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Analysis of Engine Cylinder to Optimize Heat Transfer by Varying Fin Geometry

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Abstract :**Solar energy is one of the most promising energy sources for human survival and sustainability. We can solve problems like global warming with a clean energy source like solar energy. The main objective of the study is to analyze the rate of change of heat transfer in conventional cylindrical block comparative to the proposed design of cylindrical block by varying fin geometry. And to optimize the rate of transfer of heat by providing inter cooling arrangement in the cylindrical block in the proposed geometry. the proposed design of engine cylinder block using aluminum alloy for inter-cooling arrangements has better performance and heat dissipation from the heating zone in the IC engine that is why this present work more concentrate on it and also proposed**.

Keywords*:* CFD, IC engine, Heat transfer,

I. INTRODUCTION

The world needs transportation to satisfy the most basic needs in the form of one or the other. From this moment, the combustion engine goes under the radar. It takes several types of fuels to function. From the past to the recent future, the world has been working on the IC engine, its systems, and its improvement. In recent times, the focus has been on fuel economy and limiting emissions. Studies have not found an alternative type that promises significant benefits in terms of fuel economy or emission control, and most importantly, none comes close to the overall simplicity, safety, and adaptability of current engines.

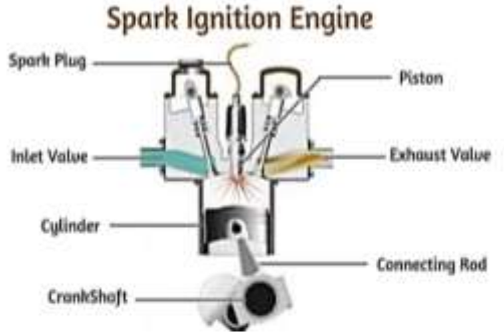


Fig. 1 Spark-ignition-engine

It appears that conventional petrol and diesel engines will retain their current dominance in land and sea transport as well as an industrial and portable power supply for the foreseeable future. [5].

II. LITERATURE REVIEW

J. Laxmi Prasad et al. [1] The ribs are an essential part of the square of the chamber of an internal combustion engine that is responsible for the allocation of heat during the interaction of the ignition by convection. The productive movement of the heat end can certainly keep up with the constant efficiency of an internal ignition engine.

Lei Li et al. [2] To further develop the convective thermal motion of the turbine disc with great tension, another type of double central turbine circle was created with wavy ribs in the inner cavity. The results show that there is a roundabout in the inner pit that joins the rear and front axles to further develop the neighborhood's convective thermal motion coefficient. The total number of Nusselts of the rear panel is greater than that of the front panel, and the temperature of the rear panel is generally lower than that of the front panel.

NgoctanTranet al. [3] In order to optimize heat development on the air side of a flat cylinder heater, four limitations are mathematically examined in this review, including blade types, compensation pitch, compensation thickness, and fin tip. Existing test results are used to validate the current mathematical strategy with the largest deviations of less than 1.65% and 0.27% for the heat movement speed and outlet temperature individually. The front speed varies from 1m/s to 6m/s. Copper and aluminum are used separately as cylinder and compensation materials.

Adeel Tariq et al. [4] The benefits of having many holes and openings in a finned heat sink are explored using a molded thermal motion model and other research. Heat exchange and expansion waste are examined through the two creative ribbed radiators (with openings and engravings). The test information confirms the CFD-shaped thermal motion pattern for the air-cooled heat sink.

III. OBJECTIVE

There are following objective are to be expected from the present work

- To analyse the rate of change of heat transfer in conventional cylindrical block comparative to proposed design of cylindrical block by varying fin geometry.
- To optimize the rate of transfer of heat by providing intercooling arrangement in the cylindrical block in proposed geometry
- Validate the result by comparing the conventional design and proposed design and evaluate the optimize results.

IV. METHODOLOGY

A. *Mathematical Analysis*

The purpose of the fins in internal combustion engines is to improve the convection heat transfer of the engine. The main purpose behind the operation of the fins is to increase the area of effective heat transfer from the surface. With natural convection, the heat transfer coefficients h are relatively low compared to forced convection. In general, the ribs are too long for their thickness, so it is assumed that the temperature varies only longitudinally. For this reason, the temperature at any point "x" along the length of the ribs is a substantially uniform cross section of the rib.

The heat transfer analysis is performed under the following assumptions:

1. Conductor heat transport in interior combustion engines blades is one-dimensional and happens along the x-axis.
2. . Loss of heat from the sidewalls of the radiators convection currents at a steady air temp T_.
3. . The thermal drain in constant.

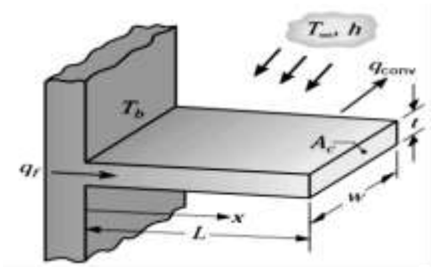


Fig. 2: Fin geometry knowledge, both theoretical and practical

Case I: The fin of infinite length:

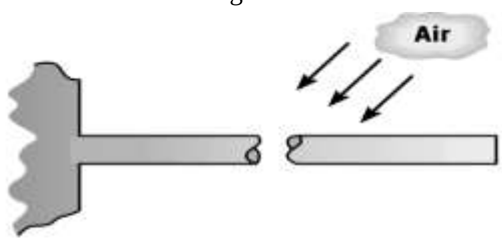
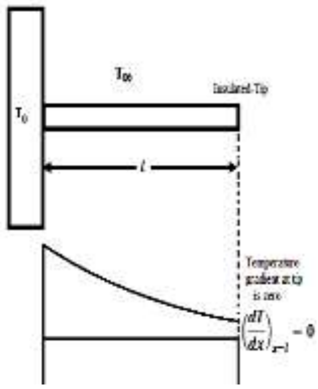


Fig. 3: Fins of indefinite lengths transmit heat.

$$Q_{Fin} = \sqrt{hPkA}(T_0 - T_\infty)$$

Case II: Fin Insulated at the tip:



$$Q_{Fin} = \sqrt{hPkA}(T_0 - T_\infty)\tanh(ml)$$

Where:

$$m = \sqrt{\frac{hP}{kA}}$$

h = convective heat transfer coefficient in W/m^2K

P = Perimeter in m

k = Thermal conductivity in W/mK

A =Cross sectional area in m^2

Fig. 4: The tip of the fin is insulating.

Case III: The finite length of the fin

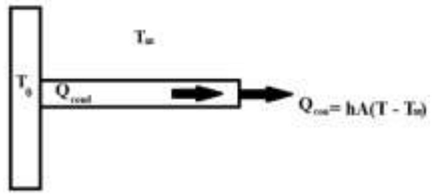


Fig. 5: Fins of finite duration are used to transmit heat.

$$Q_{Fin} = \sqrt{hPkA}(T_0 - T_\infty)\left[\frac{\tanh(ml) + \frac{h}{km}}{1 + \frac{h}{km}\tanh(ml)}\right]$$

B. *Technical Specifications of Hero Honda Splendor:*

Table 1: Technical Specifications of Hero Honda Splendor

Engine Type	4-Stroke, Single Cylinder OHC (overhead cam), Air Cooled
Bore x Stroke	50.0 mm x 49.5 mm
Compression Ratio	9.0:1
Transmission	4-Speed, Constant Mesh
Fuel Type	Petrol
CC	97.2
Stroke (mm)	49.5
Bore (mm)	50
No. of Fins	11-8-11
Fin Pitch (mm)	9
Fin Material	Al Alloy
Position of fins w.r.t. cylinder axis	Parallel
Position of cylinder in vehicle	Horizontal
Fin pitch(mm)	4

C. *Transient Thermal Analysis for the actual design of engine block*

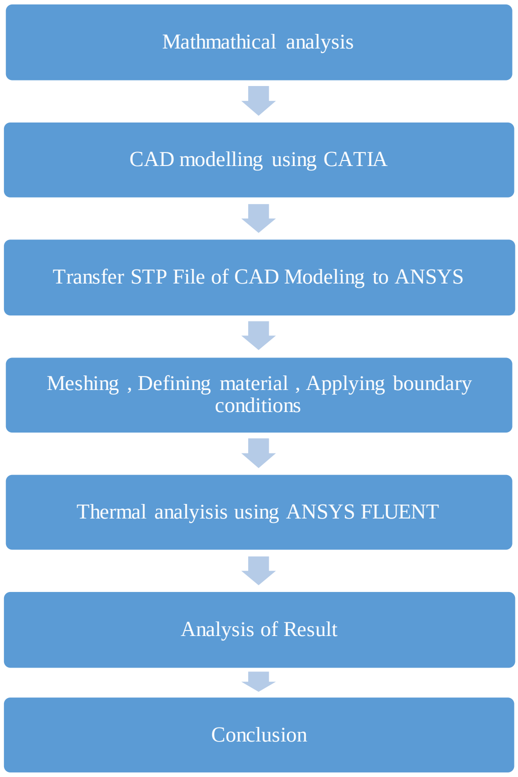


Fig. 6: Flow Chart

D. Assumptions

The following assumptions are made to perform thermal analysis of cylinder block.

- Symmetric flow and identical heat transfer throughout the heat sink
- Isothermal boundary condition is applied for the base and fins.
- Air entrance from the side is Negligible on the heat sink means the fresh air inflow and outflow from the open sides of the outmost fins wall is small compared to the air flow entering from the bottom of the fins array.

V. Result and Discussion

For the existing and suggested layout with and without inter cooling configuration, as well as for two distinct substances including such cast iron as well as Al alloy, transient heat transfer assessment was conducted employing ANSYS workbench relying on finite volumes approach. In this section, the outcomes of the aforesaid variables have been examined using several tabular and graphic displays.

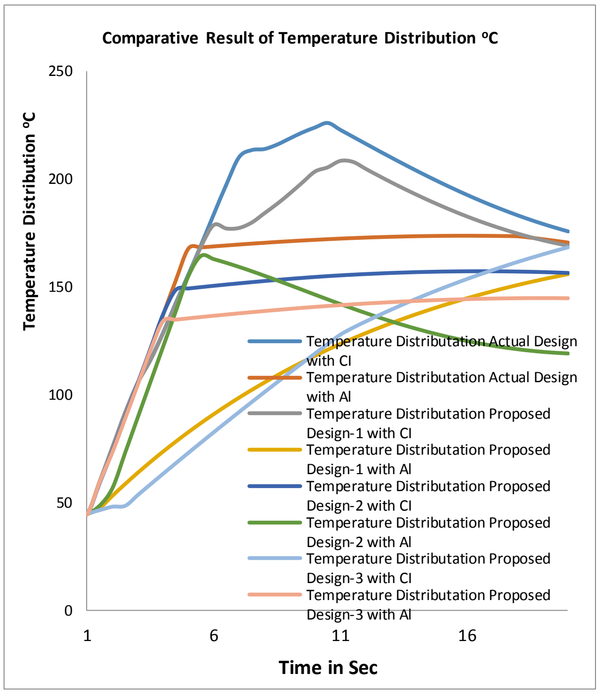


Fig. 7: Comparative Result of Temperature Allocation

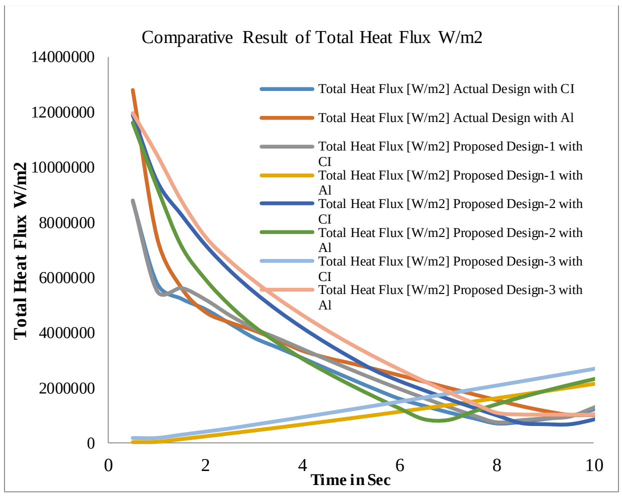


Fig. 8: Comparative Result of Total Heat Flux

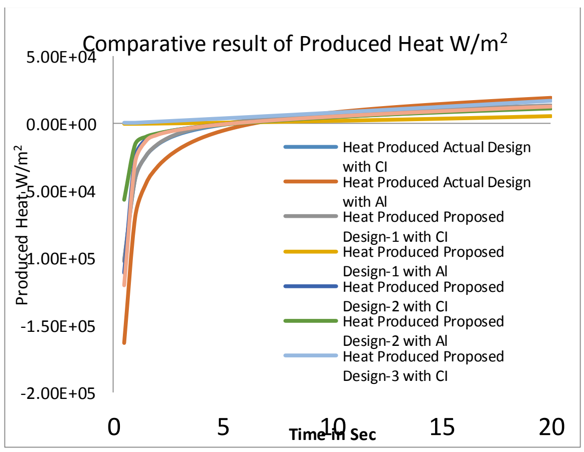


Fig. 9: Comparative Result of Produced heat

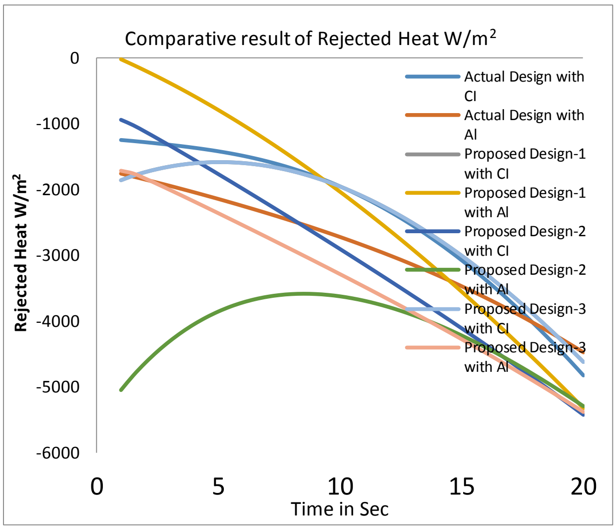


Fig. 10: Comparative Result of Heat rejected

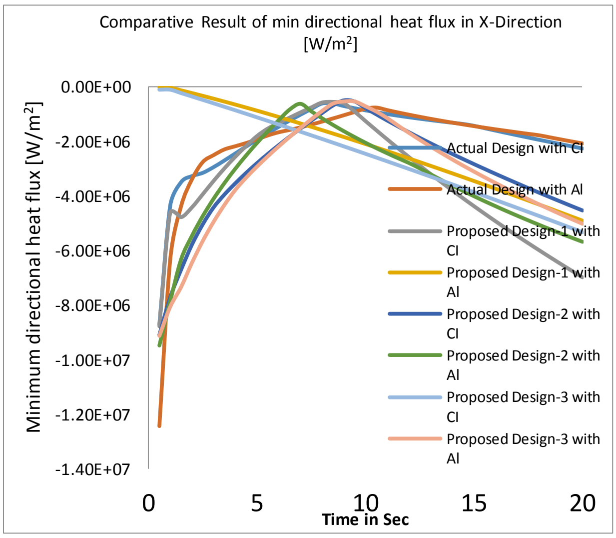


Fig 11. Comparative Result of min directional heat flux in X-direction

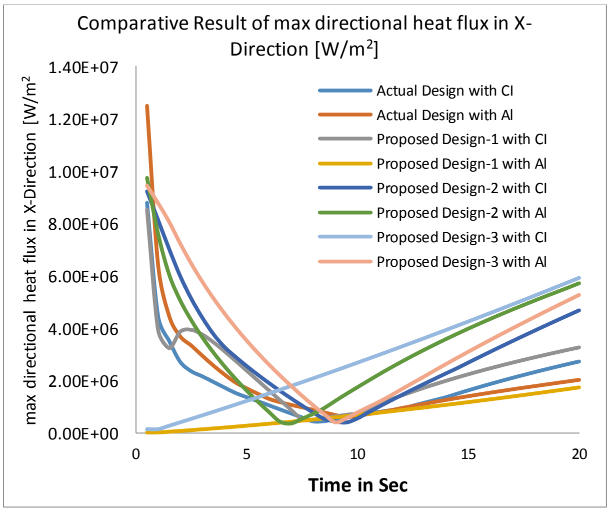


Fig 12. Comparative Result of max directional heat flux in X-direction

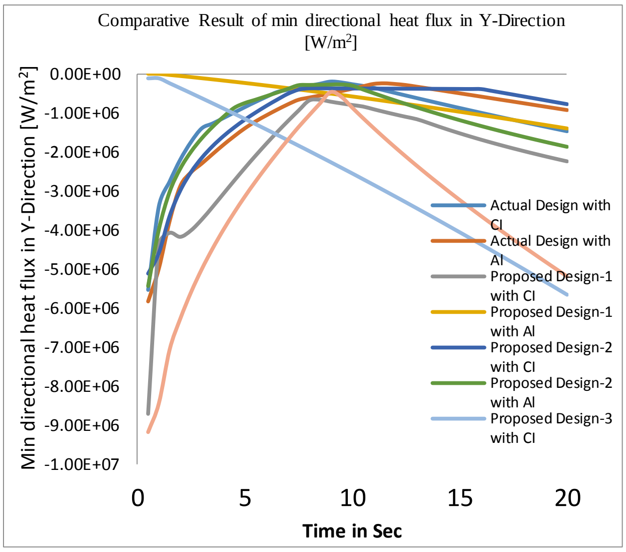


Fig. 13 Comparative Result of min directional heat flux in Y-direction

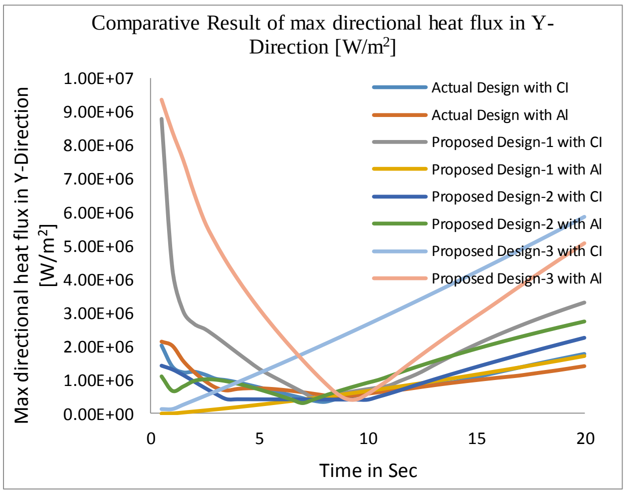


Fig. 14 Comparative Result of max directional heat flux in Y-direction

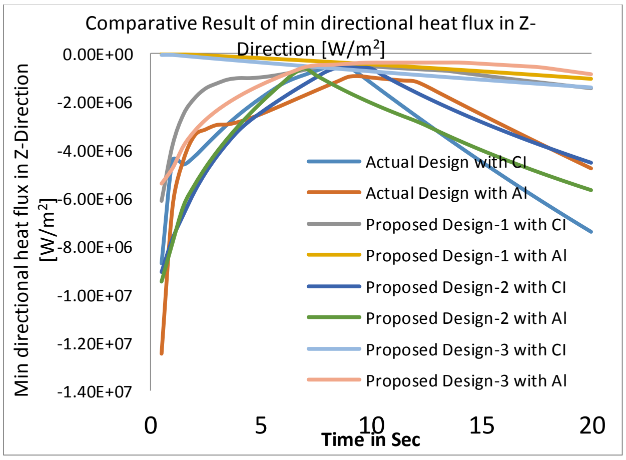


Fig. 15 Comparative Result of min directional heat flux in Z-direction

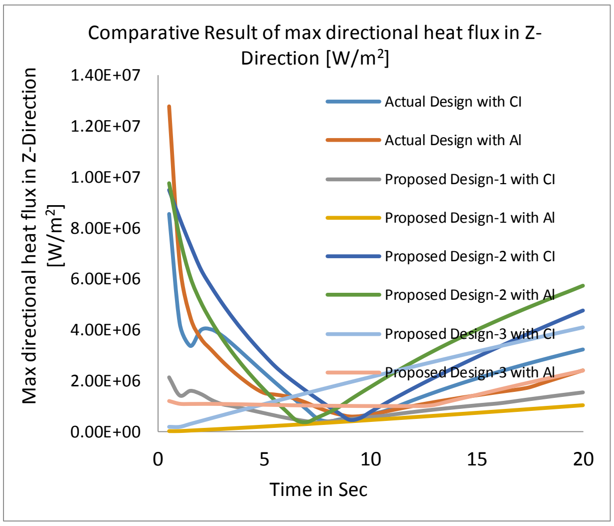


Fig. 16 Comparative Result of max directional heat flux in Z-direction

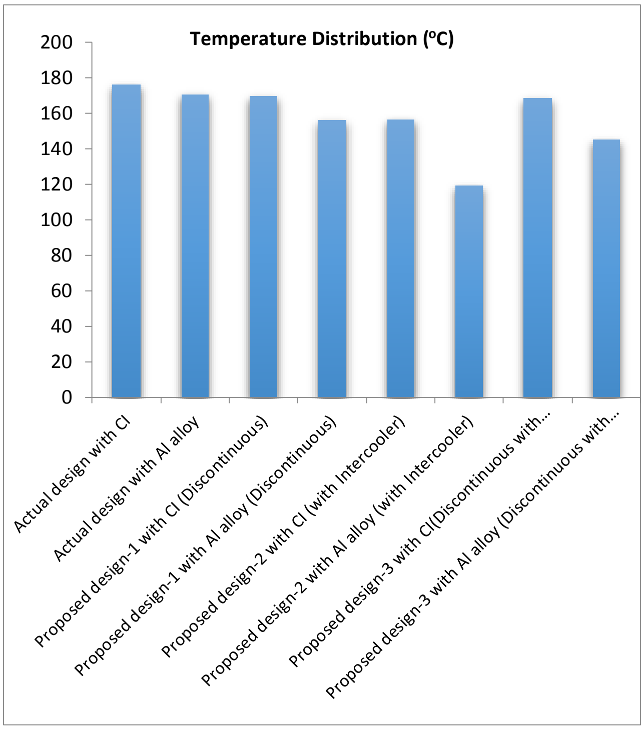


Fig. 17 Comparative Result of temperatures

VI. CONCLUSION

Mathematical In addition to optimise dimensional properties for heat transmission from the current engines cylinders blocks as well as the recommended approach of both the cylinders block, a quantitative and transitory thermal study was done.

The accompanying aspects have been recognised and summarised in the format of convincing declarations:

1. The temperatures profile throughout the cylinders blocks inside the layout phase engines cylinder blocks using cast iron as just a substance at 45oC temperature increase means that the highest temperature is 650 and the average temperature is 175.62oC, with a cumulative heat flux created of 9.08e6 W/m2.

2. The temperature profile over the cylindrical block is highest temperature 650oC and lowest temperature 170.46oC, heat capacity flux produced is 4.8063e6 W/m2. The outcome of transient temperature assessment of Real design engine cylindrical blocks for Al alloy as just a substance at 45oC temperature increase demonstrates the temperature dispersion well over cylindrical blocks is highest temperature 650oC as well as lowest heating 170.46oC, heat capacity flux produced is 4.8063e6 W/m2.

3. The temperature profile well over cylinder blocks is highest temperature 650oC and lowest temperature 169.17oC, heat capacity flux produced is 7.0734e6 W/m2, according to the results of transient temperature assessment of suggested design-1 of engine cylinder blocks with non - continuous fins for CI as a substance at 45oC atmosphere..

4. The temperature profile well over cylinder blocks is highest temperature 650oC and lowest temperature 155.88oC, heat capacity flux produced is 4.9825e5 W/m2, according to the results of transient temperature assessment of suggested design-1 of engine cylinder blocks with discontinuous fins for Al alloy as a material at 45oC surface temperatures.
5. The temperature profile well over cylindrical blocks in suggested design-2 of engine cylinderical blocks with inter-cooling configuration for CI as a substance at 45oC atmosphere shows that the highest temperature is 650oC as well as the lowest temperature is 156.26oC, with an overall thermal gradient produced of 5.2096e6 W/m2.
6. The temperature profile well over cylindrical blocks is highest temperature 650oC and lowest temperature 119.21oC, overall heat fluctuation produced is 6.3621e6 W/m2, according to the results of transient temperature assessment of suggested design-2 of engine cylindrical blocks with inter-cooling configuration for Al metal as a substance at 45oC temperature increase.
7. The temperature profile well over cylindrical blocks in envisaged design-3 of engine cylinder blocks with non - continuous blades and inter-cooling configuration for CI as a substance at 45oC air temperature shows that the optimum temperature is 650oC and the lowest temperature is 144.88oC, with such an overall thermal gradient produced of 5.3838e6 W/m2.
8. The temperature profile well over cylindrical blocks is highest temperature 650oC and lowest value 168.34oC, overall heat flow velocity produced is 5.932e6 W/m2, according to the results of transient temperature assessment of suggested design-3 of engine cylinderical blocks with non - continuous blades and

inter-cooling configuration for Al composite material as a substance at 45oC air temperature.

To summarize, the recommended engine cylinderical blocks design employing aluminium alloy for inter-cooling configurations has higher efficiency and heat absorption from the heating element in the Engines, which is why this current work focuses on this and also proposes it..

VII. Future Work

1. The current study focused solely on the redesigning of an IC engine's cylinders block as from standpoint of heat flux. There are several prospective proposals that may be implemented in the coming; the material employed for the cylinders block throughout all types of analyses in the current research is cast iron.
2. 1. In the current work, a transient temperature assessment was performed to determine the heat transmission rate. A computational fluid dynamic assessment can also be performed to determine flow of air all around cylinders block.
3. 3. Aside from cast iron as well as aluminium alloys, any other substance that can transport excess heat can be employed as a cylinders blocks.
4. 4. Thermal characteristics can be evaluated by altering the size and density of the absorber plate, which was not performed in this study..

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