International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

Effect of Grooves on the Piston Crown in Improving the Performance of Diesel Engine

N. Hiranmai[1], Dr. M. L. S Devakumar[2], M. V. Ramana Reddy[3]

[1, 2] Department of Mechanical Engineering, JNTUA College of Engineering, Ananthapuramu, A. P, India

[3]Department of Mechanical Engineering, G. Narayanamma Institute of Technology & Science for Women, Hyderabad, Telangana, India

Abstract: ***In This study presents an experimental investigation on a 4-stroke Direct Injection Diesel Engine run with Diesel. The efficiencies of the engine were compared when run using both a normal piston and a piston with grooves. The grooves were designed to create turbulence and improve the thermal efficiency of the engine. The results showed that the grooved piston improved the engines performance under all load conditions.***

Keywords: Diesel Engine, Turbulence, Engine Performance, Grooved Piston, Thermal Efficiency, Mechanical Efficiency

1. Introduction

To obtain a better combustion with lesser emissions in direct-injection diesel engines, it is necessary to achieve a good spatial distribution of the injected fuel throughout the entire space available in the combustion chamber. In DI diesel engines, swirl can increase the rate of fuel-air mixing due to the turbulence provided by the grooved piston.

2. Literature Survey

Subba Reddy et al (ref 1), have carried out an experimental investigation on D. I Diesel Engine with three different tangential grooved pistons with cotton seed oil methyl ester blended with diesel in various proportions. They have reported a decrease in Brake Specific Fuel Consumption and a slight increase in thermal efficiency, when the engine is operated on blended fuel of 20% cotton seed oil methyl ester and 80% diesel (20BD), compared to that with diesel fuel.
Prathibha et al (ref 2), have carried out an experimental investigation to study about influence of the air swirl in the cylinder upon the performance and emission of a single cylinder diesel direct injection engine by using diesel on volume basis. The swirl intensification was done by cutting grooves over the piston crown. In this work three different configurations of piston i. e. in the order of number of grooves 6, 9, 12 are used to intensify the swirl for better mixing of fuel and air and their effects on the performance and emission are recorded.

In several other reported research works, it has been concluded that the thermal efficiency of an engine enhances with the turbulence created with the help of grooves provided on the piston crown.

Properties of Diesel

Table 1: Properties of diesel

Property	Diesel
Density (kg/m^3)	805.4
Calorific value (kJ/Kg)	41991.9
Specific gravity	0.805
Flash point (^{o} C)	52
Fire point (^{o} C)	56

3. Experimental Setup

This study is significant as it provides insights into how the design of engine components, specifically the piston, can be modified to improve engine performance and efficiency. The findings could have implications for the design of more efficient and environmentally friendly engines.

The study should provide more detailed information on the experimental setup, including the specific model of the engine used, the process of creating the grooves on the piston, and the method of measuring engine performance.

In order to find out the effect of turbulence created by the Grooves provided over the Piston crown, on the performance of DI Diesel Engine when run with diesel, a single cylinder vertical type four stroke, water-coo1ed, self governed type, compression ignition engine is used in the present work.

Table 2: Specifications of Engine

Engine type	4-Stroke Diesel Engine
B. H. P	5HP
Rated speed	1500 rpm
Bore size	85mm
Stroke length	110mm
Number of cylinders	Single cylinder
Cooling	Water cooled
Cylinder arrangement	Vertical

Table 3: Groove cut specifications

Number of grooves	5
Width of cut	2mm
Depth of cut	1mm

Figure 2: Grooved Piston

4. Results and Discussions

1) Brake Thermal Efficiency

Brake thermal efficiency is more for the engine run with grooved piston, compared to that of, regular piston, at all load conditions. This may be due to complete combustion of fuel admitted into the cylinder.

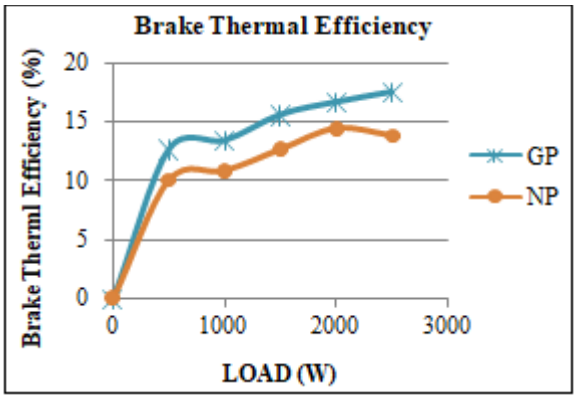

Figure 3: Load Vs Brake Thermal Efficiency

2) Indicated Thermal Efficiency

At all load conditions, it is less for the engine operated with grooved piston than that of with regular piston. This may be due to variation in amount of total power produced by the engine with respect to heat supplied in the form of fuel.

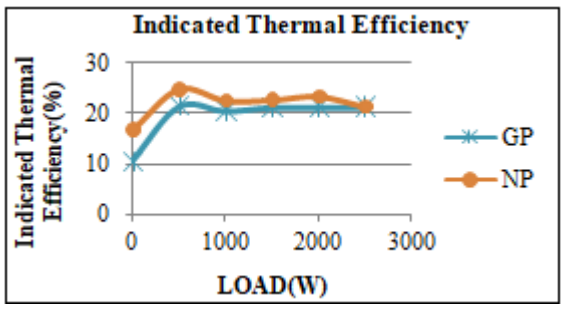

Figure 4: Load Vs Indicated Thermal Efficiency

3) Mechanical Efficiency

At all load conditions, Mechanical efficiency is more for the engine operated with grooved piston than that of with regular piston.

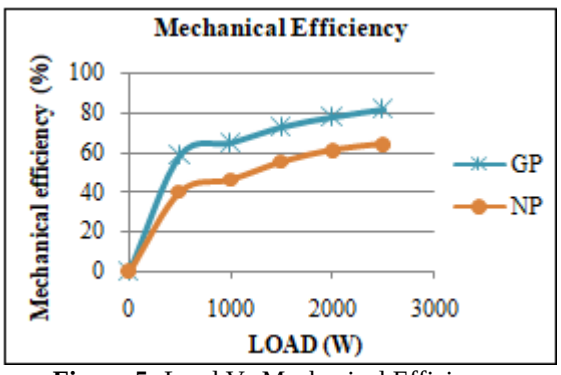

Figure 5: Load Vs Mechanical Efficiency

BSFC:

At lower load conditions, Brake Specific fuel consumption is more for the engine operated with grooved piston than that of with regular piston. .

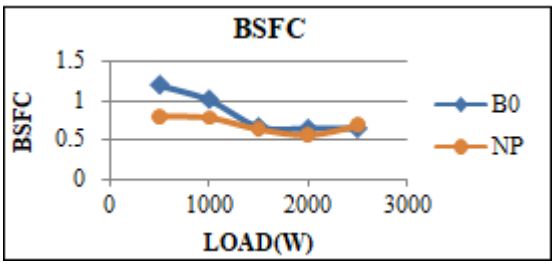

Figure 6: Load Vs BSFC

5. Conclusions

1) At all the load conditions, Mechanical Efficiency is more for the engine operated with grooved piston than that of with regular piston.
2) At all the load conditions, Brake thermal Efficiency is more for the engine operated with grooved piston than that of with regular piston.
3) At all the load conditions, Indicated Thermal Efficiency is less for the engine operated with grooved piston than that of with regular piston.
4) In lower load conditions, BSFC is more for the engine operated with grooved piston than that of with regular piston.
5) The study found that the use of a grooved piston improved the mechanical and brake thermal efficiency of the diesel engine under all load conditions. However, the indicated thermal efficiency was less for the engine operated with a grooved piston. These findings suggest that modifications to the piston design can significantly improve engine performance, providing a potential avenue for the development of more efficient engines.

6. Scope of Future Work

This work can be extended by varying the number of grooves over piston crown or by varying the dimensions of groove cut or by using various types of alternate fuels performance and emission characteristics of engine can be find out.

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Author Profile

N. Hiranmai is Research Scholar (Mechanical Engineering) in J. N. T. U College of Engineering, Ananthapuramu. She is working as Assistant professor at GNITS, Hyderabad. She holds her Masters Degree in Advanced IC Engines from JNTUA CEA. She holds her Bachelor Degree in Mechanical Engineering from G. Pulla Reddy Engineering College, Kurnool.

Dr. M. L. S Deva Kumar, Professor in Mechanical Engineering department, J. N. T. U College of Engineering, Ananthapuramu.

Mr. M. VenkataRamana Reddy, Assoc. Professor of Mechanical Engineering Department, G. Narayanamma Institute of Technology & science for women, Hyderabad.