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Design Optimization of Two-Wheeler Radiator with the Base Design Using the Mathematical Modelling Tools & Testing Data

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Abstract

Radiators are types of heat exchangers, which are used to transfer the heat from one fluid to another fluid. It is mainly used in automobile engine cooling systems and the radiators are the major source of heat rejection from the system by cooling the working fluid (generally water or glycol mixture). The application of radiators in the two-wheeler vehicle segment plays a vital role in increasing engine efficiency by maintaining the optimum temperature inside the engine assembly. As the technology advances with higher power requirements for the two-wheeler vehicle segment, thermal management of combustion engine becomes a critical part of it, resulting in the advancement of radiator technology in terms of compactness and thermal performance. In order to cater to the increasing demand for high-powered engines, performance optimization of two-wheeler radiators becomes an important aspect of design.

This paper investigates the existing design parameters i.e. both the geometrical and thermal parameters, responsible for performance and compactness of two-wheeler radiator, and optimize the design parameters using the mathematical modelling tools. The modelling & optimization is based on parametric analysis with a single geometrical variable. The paper shows the comparative analysis of two different designs in terms of thermal performance and design optimization. The optimization results in 60% (approx.) performance by weight enhancement and validated by performance testing in the laboratory. The scope of the optimization extends to various existing two-wheeler radiator performance for better design optimization. The study can be further extended to multiple geometrical parameters analysis of the compact two-wheeler radiator design.

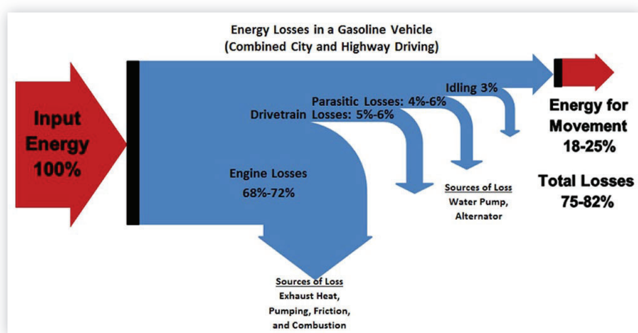
Introduction

In any vehicle, engine is the power-generator and it provides the driving power to the vehicle. In the course of heat generation through the combustion process inside the engine, it generates huge amount of heat by burning the combustible fuel-air mixture. The total heat energy generated after the combustion doesn't fully drive the vehicle rather only some percentage of it is getting transferred for the vehicle drive, rest of them are heat-losses through various medium. The typical heat distribution of an automobile engine is as follows in the Figure 1.

Due to combustion, the surrounding temperature of the engine chamber becomes very high, which overheats the auxiliary components of the engine such as pistons, valves, lubrication oil, cylindrical walls etc. So, in order to maintain the optimum temperature across the engine chamber, the thermal management of the engine becomes very critical and important. Radiators are used to dispose the excess heat of the engine. It is a type of heat exchanger, where two fluids i.e. air and engine coolant (Such as ethylene glycol or sometimes water) exchanges heat with each other and maintains the required optimum temperature of the engine.

In this paper, the thermal management of the two-wheeler engine has been considered for the analysis w.r.t. a base

FIGURE 1 Typical Heat Energy Distribution of a Gasoline Engine [7]



radiator and according to that, the performance of the heat exchanger (i.e. Radiator) has been optimized. Majorly, two different types of cooling methods are used in two-wheeler engine cooling system, first-one is air-cooling & second-one is liquid/oil-cooling systems. In the analysis second type of cooling system has been used to optimize the heat-exchanger parameters. The two-wheeler engine cooling systems (Figure 2) and the actual two-wheeler radiator (Figure 3) can be seen in the picture below.

4. The optimized radiator is having light weight, compact design with high performance in comparison to the base radiator.

Future Work

The current design optimization has been done in comparison with a base two-wheeler radiator. Further this work can be continued with the other two-wheeler radiator model as well by optimizing the geometrical parameters as well as the material of the radiator. The Aluminium has been considered as the radiator material for the current design optimization.

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Abbreviations

Nu - Nusselt Number

ITD - Inlet Temperature Difference

LPM - Litre Per Minute

CMH - Cubic Meter Per Hour