Design and Analysis of Engine Block and Different Fins using Cast Iron and Aluminium Material

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Abstract: The engine block is a connector for internal combustion channels, which provides the car's power. It is called a "block" because it is usually the solid part of the car, which puts the cylinders and their contents inside a cool and coated coffee cricket. This part is designed to be extremely durable and durable because its failure fails on the car, which will not work until the engine block is replaced or repaired.

The main objective of the project is to analyze tropical areas by changing the geometry of the cylinder block wings using an ANSYS bench. The 3D geometric model was developed using CATIA and its thermal structures are analyzed using Ansys workbench 14.5. Variations in the distribution of temperatures over time are of interest to many applications such as cooling. Accurate temperature measurements can allow critical design parameters to be subject to improved health.

The design of the fin plays an important role in heat transfer. There is a degree of improvement in the heat transfer of the air-cooled engine cylinder fin if the shape of the fin is coated differently from normal. Time for communication between the airflow and termination (the time between the inflow of air and the flow of flow flow) is also an important factor in this heat transfer.

KEYWORDS: Engine Block, CATIA, ANSYS, Heat Tranfer, Air Cooled Engine, fins

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INTRODUCTION:

The internal combustion engine is an engine in which the combustion of a fuel (normally a fossil fuel) occurs with an oxidizer (usually air) in a combustion chamber. In an internal combustion engine, the expansion of the high-temperature and -pressure gases produced by combustion applies direct force to some component of the engine, such as pistons, turbine blades, or a nozzle. This force moves the component over a distance, generating useful mechanical energy. An Engine block is the structure which contains the cylinders, and other parts, of an internal combustion engine. In an early automotive engine, the engine block consisted of just the cylinder block, to which a separate crankcase was attached. Modern engine blocks typically have the crankcase integrated with the cylinder block as a single component. Engine blocks often also include elements such as coolant passages and oil galleries.

The term "cylinder block" is often used interchangeably with engine block, although technically the block of a modern engine (i.e. multiple cylinders in a single component) would be classified as a monobloc. Another common term for an engine block is simply "block".

STRUCTURE OF PAPER

The paper is organized as follows: In Section 1, the introduction of the paper is provided along with the structure, important terms, objectives and overall description. In Section 2 we discuss related work. In Section 3 we have the designed the engine block using CATIA and shares information about the CFD simulation of engine cylinder fins. Section 4 tells usabout the CFD analysis results. Section 5 showcases the transient thermal analysis results Section 6 concludes about the analysis of the engine cylinder fins and future scope and references.

OBJECTIVES

The objective of project is to analyze the heat dissipation of the engine block using different fins to increase the heat transfer coefficient and also to calculate the temperature distribution over time such as cooling and designing the fins according to it.

RELATED WORK

There are numerous works that have been done related to Design and Analysis of engine block and the fins.

D. R.ParthasarathiThe cylinder block

forms the basic framework of the engine, it houses the engine cylinders, which serve as bearings and guides for the pistons reciprocating in them. The analysis of the engine block is to be carried out to predict its behavior under static and dynamic loading. The cylinder block has to withstand the stresses and deformations due to loads acting on it. The solid model of the block is generated in CATIA V5 R21. The model is imported to HYPERMESH 11 through IGES format. The quality mesh is prepared in HYPERMESH for converged solution and the solver set as ANSYS in which loads and boundaryconditions are applied for analysis. By using different materials Aluminium, Grey cast iron, Steel, Titanium and Brass. The static analysis is performed to predict the deformations and stresses. The model analysis using lanczo’s algorithm to predict the natural frequencies and corresponding mode shapes.

Bingxia LiuBased on diesel engine block, using the finite element analysis software ANSYS to simulate the strength. Firstly solid model and finite element model of diesel engine block are established using relevant software, and the necessary simplify operation according to the needs of finite element analysis is carried out on the block；Then strength check is made to the block model, Stress distribution results are obtained Which provides the basis for optimizing the block structure.

DESIGN OF THE ENGINE BLOCK AND THE FIN USING THE CATIA AND CFD SIMULATION

3.1 CATIA:

For the Geometry of the engine block and fins we have takenthe cylinder with fins for a 150cc engine by varying the geometry such as rectangular, circular and curve shaped (parabolic) with different materials and temperature in CATIA .

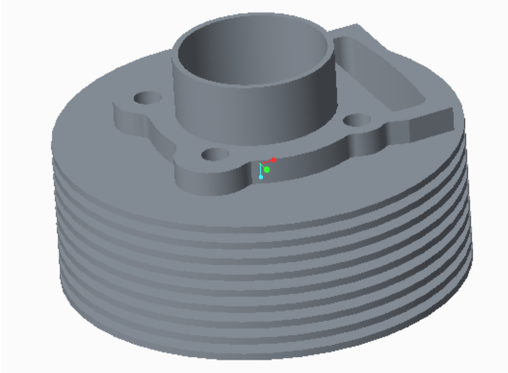


Fig 3.1 Circular Fin

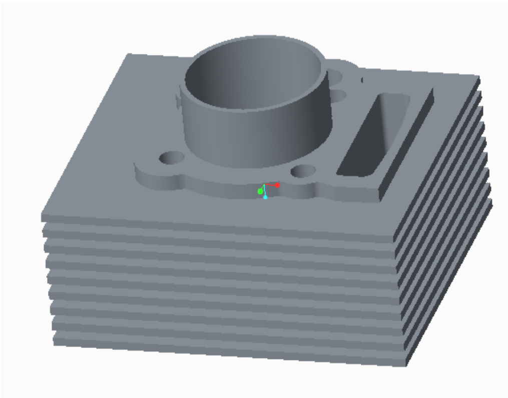


Fig 3.2 Rectangluar Fin

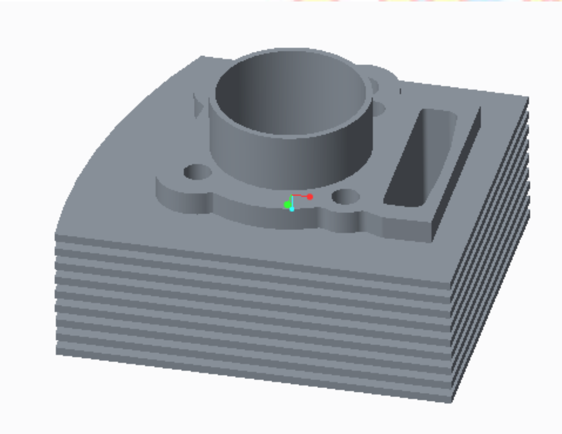


Fig 3.3 Aerodynamic Fin

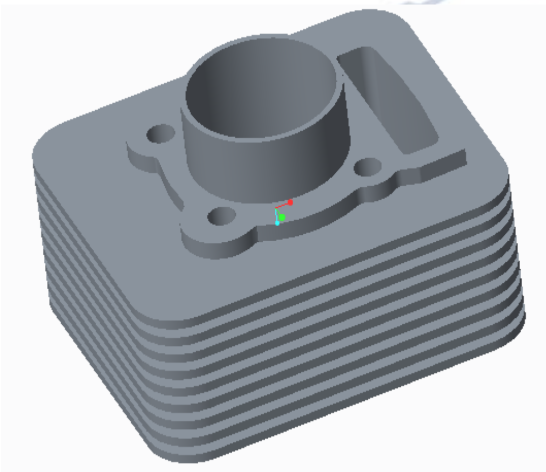


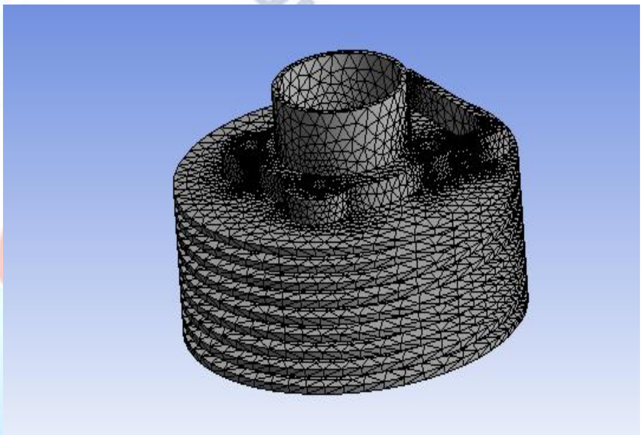
Fig 3.4 Curved Fin

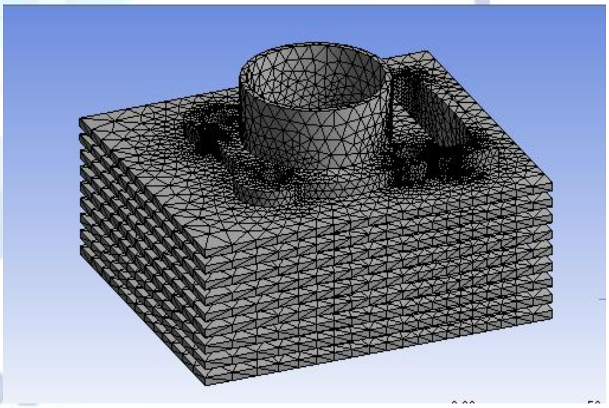
3.2 ANSYS Workbench:

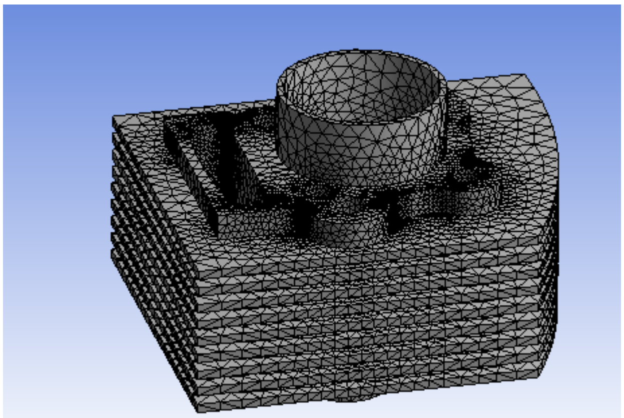
Analysis of the cylinder fin for different geometries was carried out in ANSYS workbench. The basic model was generated using CATIA and that model is imported to ANSYS work bench. Meshing is done in ANSYS work bench.

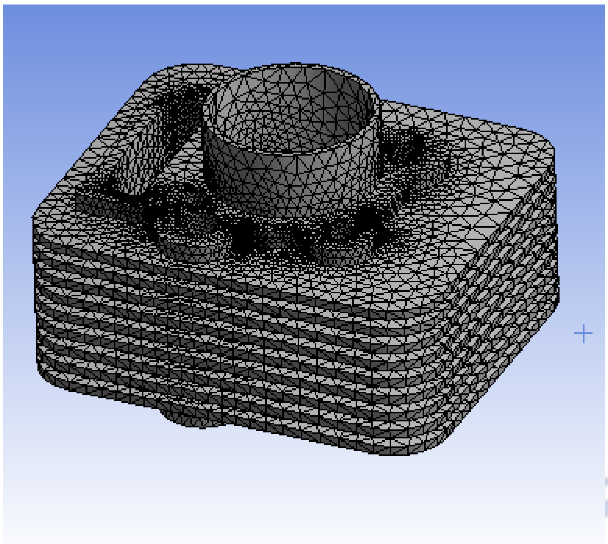
Our next stepin steady state CFD analysis is to generating mesh. The design using efficient mesh generation techniques, meshes were created with high contact sizing relevance. The total number ofelements and nodes are 19778 and 36988respectively.

3.3 MESHING









CFD ANALYSIS RESULTS

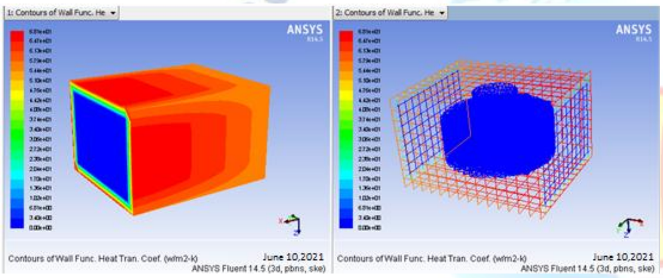


Fig 4.1 heat transfer coefficient for cylindrical fins and engine

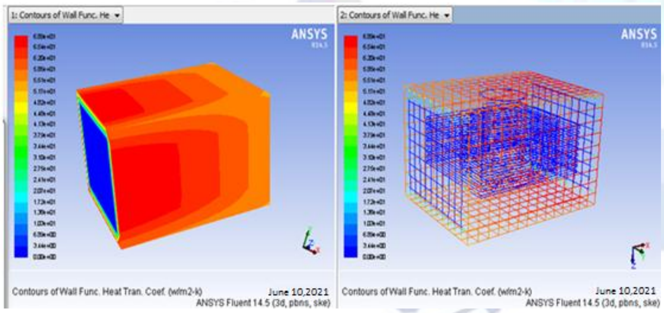


Fig 4.2 heat transfer coefficient for rectangular fins engine

Type of fin	**heat transfer coefficient(W/m²k)**
Cylindrical	681
Rectangular	683
Aerodynamic	688
Curved	696

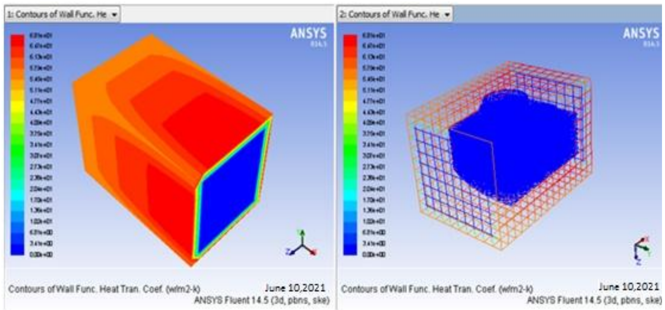


Fig 4.3 heat transfer coefficient for aerodynamic fins engine

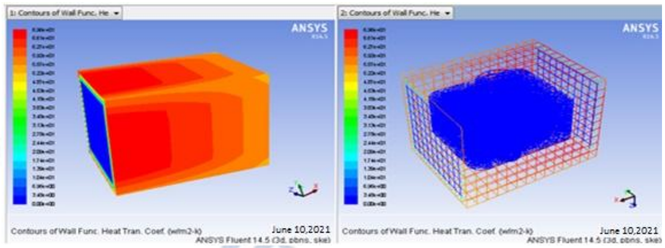
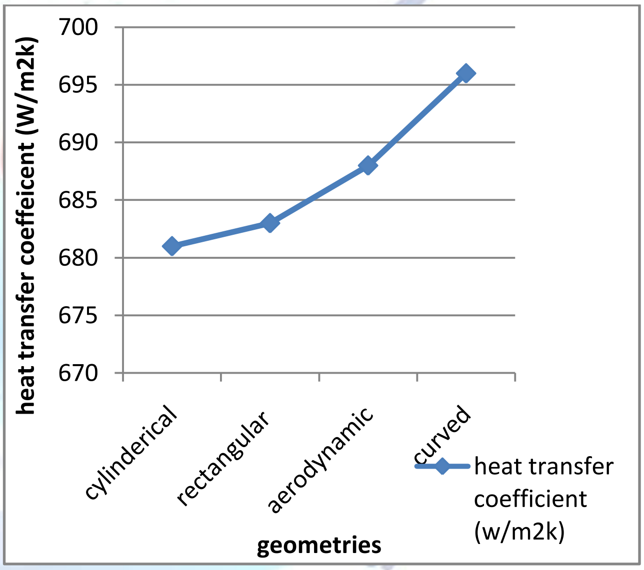


Fig 4.4heat transfer coefficient for curved fins engine



According to the above table and results shown are heat transfer coefficient values at different engine fin geometries. the maximum heat transfer coefficient value at curved fin when we compared to other geometries.

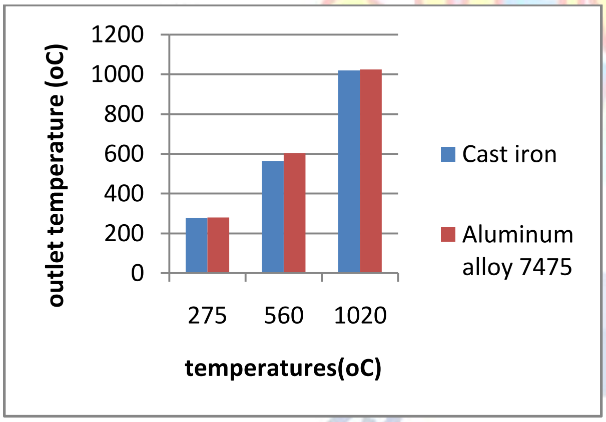
TRANSIENT THERMAL ANALYSIS RESULTS

The result of the engine block is tabulated as per respective fins

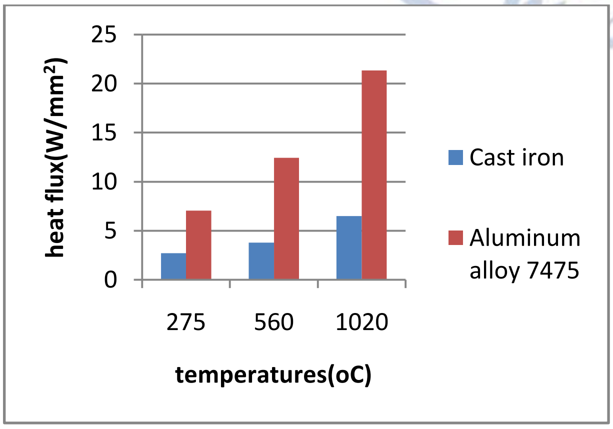
CASE:1 CYLINDERICAL FINS

MATERIALS	Inlet Temperatures(^{0}C)	Temperature distribution (^{0}C)	Heat flux (W/mm^2)
Cast iron	**275**	278.13	2.7149
	560	564.37	3.7906
	1020	1020	6.4992
Aluminum alloy 7475	275	279.82	7.0614
	560	603.3	12.434
	1020	1025.1	21.352

According to the above table, the results of engine cylinder cylindrical fins with various temperature and materials. the maximum temperature distribution at 1020^{0}C with material of aluminum alloy 7475 and maximum heat flux at 1020^{0}C with aluminum alloy 7475.



Graph 5.1 inlet temperatures versus outlet temperature distributions with two materials

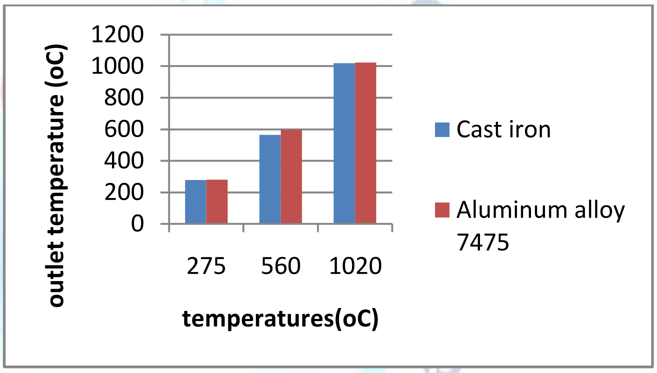


Graph 5.2 inlet temperatures versus heat flux with two materials

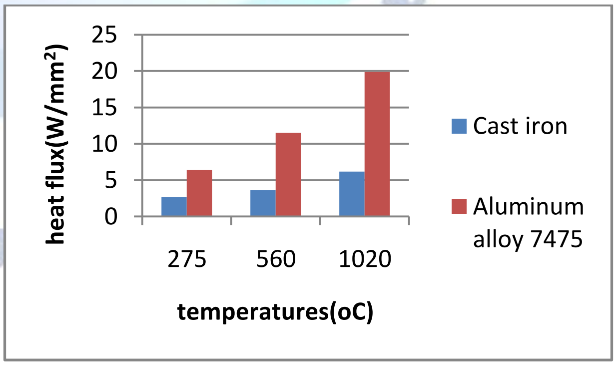
CASE: 2 RECTANGULAR FINS

MATERIALS	Inlet Temperatures(^{0}C)	Temperature distribution (^{0}C)	Heat flux (W/mm^2)
Cast iron	**275**	277.89	2.6911
	560	564.22	3.6097
	1020	1020	6.1749
Aluminum alloy 7475	**275**	279.66	6.3826
	560	596.38	11.52
	1020	1024.2	19.878

According to the above table, the results of engine cylinder Rectangular Fins with various temperature and materials. the maximum temperature distribution at 1020^{0}C with material of aluminum alloy 7475 and maximum heat flux at 1020^{0}C with aluminum alloy 7475.



Graph 5.3 inlet temperatures versus outlet temperature distributions with two materials

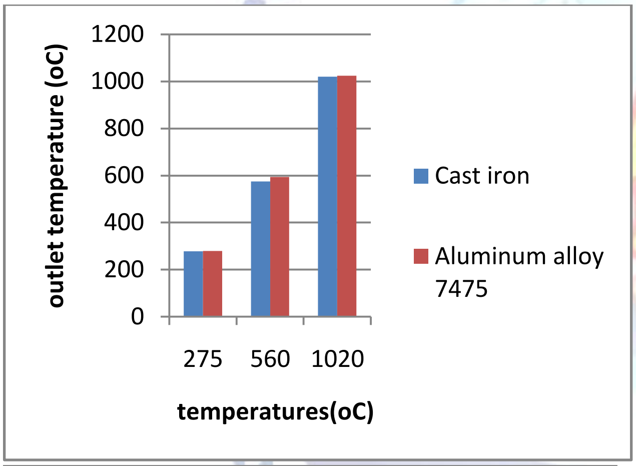


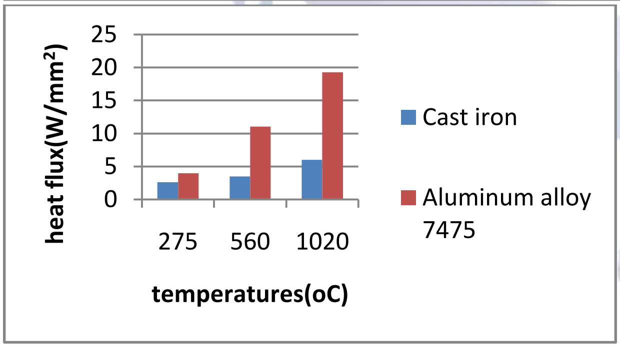
Graph 5.4 inlet temperatures versus heat flux with two materials

CASE: 3 AERODYNAMIC FINS

MATERIALS	Inlet Temperatures(^{0}C)	Temperature distribution (^{0}C)	Heat flux (W/mm^2)
Cast iron	**275**	278.05	2.625
	560	574.72	3.5038
	1020	1020	5.9864
Aluminum alloy 7475	**275**	279.61	3.994
	560	593.45	11.039
	1020	1023.9	19.298

According to the above table, the results of engine cylinder Aerodynamic Fins with various temperature and materials. the maximum temperature distribution at 1020^{0}C with material of aluminum alloy 7475 and maximum heat flux at 1020^{0}C with aluminum alloy 7475.



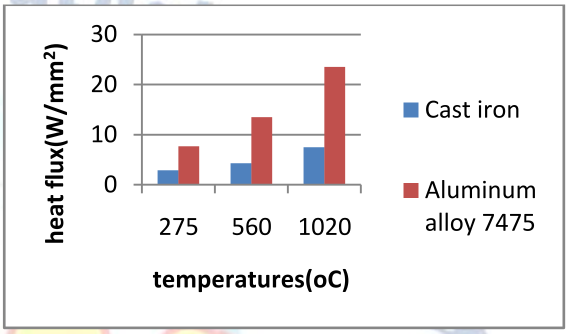


Graph 5.5 inlet temperatures versus heat flux with two materials

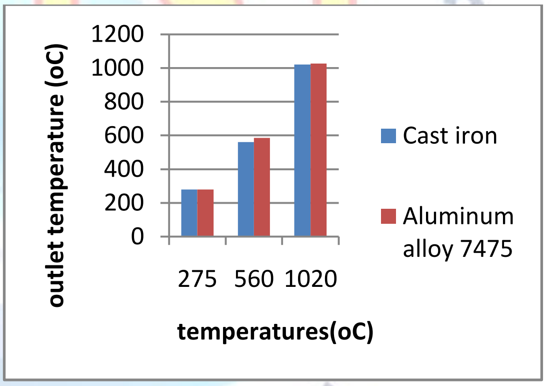
CASE: 4 CURVED FINS

MATERIALS	Inlet Temperatures(^{0}C)	Temperature distribution (^{0}C)	Heat flux (W/mm^2)
Cast iron	**275**	278.68	2.8957
	560	561.02	4.3058
	1020	1020.7	7.5072
Aluminum alloy 7475	**275**	279.62	7.688
	560	585.25	13.505
	1020	1026.3	23.567

According to the above table, the results of engine cylinder Curved Fins with various temperature and materials. the maximum temperature distribution at 1020^{0}C with material of aluminum alloy 7475 and maximum heat flux at 1020^{0}C with aluminum alloy 7475.



Graph 5.6 inlet temperatures versus heat flux with two materials



Graph 5.7 inlet temperatures versus outlet temperature distributions with two materials

FUTURE SCOPE AND CONCLUSION

Since in the upcoming days the need and development in the automobile industry is at a vast level therefore designing an engine with a more heat loss will be more efficient. An engine with high efficiency is more useful and manufacturing engines with aluminium alloy instead of cast iron and replacing the flat fins with a curved ones is better one

The main aim of the project is to analyze the thermal properties by varying geometry of cylinder fins using Ansys work bench. The 3D model of the geometries are created using CREO and its thermal properties are analyzed using Ansys workbench 14.5. The variation of temperature distribution over time is of interest in many applications such as in cooling. The accurate thermal simulation could permit critical design parameters to be identified for improved life.

Design of fin plays an important role in heat transfer. There is a scope of improvement in heat transfer of air cooled engine cylinder fin if mounted fin's shape varied from conventional one. Contact time between air flow and fin (time between air inlet and outlet flow through fin) is also important factor in such heat transfer. Curved fin shaped cylinder block can be used for increasing the heat transfer from the fins by creating turbulence for upcoming air. Improvements in heat transfer can be comparing with all the three models of the engine fins geometry by CFD Analysis and its flow.

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