ENHANCEMENT OF THERMAL PERFORMANCE IN INTERNAL COMBUSTION ENGINE FINS BY APPLICATION OF INCREASED SURFACE AREA

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ABSTRACT

In present analysis, the CAD model of ic engine fin has been developed by using UNI- GRAPHICS NX-8.0. The model has been simulated using Ansys software on steady state thermal domain
14.0 workbench in order to observe various parameters affecting the thermal performance of ic engine fins. six types of configurations of ic engine fin have been used with different profile concave fin, convex fin, convex with perforation,. An optimized model of ic engine fin has been developed with different fin profiles.. The simulation of the optimized model gives higher value of pressure temperature distribution with respect to distance in fin profiles. It has also been observed that thermal resistance was reduced at constant temperature of 495K inside the cylinder. The results are validated with reported base paper data. The configuration of convex fin profile with perforation gives maximum convergence on all parameters amongst all the configurations used.
14.1
Keywords— *Internal Combustion Engine Fins, Temperature Distribution, Surface Area of Fin, Fillet in Fin.*

I INTRODUCTION

Fins are extensions on exterior surfaces of objects that increase the rate of heat transfer to or from the object by increasing convection. This is achieved by increasing the surface area of the body, which in turn increases the heat transfer rate by a sufficient degree. This is an efficient way of increasing the rate, since the alternative way of doing so is by increasing either the heat transfer coefficient (which depends on the nature of materials being used and the conditions of use) or the temperature gradient (which depends on the conditions of use). Clearly, changing the shape of the bodies is more convenient. Fins are therefore a very popular solution to increase the heat transfer from surfaces and are widely used in a number of objects. The fin material should preferably have high thermal conductivity. In most applications the fin is surrounded by a fluid in motion,[1] which heats or cools it quickly due to the large surface area, and subsequently the heat gets transferred to or from the body quickly due to the high thermal conductivity of the fin. For optimal Heat transfer performance with minimal cost, the dimensions and shape of the fin have to be calculated for specific applications, and this is called design of a fin. A common way of doing so is by creating a model of the fin and then simulating it under required service conditions.

II INTERNAL COMBUSTION ENGINE COOLING

Internal combustion engine cooling uses either air or liquid to remove the waste heat from an internal combustion engine. For small or special purpose engines, cooling using air from the atmosphere makes for a lightweight and relatively simple system. Watercraft can use water directly from the surrounding environment to cool their engines. For water-cooled engines on aircraft and surface vehicles, waste heat is transferred from a closed loop of water pumped through the engine to the surrounding atmosphere by a radiator. Water has a higher heat capacity than air, and can thus move heat more quickly away from the engine, but a radiator and pumping system add weight, complexity, and cost. Higher-power engines generate more waste heat, but can move more weight, meaning they are generally water-cooled. Radial engines allow air to flow around each cylinder directly, giving them an advantage for air cooling over straight engines, flat engines, and V engines. Rotary engines have a similar configuration, but the cylinders also continually rotate, creating an air flow even when the vehicle is stationary. Aircraft design more strongly favors lower weight and air-cooled designs. Rotary engines were popular on aircraft until the end of World War I, but had serious stability and efficiency problems. Radial engines were popular until the end of World War II, until gas turbine engines largely replaced them. Modern propeller-driven aircraft with internal-combustion engines are still largely air-cooled. Modern cars generally favor power over weight, and typically have water-cooled engines. Modern motorcycles are lighter than cars, and both cooling fluids are common. Some sport motorcycles were cooled with both air and oil (sprayed underneath the piston heads).

III BASIC PRINCIPLES OF I. C. ENGINE

Most internal combustion engines are fluid cooled using either air (a gaseous fluid) or a liquid coolant run through a heat exchanger (radiator) cooled by air. Marine engines and some stationary engines have ready access to a large volume of water at a suitable temperature. The water may be used directly to cool the engine, but often has sediment, which can clog coolant passages, or chemicals, such as salt, that can chemically damage the engine. Thus, engine coolant may be run through a heat exchanger that is cooled by the body of water. Most liquid-cooled engines use a mixture of water and chemicals such as antifreeze and rust inhibitors. The industry term for the antifreeze mixture is engine coolant. Some antifreezes use no water at all, instead using a liquid with different properties, such as propylene glycol or a combination of propylene glycol and ethylene glycol. Most "air-cooled" engines use some liquid oil cooling, to maintain acceptable temperatures for both critical engine parts and the oil itself. Most "liquid-cooled" engines use some air cooling, with the intake stroke of air cooling the combustion chamber. An exception is Wankel engines, where some parts of the combustion chamber are never cooled by intake, requiring extra effort for successful operation. There are many demands on a cooling system.

One key requirement is to adequately serve the entire engine, as the whole engine fails if just one part overheats. Therefore, it is vital that the cooling system keep all parts at suitably low temperatures. Liquid-cooled engines are able to vary the size of their passageways through the engine block so that coolant flow may be tailored to the needs of each area. Locations with either high peak temperatures (narrow islands around the combustion chamber) or high heat flow (around exhaust ports) may require generous cooling. This reduces the occurrence of hot spots, which are more difficult to avoid with air cooling. Air-cooled engines may also vary their cooling capacity by using more closely spaced cooling fins in that area, but this can make their manufacture difficult and expensive. Only the fixed parts of the engine, such as the block and head, are cooled directly by the main coolant system. Moving parts such as the pistons, and to a lesser extent the crank and rods, must rely on the lubrication oil as a coolant, or to a very limited amount of conduction into the block and thence the main coolant. High performance engines frequently have additional oil, beyond the amount needed for lubrication, sprayed upwards onto the bottom of the piston just for extra cooling. Air-cooled motorcycles often rely heavily on oil-cooling in addition to air-cooling of the cylinder barrels. Liquid-cooled engines usually have a circulation pump. The first engines relied on thermo- syphon cooling alone, where hot coolant left the top of the engine block and passed to the radiator, where it was cooled before returning to the bottom of the engine. Circulation was powered by convection alone.

V LITERATURE REVIEW

Pulkit Sagar et al. [1] This paper analysed An air cooled motorcycle engine release the heat to the atmosphere through the mode of forced convection, fins are provided on the outer surface of the cylinder block of the engine. The heat transfer is depends upon the velocity of the air, ambient temperature, geometry of the fin and the surface of the fin. The fins allows the cooling wind over its surface and transfer heat from fins surface to the air. The investigation covered the determination of the effect of geometry, different shape and the surface roughness of the fins on the heat transfer. The main aim of the project is to analyse the heat transfer rate by varying the shape and surface roughness of fins. The model are created by varying the shape and roughness of the fin in AUTODESK INVENTER 2015and simulated in AUTODESK NASTRAN 2015. The main aim of this paper is to study following effects on the heat transfer through fins in motorcycle and other motor power vehicles by changing the geometry.

Xiaoyu Hu et al. [2] In this paper, the thermo-hydraulic performance of an opposed piston opposed cylinder (OPOC) cylinder water jacket with helical fins on the annulus side was studied experimentally and numerically. Three dimensional computational fluid dynamics (CFD) software FLUENT has been adopted to explore fluid flow characteristics, pressure drop and cylinder wall temperature under different configurations.

Divyank Dubey et al. [3] in this paper investigate that Fins are the extended surfaces which help to dissipate heat generated in the engine but these extended surface length are limited which limit the rate of heat dissipation. Various automobile industries work to increase this heat dissipation rate by which engine efficiency can be increased. In this paper we try to increase the heat dissipation rate through these extended surfaces by increasing engine fin tip thickness about 3mm and also providing slots of 50mm, 75mm, and 100mm

Cosimo Buffone [4] This paper main goal is aimed at a paradigm shift in the enhancement of heat transfer rate between finned surfaces and surrounding fluid by presenting a novel approach in composite fins. This approach consists in using high thermally conductive coatings on top of the finned substrate in order to increase the local temperature along the fin washed surface. In the present paper a high thermal conductivity coating has been applied to an aeroengine vane of different shape and dimensions subject to icing conditions at high Reynolds numbers and where the main aim was to keep the vane warm as to avoid icing in aerospace applications.

Jie Wen et al. [5] investigation a novel compact plate finned-tube air-fuel heat exchanger which is designed by means of using logarithmic mean temperature difference method (LMTD) and both thermal and hydraulic performance of the heat exchanger are experimentally investigated. Worldwide, due to the harsh working condition, both aviation industry and aerospace industry department are in badly need of compact heat exchanger with light weight and high efficiency. In this paper, the design, manufacture and tests of a prototype, plate finned tube heat exchanger are presented. The stainless-steel heat exchanger weights 1.207 kg and by using the fuel RP-3 as the coolant, it can cool the high-temperature air from high pressure compressor in aircraft engine in a very limited space. The study of flow resistance in air-fuel flow allows determining the flow friction factor. Experimental values of heat transfer for the heat exchanger are also calculated. In addition, obtained values of heat transfer coefficient show some differences with literature correlations. Based on these differences, an empirical correlation for the outside heat transfer of compact finned tube heat exchanger is established, which will be helpful for the researchers to design similar heat exchangers

.**MODELING AND ANALYSIS**

Procedure for Solving the Problem

- Create the geometry.
- Meshing of the domain.
- Steady state thermal solver.
- Set the material properties and boundary conditions.
- Obtaining the solution.

Finite Element Analysis of I. C Engine Fin Profile

Analysis type Steady state thermal domain

Type of Element

Tetrahedral

Preparation of the CAD models

The dimensions of the computational domain of IC engine fin were based on the work done by Pulkit Sagar [1] [Numerical simulation of the thermal performance of a IC engine fin author of base paper that was considered for present simulation of IC engine fin model. After this process the constraints were applied and this way the model was created in modelling software UNI -GRAPHICS NX-8. The following show basic geometric parameters of IC engine fin.

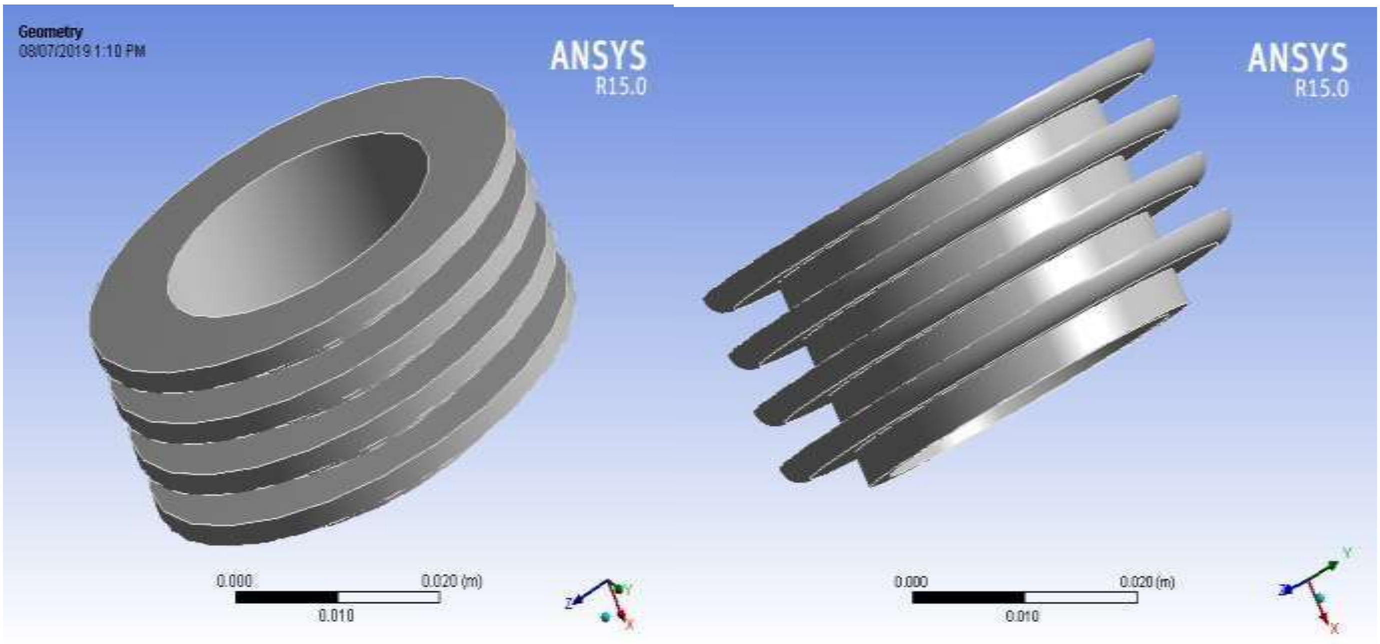

Figure : 3D Model of IC engine fin.

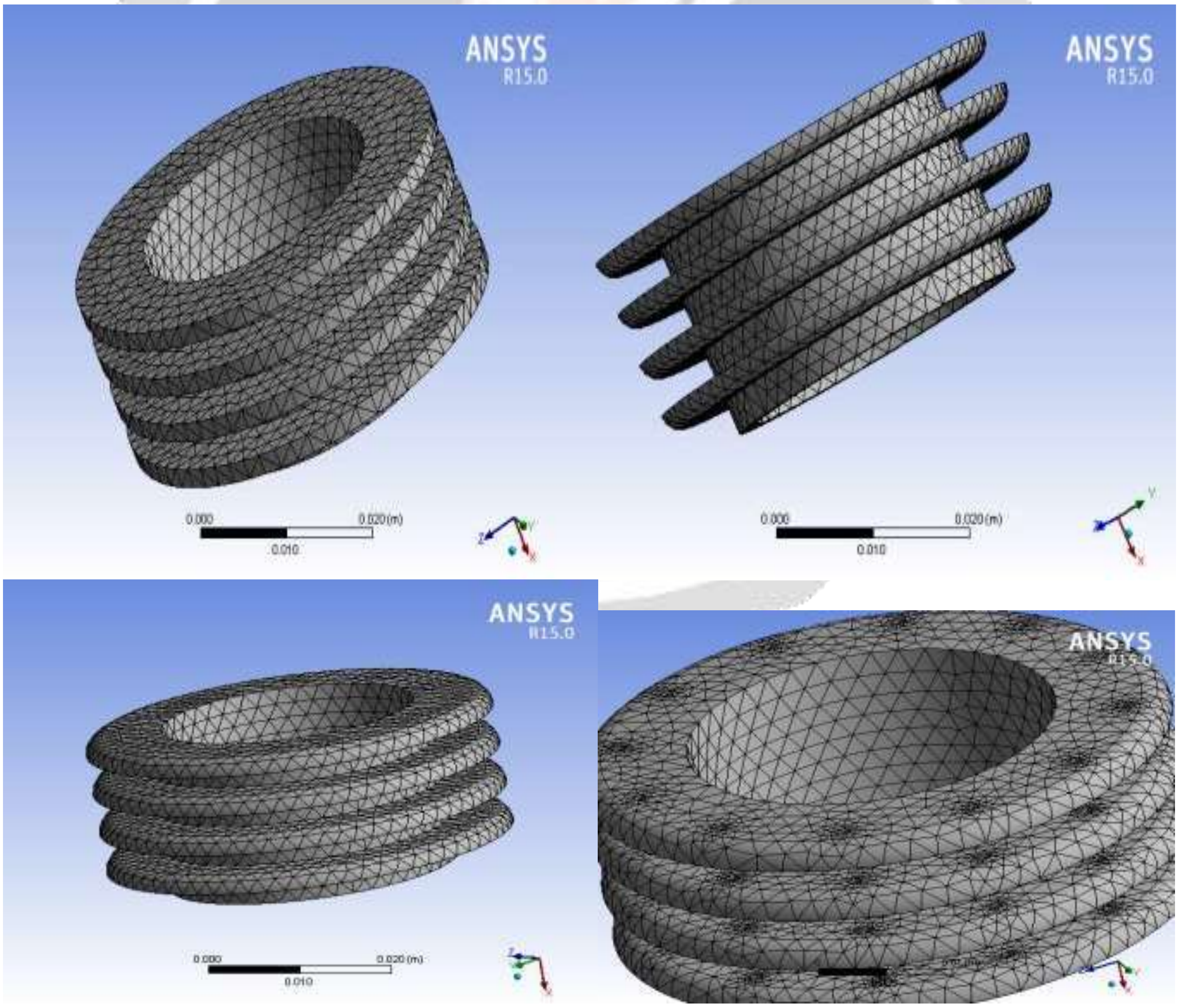

Figure: Mesh of IC engine fin

Table : Materials Properties

Properties	Aluminum
Thermal Conductivity, K	167 W/mk
Heat Transfer Coefficient (h)	22 W/mk2

RESULT AND DISCUSSION

Table Temperature distribution in IC Engine fin with concave fin profile.

Concave Shaped Fin	
Distance (mm)	**Temperature (kelvin)**
10	494.74
20	492.58
30	395.52
40	363.58
50	324.55

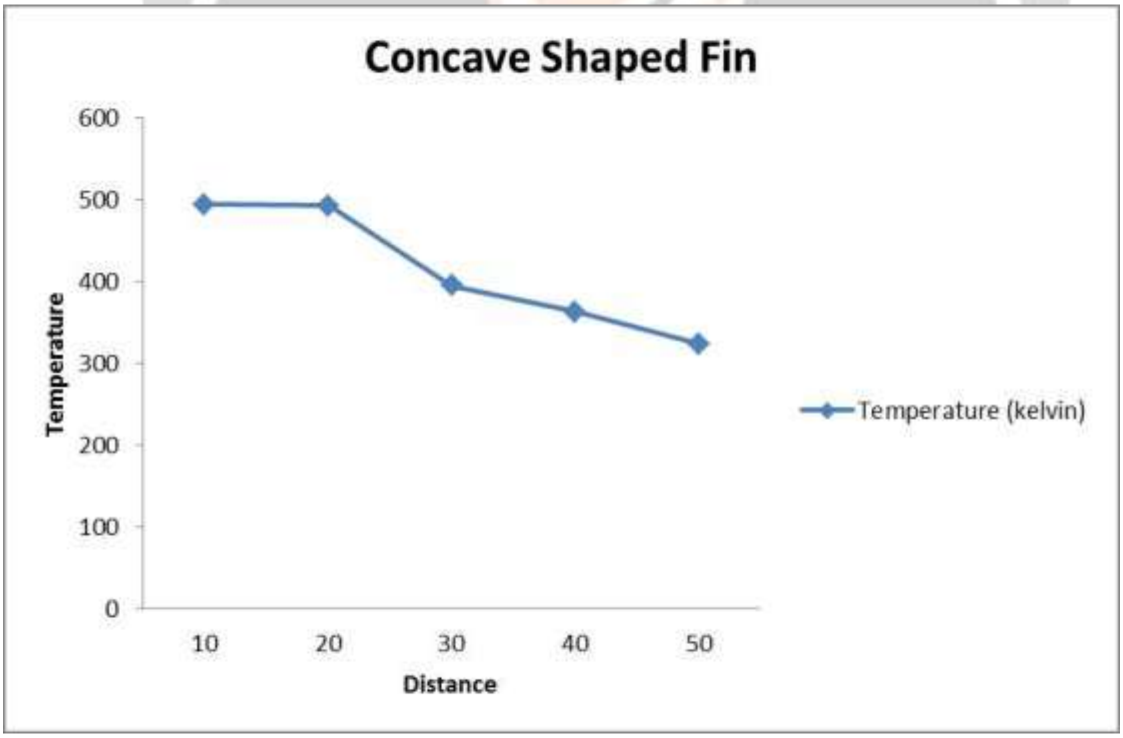

Figure Temperature distribution and distance effect in IC Engine fin with concave fin profile.

Table Temperature distribution in IC Engine fin with convex profile.

Perforated elliptical Shaped Fin	
Distance	**Temperature**

(mm)	(kelvin)
10	494.74
20	496.88
30	410.58
40	373.55
50	335.63

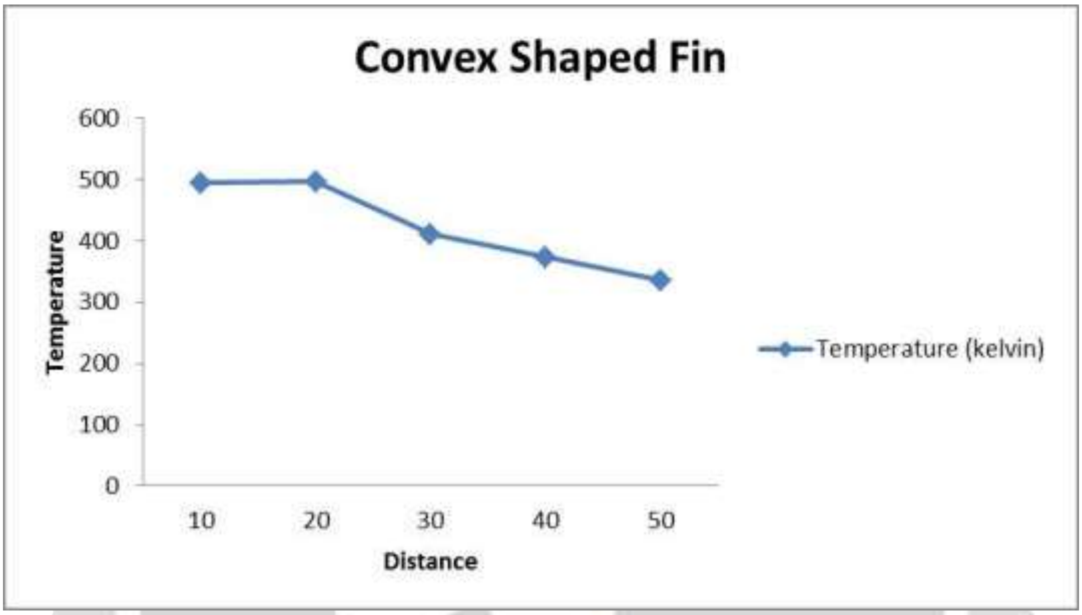

Table Temperature distribution in IC Engine fin with convex perforated profile.

Perforated elliptical Shaped Fin	
Distance (mm)	**Temperature (Kelvin)**
10	494.25
20	492.58
30	442.85
40	384.25
50	350.85

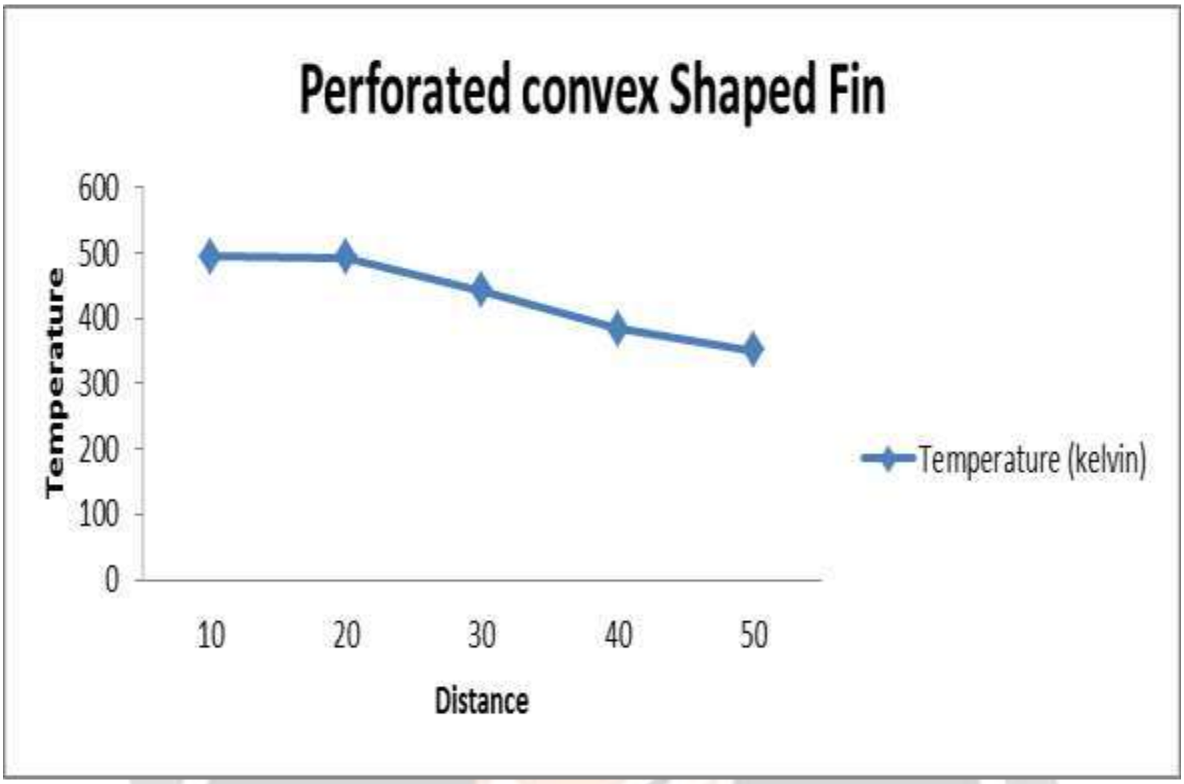

Table 6.17 Temperature distribution and distance effect in IC Engine fin with concave fin profile.

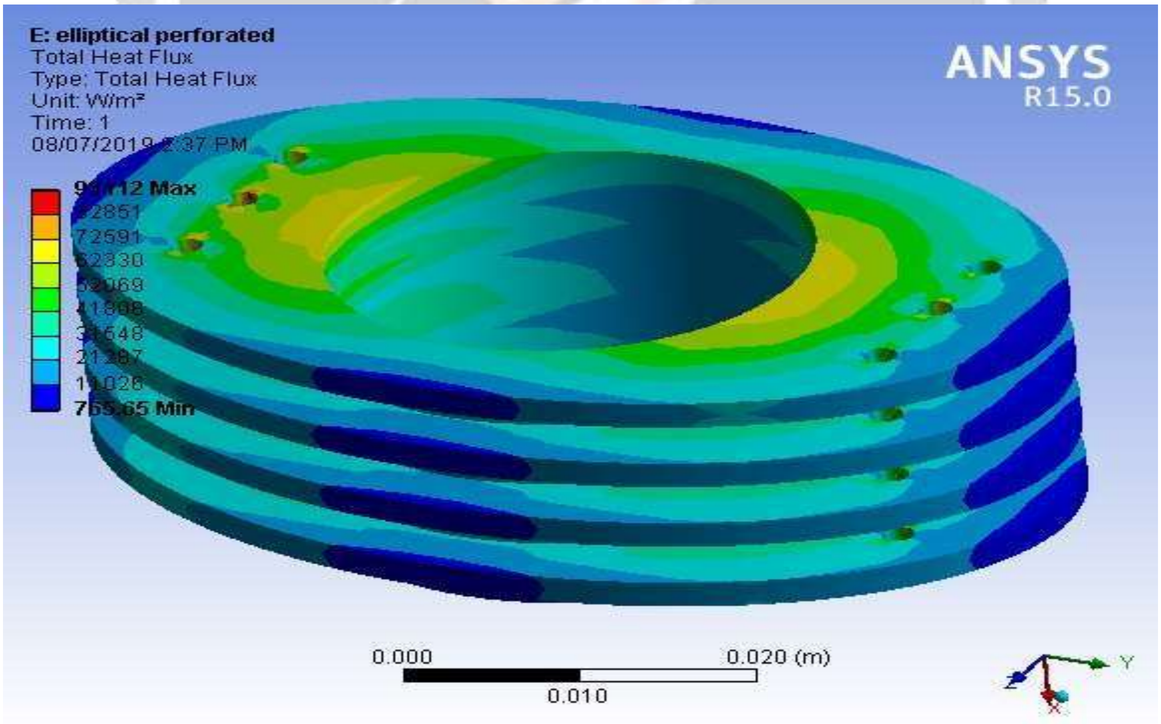

Figure : Heat flux distribution in IC Engine fin with perforated elliptical fin profile.

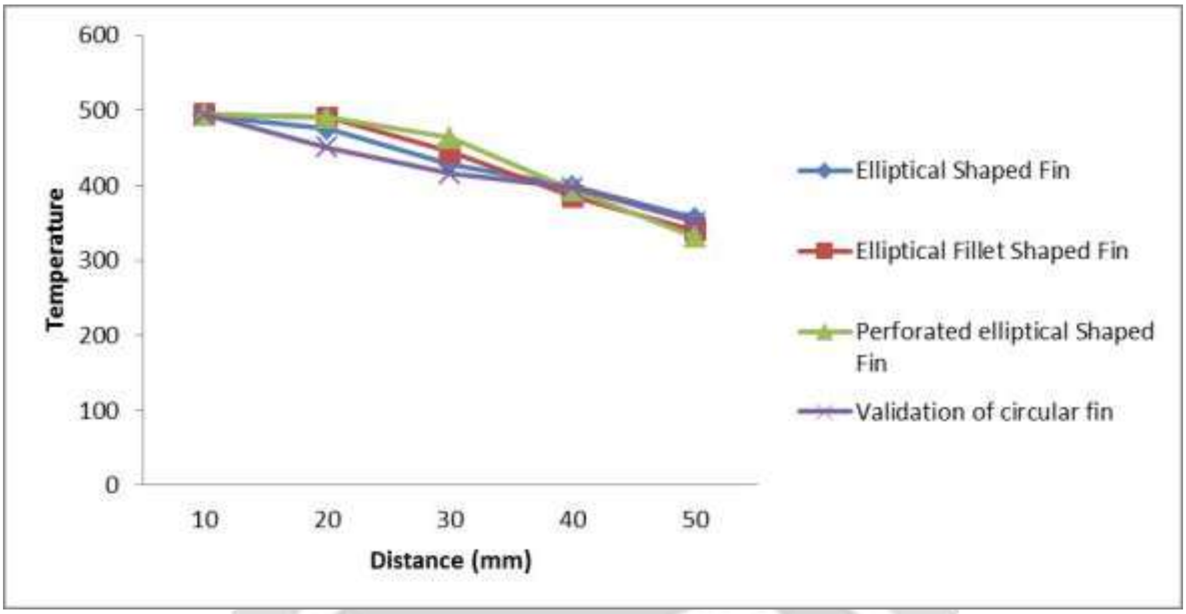

Figure: Temperature distribution and distance effect in IC Engine fin with perforated elliptical fin profile

VII CONCLUSION

- In this research, detailed analysis of the influences of temperature distribution, heat transfer coefficient and thermal performances of ic engine fin with different profiles has been conducted by simulations using the ANSYS software on steady state thermal domain 15.0. Work bench. The following conclusions are withdrawn.
- The different ic engine fin model was developed on Uni-Graphics Nx-8.0 and analysis was done using the Ansys software (Steady State Thermal domain) 14.5.
- The temperature distribution is the major parameter in the performance of ic engine different fin profile. The fin surface area is constant and the thermal resistance and will increase significantly.
- In the study, concave, convex, convex with perforation ic engine fin are the key geometric parameter on the performance of ic engine fin.
- The proposed four types of ic engine fins represented on results show that increase in surface area.
- it concludes that at constant temperature, convex shaped fin with perforation configuration having better heat transfer rate with an optimizing configurations.
- The simulations of CFD models of ic engine fins with different configurations show a good relation with experimental results presented in the literature.

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