A FEM Investigation for I C Engine Cylinder Block by Varying Thicknesses of Water Jacket

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***Abstract* - A FEM Investigation for IC engine Cylinder Block by Varying Thicknesses of Water Jacket (6mm, 8mm, 10mm, 12mm) Using Ansys." mainly focuses on the modeling and FEA analysis of IC engine cylinder head to reduce Nodal Temperature and to examine Thermal Flux, Vector Plot. The cylinder block is cast from gray iron or iron alloyed with other metals such as nickel, chromium, or molybdenum. Some lightweight engine blocks are made from aluminium. Cylinders are machined by grinding or boring to give them the desired true inner surface. In this research the results of experiments made by using ANSYS software which has been suitably employed to assess the behavior of IC Engine Block**.

***Keywords* - Cylinder Block, FEM, Water Jacket, Nodal Temperature**

I. Introduction

The cylinder block or engine block is a machined casting (or sometimes an assembly of modules) containing cylindrically bored holes for the pistons of a multi-cylinder reciprocating internal combustion engine, or for a similarly constructed device such as a pump. It is a complex part at the heart of an engine, with adoptions to attach the cylinder head, crankcase, engine mounts, drive housing and engine ancillaries, with passages for coolants and lubricants. The distance between the cylinder bores (midpoint to midpoint) cannot easily be changed since the machining facilities would require extensive modification. Instead, the bore (diameter) is commonly varied to obtain different engine displacements. This and the minimum thickness of material required between two cylinders are a limiting factor concerning the potential displacement because the bore to stroke ratio has to stay within certain limits. Engine blocks are usually made from cast iron or, in modern engines, aluminium and magnesium.

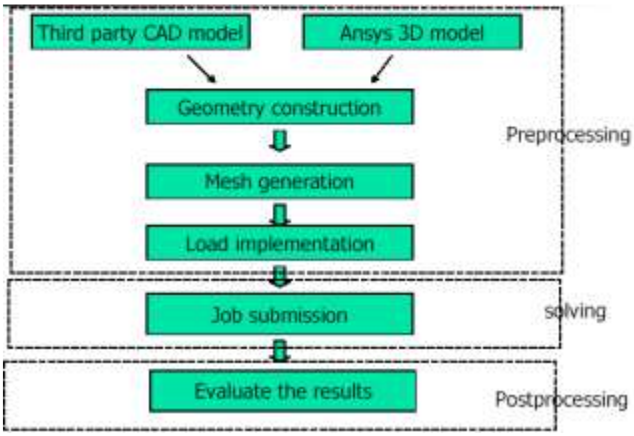
II. Cylinder Block Construction

Materials and process selection are key issues in optimal design of industrial products. Recently many materials which have long been used in industry are being replaced by newer materials in order to meet demands of cost reduction and better performance. In the manufacture of mechanical parts, knowledge of material properties, cost, design concepts and their interactions is required. The large number of available materials, together with the complex relationships between the various selection parameters, often makes the selection processes a difficult task. When selecting materials, a large number of factors must be taken into account. The cylinder block is cast from gray iron or iron alloyed with other metals such as nickel, chromium, or molybdenum. Some lightweight engine blocks are made from aluminium. Cylinders are machined by grinding or boring to give them the desired true inner surface. The liners are inserted into a hole in the block with either a PRESS FIT or a SLIP FIT. Liners are further designated as either a WET-TYPE or DRY-TYPE. The wet-type liner comes in direct contact with the coolant and is sealed at the top by a metallic sealing ring and at the bottom by a rubber sealing ring. The dry-type liner does not contact the coolant. Engine blocks for L-head engines contain the passageways for the valves and valve ports. The lower part of the block (crankcase) supports the crankshaft (the main bearings and bearing caps) and provides a place to which the oil pan can be fastened. The camshaft is supported in the cylinder block by bushings that fit into machined holes in the block. On L-head in-line engines, the intake and exhaust manifolds are attached to the side of the cylinder block. On L-headV-8 engines, the intake manifold is located between the two banks of cylinders; these engines have two exhaust manifolds, one on the outside of each bank.

III. Fem Analysis

The finite element method (FEM) (sometimes referred to as finite element analysis) is a numerical technique for finding approximate solutions of partial differential equations (PDE) as well as of integral equations. The solution approach is based either on eliminating the differential equation completely (steady state problems), or rendering the PDE into an approximating system of ordinary differential equations, which are then numerically integrated using standard techniques such as Euler's method, Runge-Kutta, etc. With the advance in the computer technology and CAD system, complex problem can be modified with relative ease. Several alternative configuration can be tested on a computer before the first prototype is built all of these suggests that we need to keep pace with these developments by understanding the basic theory, modeling techniques and computation aspect of the finite element method.

IV. Flow Chart



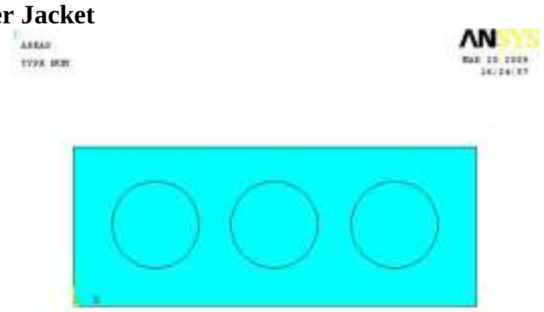
V. Technical Data

Type :	3 cylinder inline
Valves:	2 per cylinder
Bore x Stroke:	68.5 x 72 mm
Displacement:	796cc
Max. Torque	5.7 Kgm@2500 rpm
Max. Power	39.592bhp@5500 rpm
Engine Length:	3300 mm
Engine Width:	1410 mm
Compression Ratio:	8.8 : 1
Block Material:	Cast Iron
Block Dimension:	315 x 128 mm

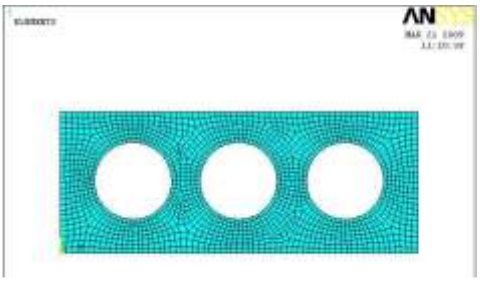
VI. Assumptions Using Ansys

Following Assumptions were made while doing Analysis in Ansys
1. Only 2D Steady State Thermal Analysis is considered.
2.Top view of IC Engine Block after taking cross section is considered.
3. Water Temperature remains constant.
4. Heat Flow takes place only in two direction i.e. x and y direction and region between them and not in any other direction.
5. Convection is only considered out side the block which is in contact with air.
6. Only temperature is considered inside the cylinder.
7. Convective co-efficient of air is taken as 0.024 W/mK at temperature 20 °C which may vary according to temperature.

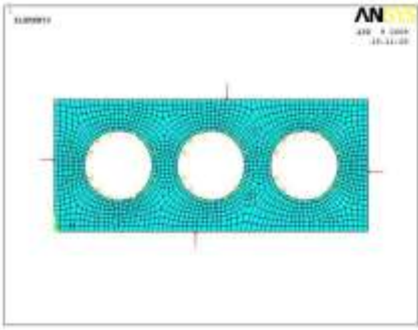
CASE I: Engine Block without Water Jacket



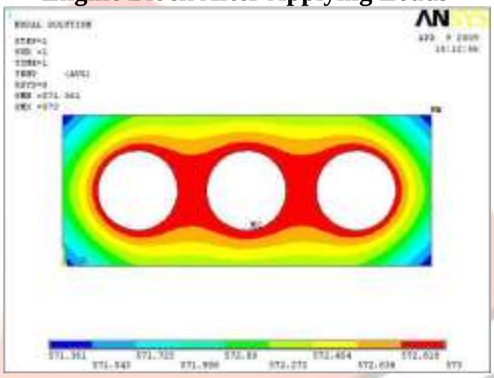
Engine Block Modelling



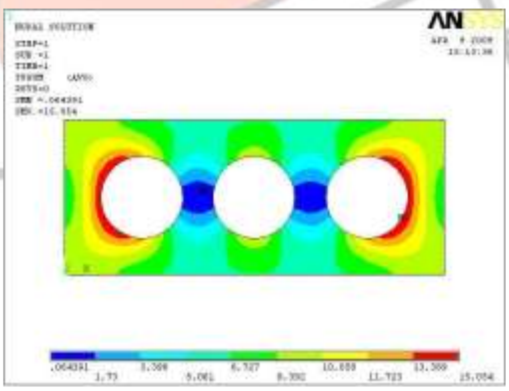
Engine Block After Meshing



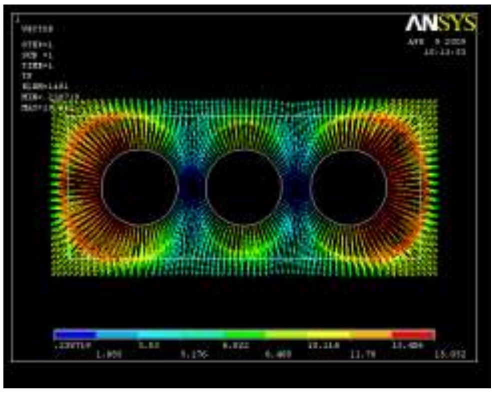
Engine Block After Applying Loads



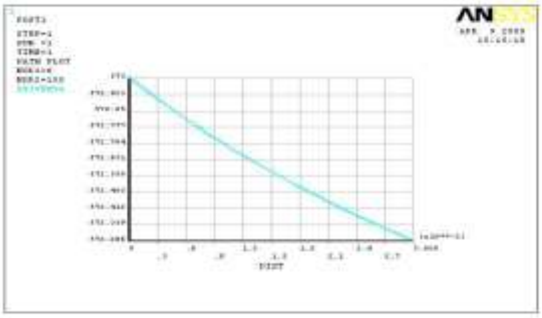
Nodal Temperature without water Jacket



Thermal Flux Without Water Jacket

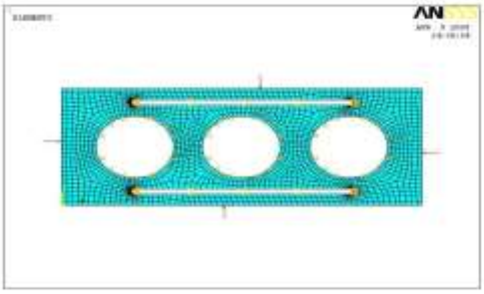


Vector Plot Of Thermal Flux Without Water Jacket

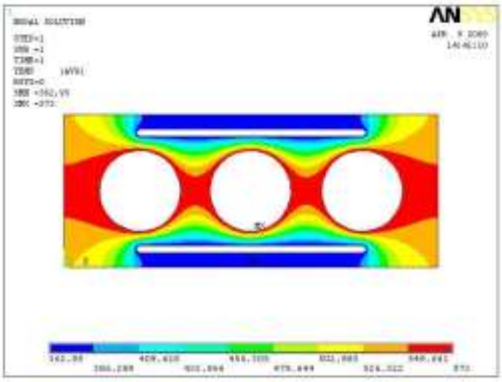


Temperature Graph Without Water Jacket

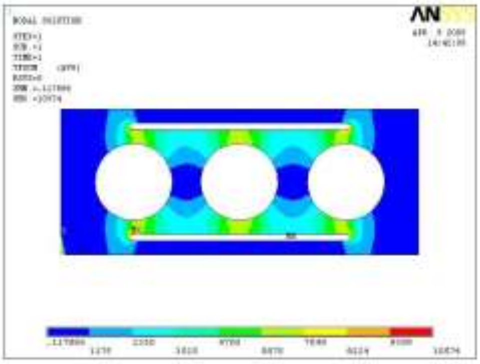
CASE II : WITH WATER JACKET THICKNESS = 6MM



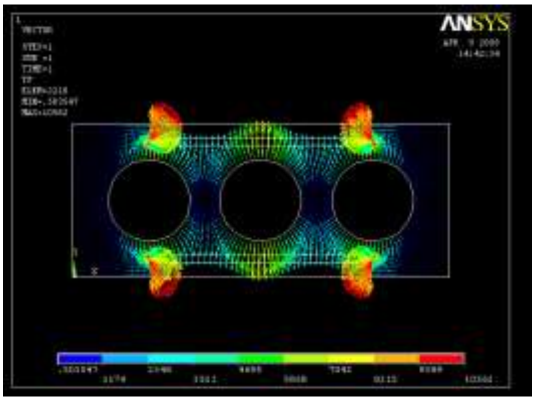
After Applying Load with Water Jacket



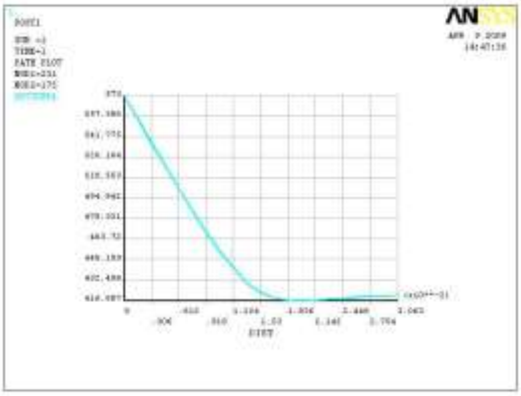
Nodal Temperature with Water Jacket Thickness = 6 mm



Thermal Flux with Water Jacket Thickness = 6 mm

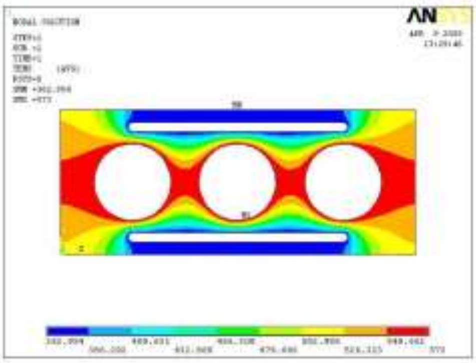


Vector Plot of Thermal Flux with water jacket thickness = 6mm

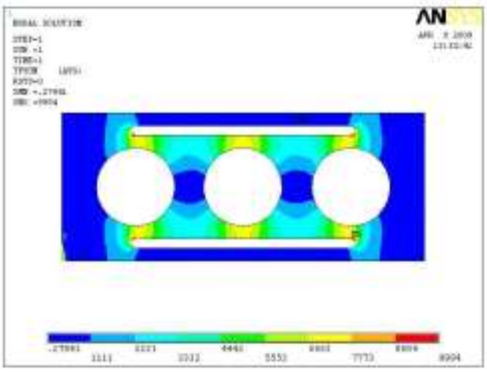


Temperature Graph With Water Jacket Thickness = 6mm

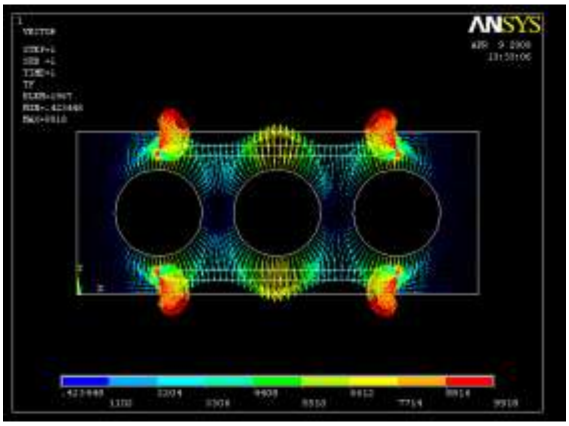
CASE III : WITH WATER JACKET THICKNESS T = 8 MM



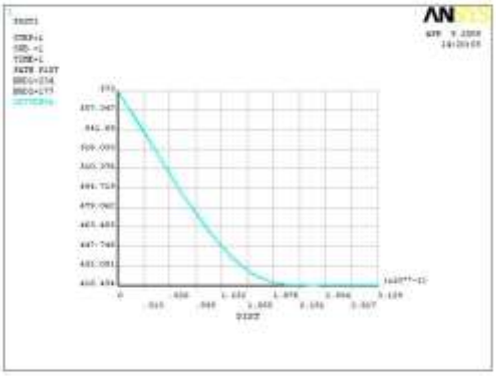
Nodal Temperature with Water Jacket Thickness = 8 mm



Thermal Flux with Water Jacket Thickness = 8 mm

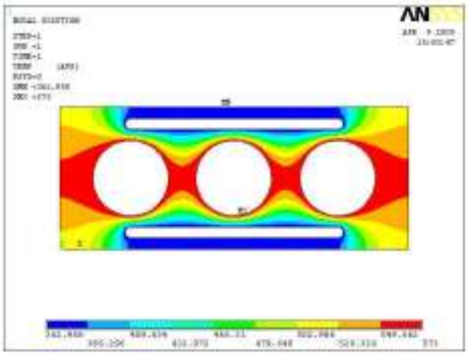


Vector Plot of Thermal Flux with water jacket thickness = 8mm

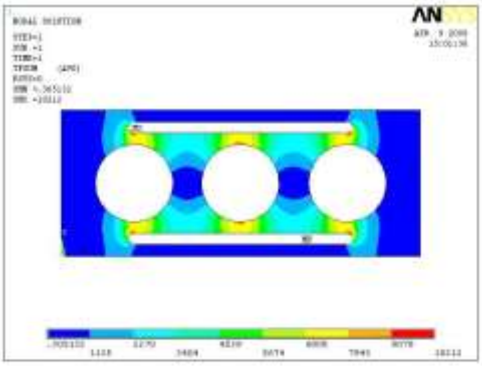


Temperature Graph With Water Jacket Thickness = 8 mm

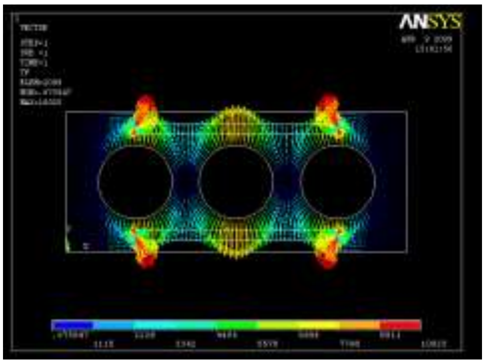
CASE IV : WITH WATER JACKET THICKNESS T= 10 MM



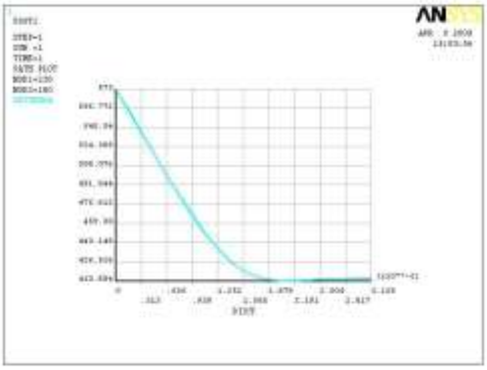
Nodal Temperature with Water Jacket Thickness = 10 mm



Thermal Flux with Water Jacket Thickness = 10 mm

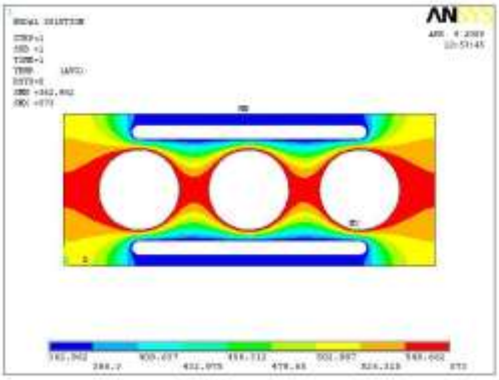


Vector Plot of Thermal Flux with water jacket thickness = 10mm

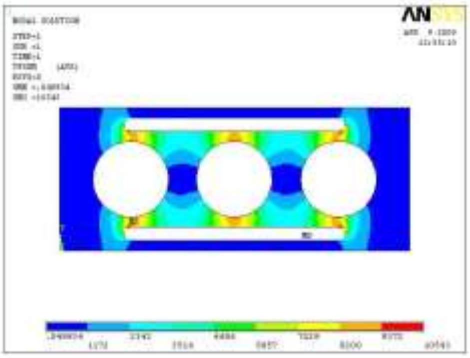


Temperature Graph With Water Jacket Thickness = 10 mm

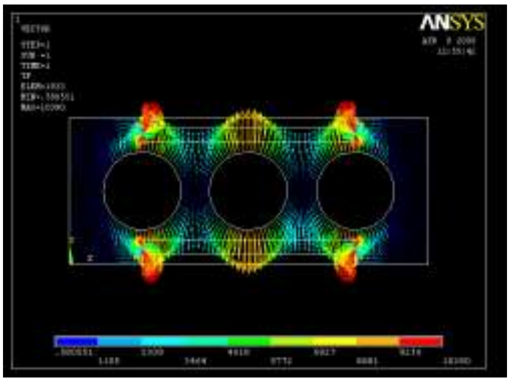
CASE IV : WITH WATER JACKET THICKNESS T= 12 MM



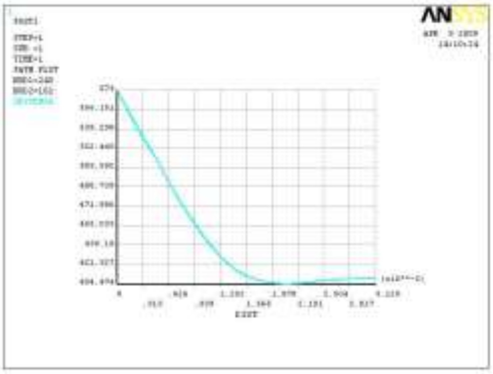
Nodal Temperature with Water Jacket Thickness = 12 mm



Thermal Flux with Water Jacket Thickness = 12 mm



Vector Plot of Thermal Flux with water jacket thickness = 12mm



Temperature Graph With Water Jacket Thickness = 12 mm

VII. RESULTS & CONCLUSION

In this paper we have done 2D Steady State Thermal analysis on IC engine block cross-section. First we have done modeling of IC Engine block in two dimensions, after applying the Thermal load on the engine block without water jacket, with water-jacket of random thickness 6mm, 8mm, 10mm and 12mm individually and plotted the graph of temperature versus distance on path A-B as shown in fig

Nodal Temperature distribution after analysis for varies cases are as follow:
CASE: I – Without water-jacket 571.361 to 573 oK
CASE: II – With water-jacket of thickness 6 mm 362.65 to 573 oK
CASE: III – With water-jacket of thickness 8 mm 362.954 to 573 oK
CASE: IV – With water-jacket of thickness 10 mm 362.958 to 573 oK
CASE: V – With water-jacket of thickness 12 mm 362.962 to 573 oK

Temperature Graph:
As we move from Point A to Point B we got following result on graph
CASE: I – Without water-jacket
As we move from point A to B, Temperature decreases uniformly from 573 to 572.55 oK with respect to distance as shown in graph.
CASE: II – With water-jacket of thickness 6 mm
In this case as we move from point A to B, Temperature decreases from 573 to 461.887 oK up to distance 1.836 × 10-2 m and then slightly increases as shown in graph
CASE: III – With water-jacket of thickness 8 mm
In this case as we move from point A to B, Temperature decreases from 573 to 416.434 oK up to distance 2.035 × 10-2 m and then remains constant throughout as shown in graph

CASE: IV – With water-jacket of thickness 10 mm
In this case as we move from point A to B, Temperature decreases from 573 to 410.684 oK up to distance 1.878 × 10-2 m and then slightly increases as shown in graph.

CASE: V – With water-jacket of thickness 12 mm
In this case as we move from point A to B, Temperature decreases from 573 to 404.474 oK up to distance 2.034 × 10-2 m and then slightly increases as shown in graph

 If we do not consider water-jacket, temperature in Engine Block increases rapidly, to decrease the temperature we are using water-jacket of various thickness.

 While in the case of 6mm, 10mm and 12 mm thickness of water-jacket, temperature decreases up to some distance but after that it starts increases but in the case of 8mm thickness temperature does not increase and remains constant after some distance.

 Thus we can conclude that using Engine Block with water-jacket of thickness 8mm will give better performance.

VIII. REFERENCES

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