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Study on Cooling Effects in Fin Type Engine Cylinders in Two Wheelars

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Abstract: Effects of the number of fins, fin pitch and wind velocity on air-cooling were investigated using experimental cylinders for an air-cooled engine of a motorcycle. Experimental cylinders that had a various number of fins and fin pitches were tested in a wind tunnel. Then the temperature inside of the cylinder, on the surface of the fins and in the space between the fins was measured. Results indicated that the heat release from the cylinder did not improve when the cylinder had more fins and too narrow a fin pitch at lower wind velocities, because it was difficult for the air to flow into the narrower space between the fins,so the temperature between them increased.This paper describes our effort to find out the effect of thickness and geometry on engine cylinder fins for temperature distribution, for this purpose, we have used fins with rectangular geometry, triangular geometry and thickness 2.5mm, 3mm.

Key words: Engine cylinder fins, Geometry, Thermal analysis, FEA.

Introduction

Once motorcycle engines used air-cooling. However, almost all modern motorcycle engines use liquid-cooling except for motorbike engines, because it is more difficult for air-cooling than liquid-cooling to uniformly cool an engine cylinder. The air-cooled engine is also designed more by trial and error. In order to permit the development of design data for most effective cooling fin, an experimental model cylinder for an air-cooled engine was developed. This experimental cylinder was tested in a wind tunnel.

For this objective Engine contain of cooling mechanism in engine to take out this heat from the engine limited heavy vehicles uses water-cooling method and nearly all two bikes use Air cooled engines, because of Air-cooled engines has rewards like lighter weight and smaller space requisite hence they are only option. Heat produced during combustion in Internal Combustion engine must be maintained at upper level to rise thermal efficiency, but to prevent engine parts from thermal damage some heat must be remove from the engine. In air-cooled engine exterior stretched surfaces are called as fins and provided at the periphery of

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engine cylinder to increase heat transfer rate[1]. Fins are widely used for cooling of IC engines. Engine cylinder fins are the outside stretched surfaces purposely provided on condition that it removes heat from place. The amount of conduction, convection and radiation of an object determines the amount of heat it transfers. Increasing the temperature gradient between the object and the environment, increasing the convection heat transfer coefficient and increasing thesurface area of the object increases the heat transfer[2].

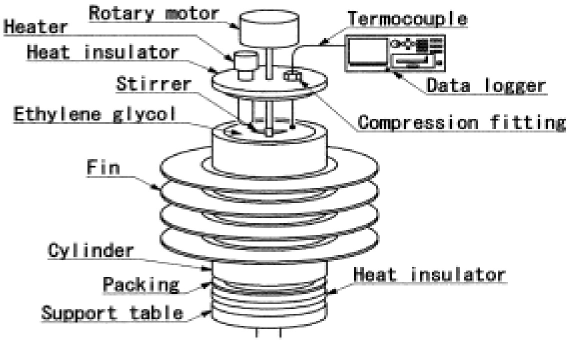


Figure 1 Measuring equipment for ethylene glycol temperature

Experimental procedure

(1) The experimental equipment in Fig. 3 was set and the cylinder was filled with 300 cm^3 of heat storage liquid.

(2) The heat storage liquid was heated and the stirrer was operated.

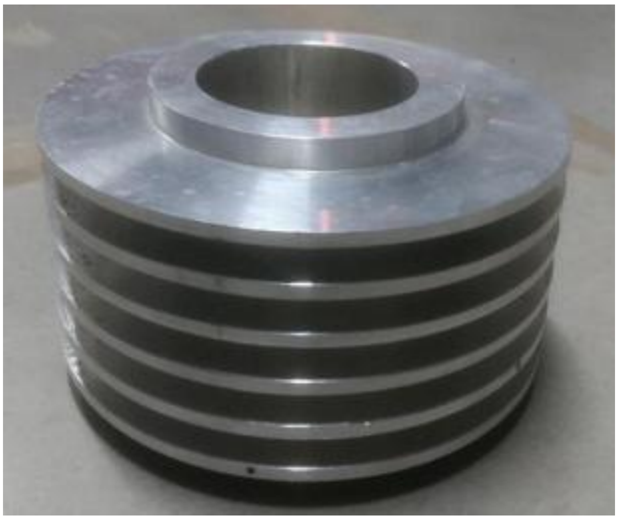
(3) When the heat storage liquid reached a temperature of approximately 150°C, the heater was turned off and removed.

(4) The temperature of the heat storage liquid decreased to 120°C by cooling at room temperature. At 120°C the wind tunnel was operated and the temperature was recorded.

(5) The temperature was recorded until it reached room temperature. Heat release from the cylinder was obtained by multiplying the mass and the heat capacity of the heat storage liquid by the difference between 120°C and the temperature after 10 minutes from the start of recording, then dividing it by measurement time.

Analytical approach

To investigate the performance of the temperature distribution through cylinder with fins first finite element analysis is completed using ANSIS R16.2 to Redefining of design earlier in product development stage also comparing the various design alternatives through simulation[3]. Reduce the amount of time and money required for prototype testing and create more reliable, better quality design[4], during FEA software model of a cylinder with rectangular geometry Fins of Aluminum Alloy 6061 are implemented and results are calculated for Temperature Distribution of Rectangular Fins with Alloy 6061 in 2.5 mm and 3 mm Fin Thickness. Implemented model of cylinder is as shown in figure 2.Then experimental setup developed it consists of a cylinder with rectangular geometry fins by using Al 6061 as shown in figure 3. Six fins are manufactured on the cylinder so that temperature at the end of fin tip is find out [5][6].



Cylinder with 3.0 mm thick rectangular fin

A set of two cylinders are manufactured with fin thickness of 2.5 mm and 3.0 mm. The cylinder with fins are enclosed in box made out of cardboard to avoid external wind disturbances. The enclosure also helps in developing a pure natural convection transfer through the set of fins by isolating the cylinder from the surrounding effects[8]. The experimental setup implemented as shown in figure 4, it consists of cylinder with fins, digital temperature indicator, dimmer stat (voltage regulator) and thermocouple sensor cables as shown in figure 5, with the help of experimental setup temperature at tip of the fin measured practically using following procedure[10].

1. Connect the dimmer stat to the heating element. Bring the knob of dimmer stat to zero

2. Connect the probes of digital temperature indicator at different locations on the cylinder and on the fins as per requirement. Switch on the mains supply.

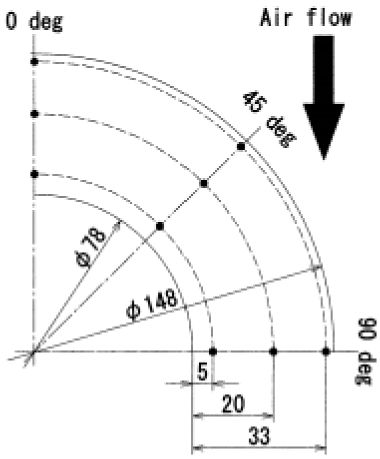
3. Increase the voltage supply to the heating element by rotating the knob slowly then Switch on the power supply of digital temperature meter and See the temperature of the inside and outside surface and fins indicated by the digital temperature indicator by rotating the knob provided.

4. Increase or decrease the voltage supply provided to the heating element depending on the temperature required at the inside surface of cylinder.

5. Wait until the temperature indicated by digital temperature indicator becomes steady. If the temperature indicated is steady, then it means that the experiment has reached steady state.

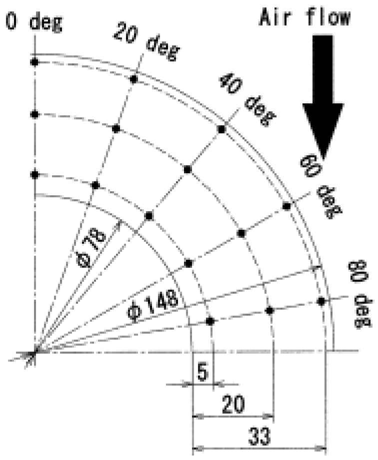
Heat transfer from the fins into the air Cylinders

To measure heat transfer coefficient on the fin surface. In order to measure the temperature on the fin surface, junctions of K type thermocouple of 50 µm wire diameter were placed at distances of 5, 20 and 33 mm from the fin root in radius and the windward angle of 0◦ (facing the oncoming air stream) to 180◦ with the equiangular spiral of 45◦ in circumference as shown in Fig. 4. In this case, the temperature on the fin surface was measured at fifteen positions on the center fin of three fins. Insulator covers were set not only at the top and bottom of the cylinder but also at a width of 30 mm from both the top and bottom. A temperature controller was used to keep the heat storage liquid at a constant temperature.



Measuring points for temperature on cooling fin surface

23 ± 1◦C and wind velocities of 0, 20, 40 and 60 km/h. The measured temperature was accurate to within ±0.6◦C in this experiment.



Flow pattern on the fin surface

The experiments were carried out without the heat storage liquid in the cylinder, at an ambient temperature of 23±1◦C and a wind velocity of 60 km/h. The flow pattern on the fin surface was formed in 1 min. after the wind tunnel was operated. When the oil film on the fin surface was sufficiently dry, the air flow was turned off.

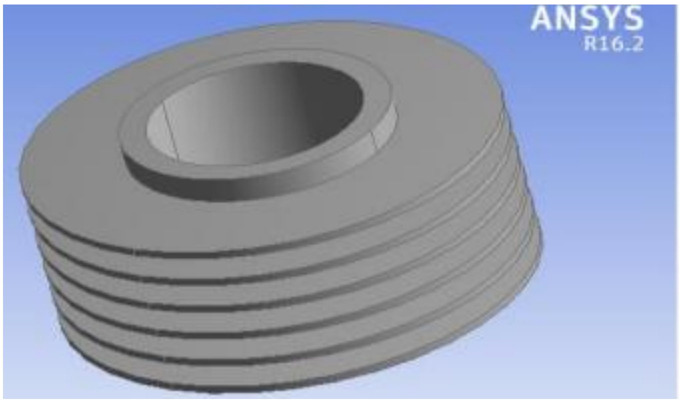


Figure shows the design of cylinder with 3mm thickness fins

Results and discussions

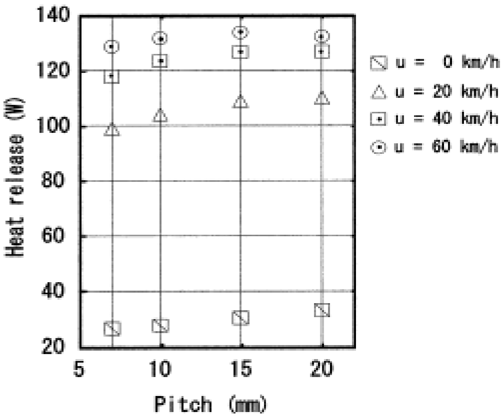
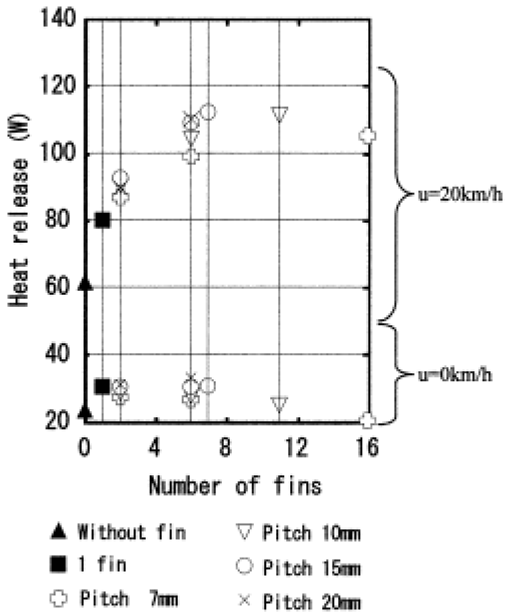


Figure Effect of fin pitch on heat release from cylinder (6 Fins)



Effect of number of fins on heat release from cylinder

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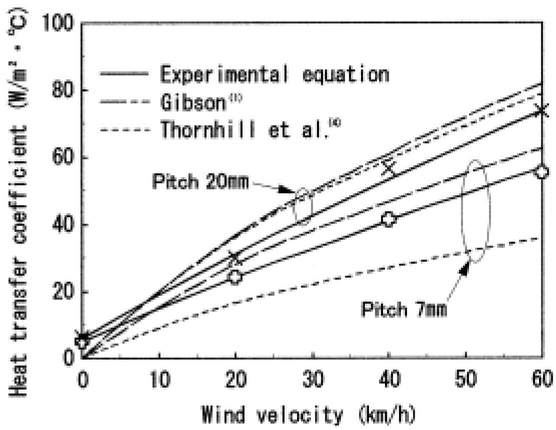
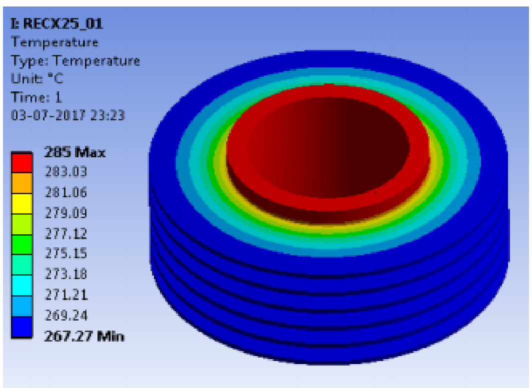
Heat release from the cylinder increased with increased wind velocity in each fin pitch. When the wind velocity increases, the fin pitch has less effect on heat release from the cylinder. It appears that the air does not flow well between the fins with narrower fin pitch at a lower wind velocity but the air flows well between the fins with each fin pitch at a higher wind velocity. When the fin pitch increased with each fixed number of fins, except for a fin pitch of 20 mm at wind velocities of 40 and 60 km/h, heat release from the cylinder increased. Figure 8 shows the effect of the number of fins on heat release from the cylinder at wind velocities of 0 and 20 km/h. Heat release from the cylinder increased with an increased number of fins with each fixed fin pitch at a wind velocity of 20 km/h.

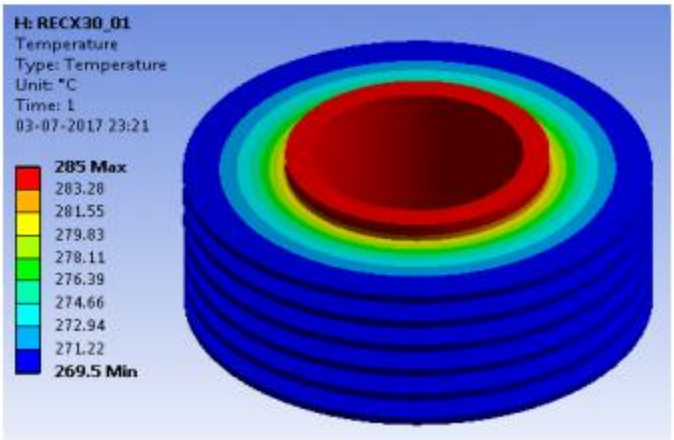


Each temperature between the fins for a wind velocity of 60 km/h is lower than that for 20 km/h in each fin pitch. The temperature distribution between the fins for a fin pitch of 10 mm is almost the same as that for a fin pitch of 20 mm at a wind velocity of 60 km/h. Even if the fin pitch decreases from 20 to 10 mm at a wind velocity of 60 km/h, the air flows well between the fins and the thermal boundary layers on the upper and lower fin surfaces are thinner. It was considered that the thinner thermal boundary layer would have a minimum effect on heat release from cylinder.

The results obtained for temperature distribution from the Finite Element Analysis using ANSYS are shown in figure 6 and figure 7 and Experimentation of different size models are collected and made it in tabulated form as follows in table 1 and table 2. Various graphs are plotted for experimental results as shown on figure 8 and ANSYS results in figure 9 and discussion is carried out on graphs.



Temperature Distribution for Rectangular Fins of Aluminium Alloy 6061 with 3.0 mm Fin Thickness



Temperature Distribution for Rectangular Fins of Aluminium Alloy 6061 with 3.0 mm Fin Thickness

Table 1 ANSYS Result table for Temperature Distribution fines with rectangular geometry.

SR. NO.	THICKNESS	Practical	Analytical
1	2.5	265.33	267.27
2	3	266.83	269.5

Conclusions

(1) To increase the cylinder cooling, the cylinder should have a greater number of fins. However, the cylinder cooling may decrease with an increased number of fins and too narrow a fin pitch at non-moving or lower speeds. Because the air does not flow well between the fins, overlapping of thermal boundary layers occurs on the upper and lower fin surfaces.

(2) At a lower speed the air flow separated on the fin surface at the leeward side and the temperature on the fin surface increased there. The higher temperature on the local fin surface makes cylinder bore a greater deformation, as a result, scuffing and increased lubricating oil consumption may occur. (3) The optimized fin pitches with the greatest effective cooling are at 20 mm for non-moving and at 8 mm for moving.

Finite element analysis and experimental investigation on the thermal behavior of cylinder with different fins of varying fin thickness, geometry and material is carried out. Based on the finite element analysis and experimental investigation of different fins, following conclusions are drawn. Results obtained from the finite element analysis are in close approximation with results of experimental method. FEA and Experimental results analysis shows that the temperature distribution is maximum for the cylinder with rectangular fin of 3.5 mm fin thickness for aluminium alloy 6061 and minimum for triangular fin of 2.5 mm thickness for aluminium alloy 6061.

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