



Comparative Analysis of Two-Wheeler Engine Cylinder Fins for Enhanced Performance

V. Pandiyarajan¹, Abdul Samad², Kathirvel³

¹Department of Mechanical Engineering, Faculty, Sri sairam college of Engineering,
Bengaluru

^{2,3,4}Department of Mechanical Engineering, Student, Sri sairam college of Engineering,
Bengaluru

ABSTRACT

The engine cylinder is a critical component in automobiles, subjected to high thermal stresses. Cylinder fins are designed to dissipate heat effectively, ensuring engine efficiency and preventing damage. This report analyzes the thermal properties of cylinder fins using ANSYS Workbench, focusing on varying fin geometry, material, and thickness. The aim is to enhance the heat dissipation rate by optimizing the fin design. Simulations reveal that modified fin designs improve heat transfer and reduce thermal stress, leading to better engine performance.

Keywords: Heat Dissipation, Thermal Conductivity, Fin Geometry, ANSYS, Aluminum Alloy

1 Introduction

Internal combustion engines (ICE) generate significant heat during operation. Excess heat must be dissipated to avoid engine damage, pre-ignition, and lubricant degradation. Traditional cooling methods include air and water cooling systems. This study focuses on air-cooled engines commonly used in motorcycles. Cylinder fins, as extended surfaces, increase the surface area for heat dissipation, enhancing engine cooling.

Efficient cooling is crucial as both insufficient and excessive cooling can reduce engine efficiency. This analysis investigates the impact of varying fin geometry, material, and thickness on heat dissipation.

2 Recent Works

Previous research highlights the importance of fin geometry in enhancing heat transfer. Studies using CFD (Computational Fluid Dynamics) and experiments have shown that varying the shape, pitch, and material of fins can significantly affect the heat dissipation rate. Rectangular and elliptical fins generally provide better cooling compared to triangular fins. Furthermore, the use of materials with higher thermal conductivity, such as aluminum alloys, improves heat transfer efficiency.

Notable studies have also emphasized the benefits of using permeable fins and the impact of airflow velocity on cooling performance. Improved fin designs can lead to better heat dissipation, reducing engine overheating and enhancing overall performance.



3 Methodology

The analysis was conducted using ANSYS Workbench for finite element analysis (FEA). The study involved:

Modeling: The cylinder fins for a 125cc motorcycle engine were modeled using PTC Creo software.

Material Selection: Aluminum alloy 6061 was chosen due to its high thermal conductivity and ease of manufacturing.

Design Variations: Five different fin geometries were tested, including flat, step-shaped, and S-shaped designs.

Simulation Setup: Transient thermal analysis was performed, considering boundary conditions such as heat flux and convection.

The goal was to compare the heat dissipation capabilities of different fin designs under similar conditions.

4 Results and Discussion

The simulations revealed significant differences in heat dissipation and thermal stress across the fin designs:

- **Flat Fins** (Model 1): Showed moderate heat dissipation but higher thermal stress.
- **Step-Shaped Fins** (Model 2): Improved heat transfer due to increased surface area, but with slightly higher stress levels.
- **S-Shaped Fins** (Model 3): Achieved the highest heat transfer coefficient but exhibited increased thermal strain.
- **Elliptical Fins** (Model 4): Provided balanced performance, with good heat dissipation and lower stress.
- **Modified Wavy Fins** (Model 5): Demonstrated the best overall performance, with enhanced heat dissipation and the lowest thermal stress.

The comparison indicated that the wavy fin design (Model 5) effectively maximized heat transfer while minimizing stress, making it the most efficient design among those tested.

5 Conclusions

This study successfully analyzed the impact of different fin geometries on the heat dissipation performance of a motorcycle engine cylinder. By modifying the fin design, significant improvements in cooling efficiency were achieved. The wavy fin design emerged as the optimal solution, offering enhanced heat transfer and reduced thermal stress. Future research could explore further optimization of fin shapes and materials, as well as experimental validation of the simulation results.



References

All cited references should be listed after declarations section in the following style-

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