULAR FINS

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ABSTRACT

Annular fins are being used for many applications as engine fins, heat exchanger tube fins applications. There are many efforts being made to improve the thermal performance of annular fins for different applications. This work is intended to perform comparative study of four geometries used to improve the performance of annular fins. For this work forced convection & turbulent flow is used to cool the fins in tunnel for three various speed Re range 40000-850000 & three heat flux supply are being used range of heat flux is 900-2000 for two different arrangement of number of fins. At the end, modified geometry is found to be giving good results for heat transfer.

Keywords: forced convection, comparative study, and turbulent, modified fins.etc.

1. INTRODUCTION

The engine cylinder is major component of automobiles which is subjected to high temperature variations and thermal stresses. In order to cool the cylinder fins are provided to increase the rate of heat transfer. If fins are not dissipating heat properly there are lots of problems like overheating, also burning of oil layer may occur. If fins are dissipating heat in excess, more loss of heat will take place and engine becomes less efficient according to second law of thermodynamics. It is become critical job for a designer to design the fins precisely matching exact requirements by thermal loading. Many researchers have found their interest to enhance the heat transfer from engine cylinders. Basically in a heat transfer context engine fins are analyses clearly as an annular fin over a cylinder. Engine life and effectiveness can be improved with effective cooling. Engine heat is transferred by conduction through combustion chamber walls and finned material. Air medium takes that heat away by convection process from surface of fins. This work is focusing on material saving and improving heat dissipations by introducing new profiles for annular fins.

2. LITERATURE

Yamammoto et.al.[1] performed an experimental analysis for annular fins for various slit. Slits used variable width & slit position & orientation. Author uses Aluminum alloy for fins and uses insulation between consecutive fins ultimately found modified geometry gives better cooling for natural convective heat transfer. Author plotted heat dissipation verses number of slit and also temperature vs. distance from root. Yamammoto et.al.[2] performed an experimental analysis for annular fins for various perforations. Residual heat released in natural convection heat transfer is investigated. Variables used are angle between consecutive perforations, diameter of port, pitch circle diameter. Geometry with perforation surly gives better cooling than regular geometry for annular fins.

3. ASSUMPTIONS

- The heat flow in the fin and its temperatures remain constant with time.
- Fin material is homogeneous.
- Convective heat transfer coefficient on surface of the fin is constant.
- There is no contact resistance at fin base joint.
- No heat source within fin itself.

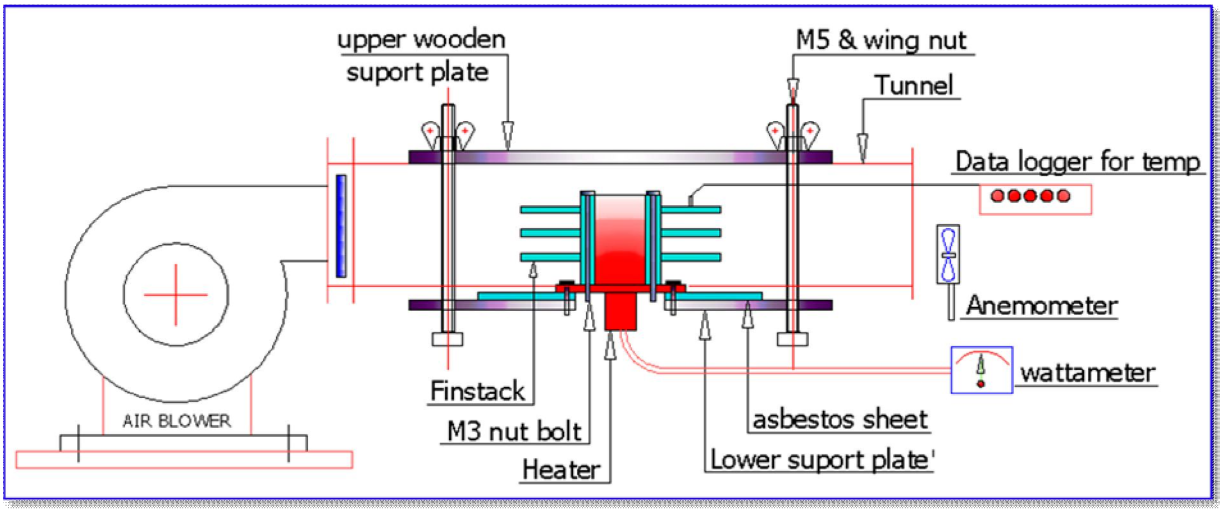
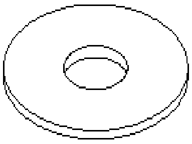
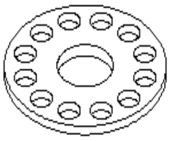
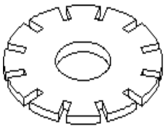
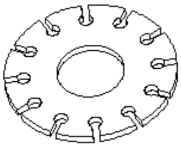


Figure1: Experimental set-up general assembly diagram

Geometry				
	Plane	Perforated	Slit	Modified
Reynold's number	40723	61084.5	81446.1	
Heat flux(W/m^2)	909.09	1363.63	1818.18	
Spacing	16.66mm	28mm		
Orientation	10 Deg Ccw	15 Deg Ccw	20 Deg Ccw	
Single fins are being analysed by experimental and numerical method				

4. RESULT AND DISCUSSION

Experimental investigation is performed according to the variables mentioned in above table 1.Results for stack of 3 fins stack of 2 fins, enhancement of heat, effect of offset of angel are being discussed in detail in further context.

Result And Discussion of Stack of 3 fins

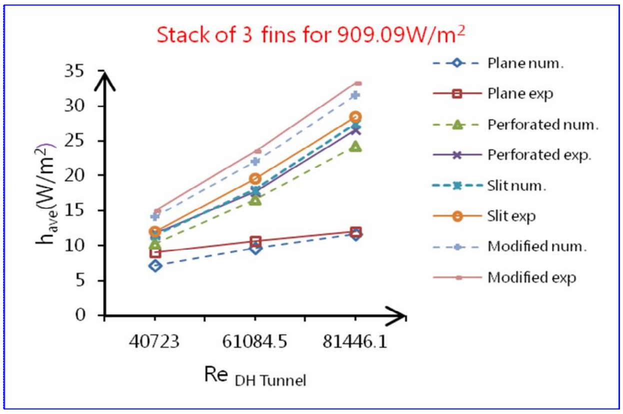


Figure 2 Graph of h_{ave} verses Reynolds number for D_H of tunnel for stack of 3 fins at 909.09W/m^2

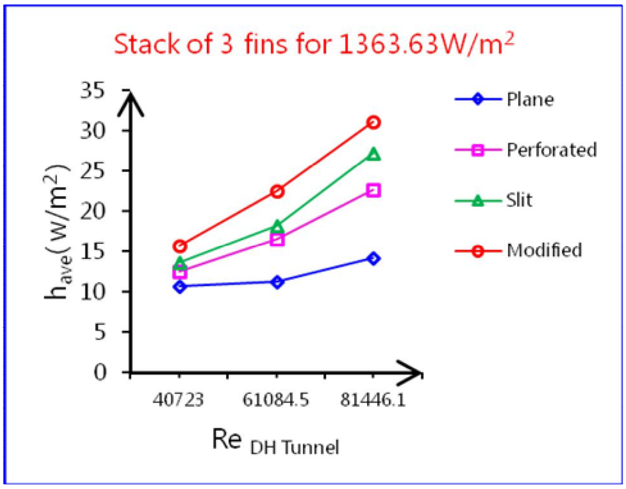


Figure 3: Graph of h_{ave} verses Reynolds number for D_H of tunnel for stack of 3 fins at 1363.63W/m^2

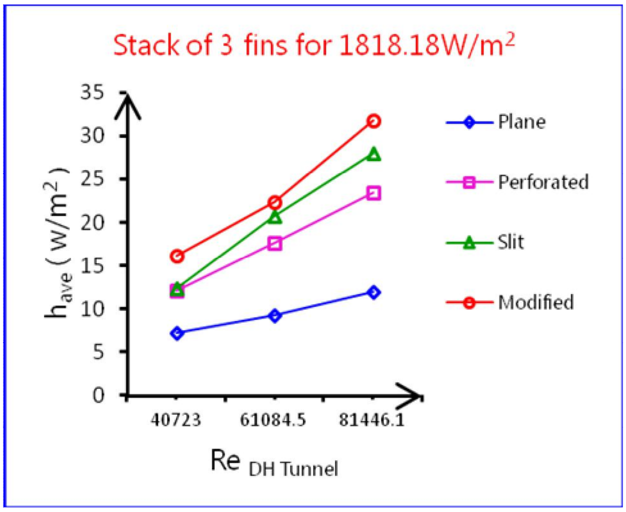


Figure 4 Graph of h_{ave} verses Reynolds number for D_H of tunnel for stack of 3 fins at 1818.18W/m^2

Result And Discussion of Stack of 2 fins

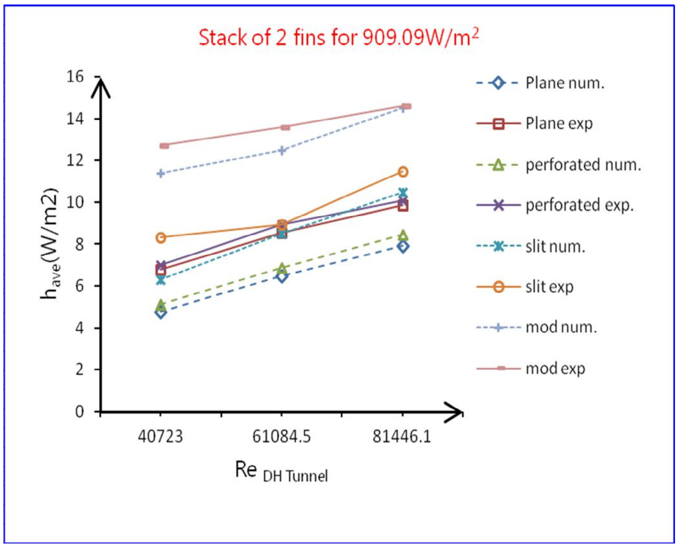


Figure 5 Graph of h_{ave} verses Reynolds number for D_H of tunnel for stack of 2 fins at 909.09W/m^2

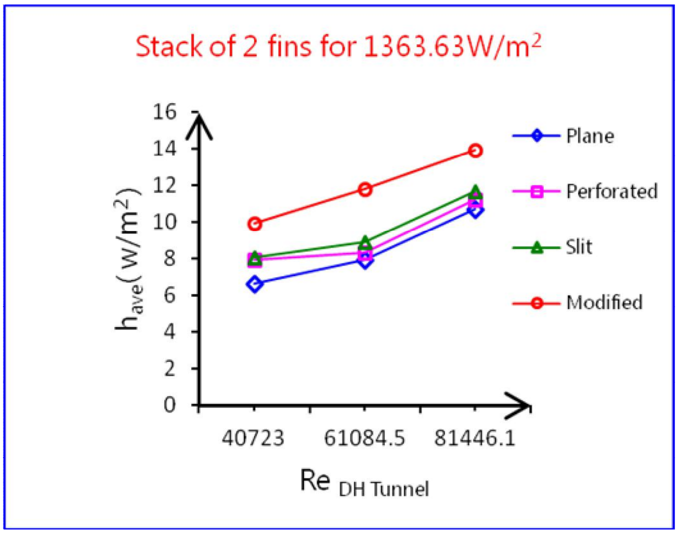


Figure 6 Graph of h_{ave} verses Reynolds number for D_H of tunnel for stack of 2 fins at 1363.63W/m^2

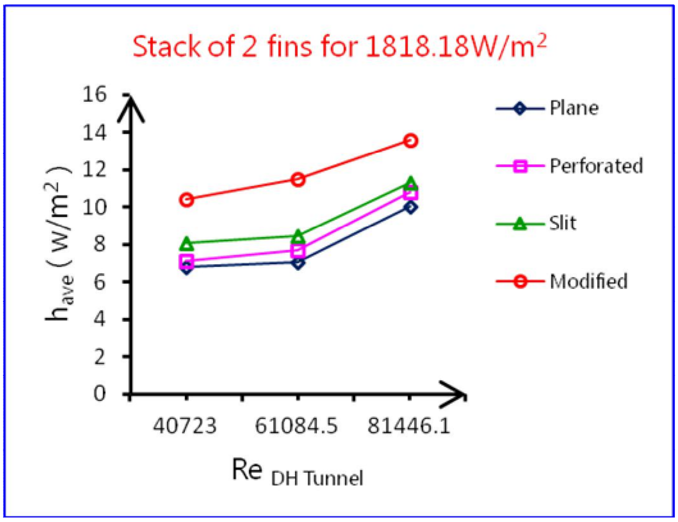


Figure 7 Graph of h_{ave} verses Reynolds number for D_H of tunnel for stack of 2 fins at 1818.18W/m^2

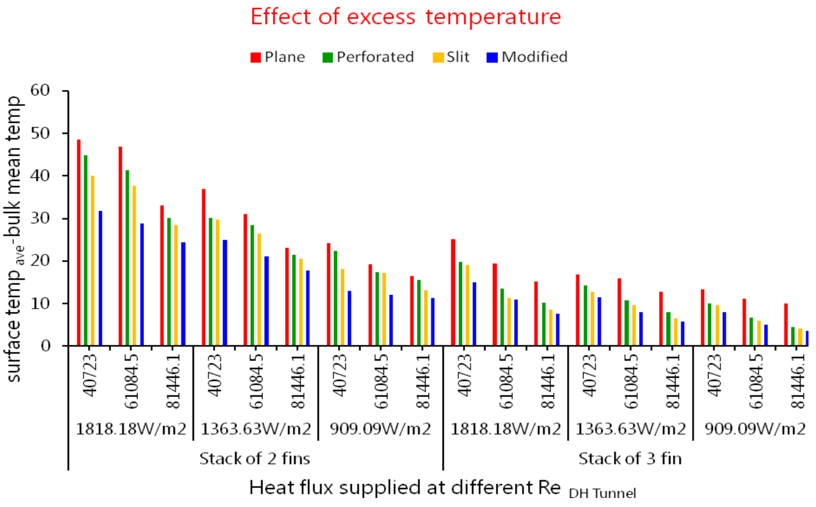


Figure 8: Graph of Surface temp – bulk mean temperature verses heat fluxes supplied at different Reynolds number for both stack of 2 & 3 numbers of fins

For more speed of air it is observed that there is less excess temperature for every heat supplied for all geometries & for every arrangement of stacks. Graph minutely shows variation in cooling capacity for both numbers of fins. Most cooled system found to be least wattage of heat supplied, most supply of air & more number of fins for this experimentation.

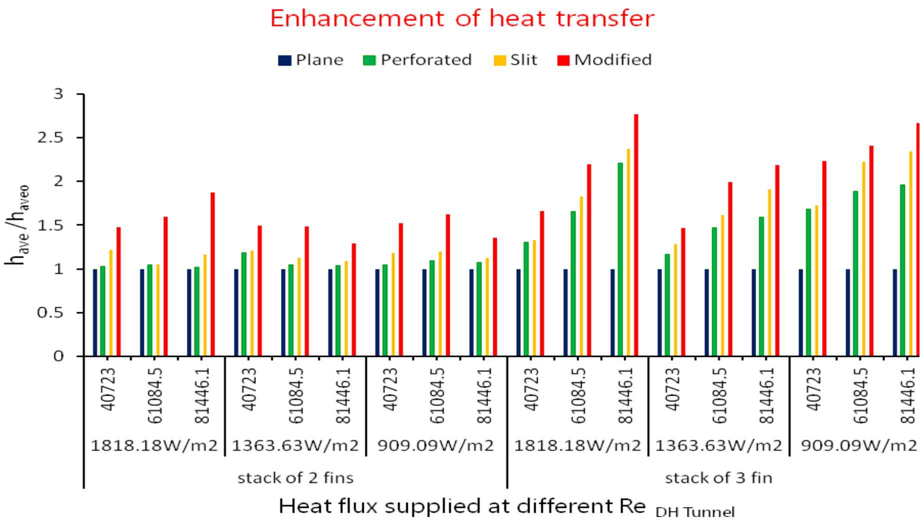


Figure 9: Graph of (h_{ave}/ h_{aveo}) verses heat fluxes supplied at different Reynolds number for both stack of 2 & 3 numbers of fins

Plane fins area is considered as original area for estimating average heat transfer co-efficient. Enhancement in average heat transfer co-efficient is more in stack of three fins than stack of two fins. Average heat transfer co-efficient also increases as heat flux supply increases. Graph shows most enhanced system is most watt supplied system & most number of fins for this experimentation particularly for modified geometry

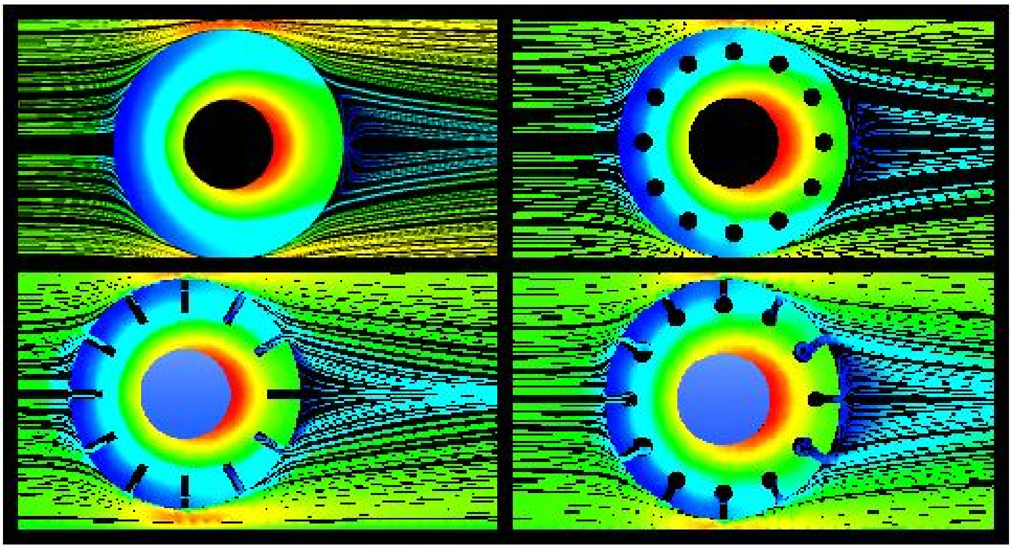


Figure 11: Streamlines of air arround different geometries in FLUENT

5. CONCLUSION

Investigation presents experimental results for heat transfer characteristics of annular fins for turbulent airflow conditions using four different variations in geometry. Average heat transfer co-efficient were obtained experimentally & the attempt is being made to conform these numerically. Experimental work is accomplished for two arrangements of fin stack & for four geometries for different heat flux.

Key findings are being summarized as follow

1) As soon as speed of air increases, the heat transfer co-efficient also increases for all supply of heat & for all stack of two & three fins.
2) System is found to be cooled for more number of fins. As excess temperature graph clearly gives trends that more are the fins more is the cooling.
3) Stack found to be coolest for Modified fins as excess temperature is very less for given supply of heat.& it reduces material required for fins.
4) Ratio of average heat transfer co-efficient is found to most for stack of 3 fins for most supply of heat.
5) Ratio of average heat transfer co-efficient for different angle of slit offset are being tested & best angle is 15 Deg that is staggered arrangement is best for offset rotation .
6) Optimum number of fin found to be 3 number of fins.
7) As soon as spacing increases, average heat transfer co-efficient decreases as work falls beyond the limit of spacing for optimum value of average heat transfer co-efficient for particular spacing. So from experimentation generally it can be concluded, that geometry proposed was indeed found to enhance the thermal performance as heat transfer co-efficient for annular fin system.

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