Testing and Analysis of the Correlation between Engine performance and Engine life

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Abstract— Engine performance is a function of the mileage of the engine. As the number of years of usage increases, the performance of the engine also reduces due to a number of factors like mechanical losses and wear and tear. This was the primary assumption made by the authors and testing was done to validate this statement. The aim of the paper is to validate the primary assumption, quantify the power loss due to an increase in mileage and finally enumerate the factors that have led to the power loss. This paper stresses on the importance of proper maintenance engine maintenance by proving that there are considerable losses even in well-maintained engines. Thus the authors believe that this paper is an important contribution to the field of automotive service and maintenance.

Index Terms— Engine, Performance, Mileage, Service, Maintenance, Automobiles, spark ignition, compression ignition, dynamometer

1 Introduction

1.1 Problem Statement and Approach

THIS paper was developed to test and validate a primary assumption that there is loss in engine performance as the mileage of the engine increases due to increase in mechanical losses [1]. Also, the factors that lead to the power loss have been enumerated based on observation. The research was carried out by primarily choosing two models of engines- a single cylinder spark ignition engine and a twin cylinder compression ignition engine. Two engines of each model were chosen. One engine was a 6 month old engine (assumed to be new) while the other was a 3.5 years old engine (comparatively old). The brake power of the new and old engines were obtained experimentally and plotted against brake thermal efficiency. The test data for the new and old engines were compared and the performance loss was established for both the models.

1.2 Data Acquisition Method

The engine was coupled to an Eddy current Dynamometer. The dynamometer used was air-cooled with a maximum power-rating of 14.7 KW. The dynamometer gives the torque as the output [2]. The brake power was calculated from the torque obtained from the dynamometer.
The brake power was calculated using the following formula [3]-

$$BP=2\pi NT/60000 \quad KW \qquad (1)$$

BP- Brake Power
N- Speed of Engine
T- Torque of the engine obtained from the dynamometer
To obtain the brake thermal efficiency, the following formula [4] was used-

$$BTE=BP/(MOF/s*CV)\ \% \qquad (2)$$

BTE- Brake Thermal Efficiency
MOF/s- Mass of Fuel/second
CV- Calorific Value of the fuel
Calorific value of Gasoline= 44000 KJ/kg [5]
Calorific value of Diesel= 43000 KJ/kg [6]
The brake power and brake thermal efficiency were then plotted against each other. The analysis was made using these graphs.

1.3 Structure of Research Paper

The next section contains the equipments and materials that were used for testing. The method in which the tests were conducted has also been explained. The data analysis has then been presented and the old and new versions of the two engine models were compared in terms of engine performance. Then the power drop due to engine mileage has been quantified and the factors that affect this power loss have been enumerated.

2 MATERIALS AND METHODS

A twin cylinder CI engine and a single cylinder SI engine were used. The specifications for both the engines that have been used have been given below.

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TABLE 1
CI Engine Specifications

POWER	3.8 KW
SPEED	1500 RPM
COMPRESSION RATIO	16:1.
TYPE OF FUEL	DIESEL
AIR INDUCTION METHOD	NATURALLY ASPIRATED
NUMBER OF CYLINDERS	TWO; PARALLEL TWIN
TYPE OF COOLING	LIQUID COOLED
NUMBER OF STROKES	4

TABLE 2
SI Engine Specifications

POWER	3.8 KW
SPEED	3600 RPM
COMPRESSION RATIO	4.67:1
TYPE OF FUEL	GASOLINE
AIR INDUCTION METHOD	NATURALLY ASPIRATED
NUMBER OF CYLINDERS	1
TYPE OF COOLING	AIR COOLED
NUMBER OF STROKES	4

The eddy current dynamometers used had a maximum power rating of 14.7 KW. The specifications of the eddy current dynamometer used for obtaining data have been given below.

TABLE 3
Eddy Current Dynamometer Specifications

MAX POWER	14.7 KW
MAX SPEED	15000
MAX TORQUE	46.8
MAX TORQUE SPEED	3000
MOI	0.0147

To conduct the experiment, the four engines: 6 months old SI engine, 3.5 years old SI engine(of the same specifications), 6 months old CI engine and a 3.5 years old CI engine(of the same specifications) were chosen. The first engine was bolted onto the test rig. The output shaft was then coupled to the eddy current dynamometer. The engine was started and allowed to warm up for 5 minutes. Then load was increased gradually in steps of 20% until100% load was achieved. The torque output was taken from the dynamometer display. The dynamometer also gives the value of the total fuel consumption. Eddy current dynamometers require an electrically conductive core, shaft, or disc moving across a magnetic field to produce resistance to movement. This resistance is utilized to calculate the torque of the engine [7]. The torque was used to calculate the brake power using the formula (1). The brake thermal efficiency was calculated using formula (2). The same procedure was repeated for all the remaining three engines and the performance curves for brake power were generated for all engines.

3 RESULTS AND DISCUSSIONS

The first SI engine which was 6 months old was tested and the following results were generated-

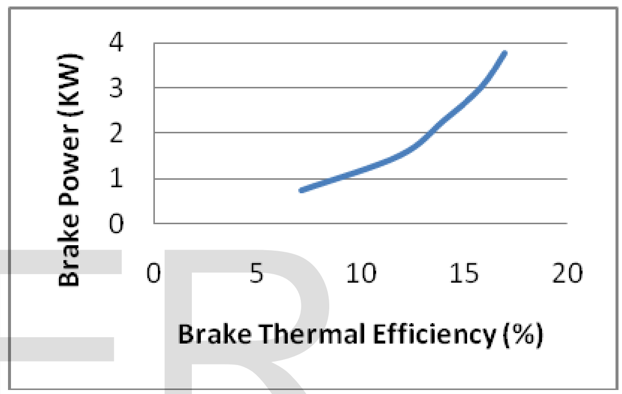

Fig. 1. Brake Power vs. Thermal Efficiency for 6 months old SI engine

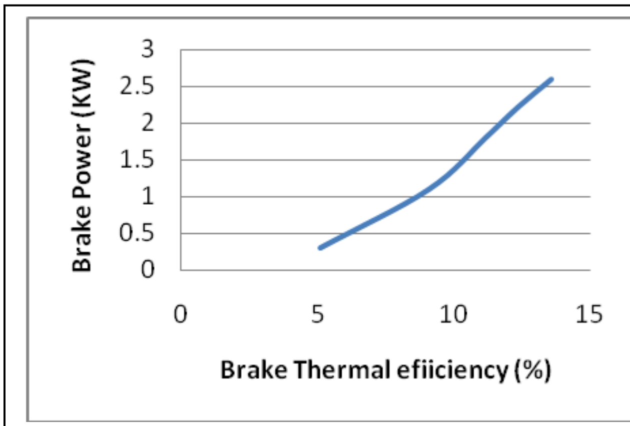

Fig. 2. Brake Power vs. Thermal Efficiency for 3.5 years old SI engine

In figure 1, the curve for the 6 months old SI engine has been depicted. The peak brake power that is achieved is about 3.8 KW. In figure 2, the curve for the 3.5 years old SI engine has been depicted. The peak brake power that is achieved is about

2.6 KW. Thus there has been a 32% drop in power in the single cylinder SI engine.

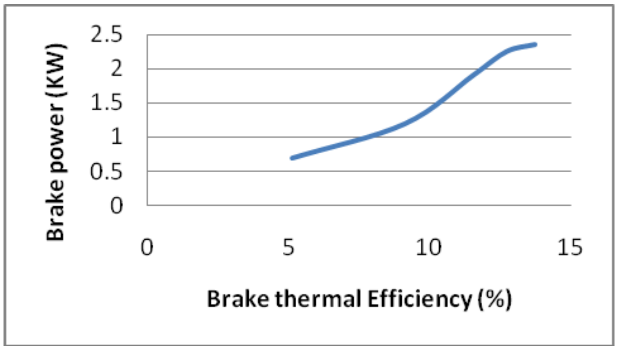

Fig. 3.Brake Power vs. Brake Thermal Efficiency for 6 months old CI engine

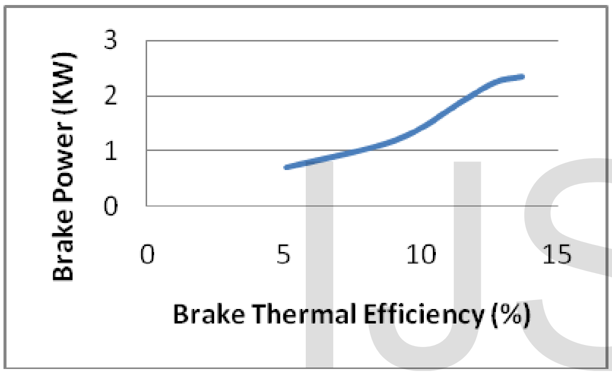

Fig. 4.Brake Power vs. Brake Thermal Efficiency for 3.5 years old CI engine

Figure 3 depicts the performance curve for power for the 6 months old twin cylinder CI engine. The peak power that is obtained is about 3.8 KW. Figure 4 represents the power curve for the 3.5 years old, twin cylinder CI engine. The peak power obtained is about 2.35 KW. Thus the power loss due to increase in mileage is approximately 38%.

4 CONCLUSION

As depicted by the results, there is a major loss in power due to increase in engine mileage. There has been more than 30% loss in power in both a single cylinder SI engine and twin cylinder CI engine. This is a drastic loss in power. Some factors that are attributed to power loss have been identified based on observation. The major issues were wear and pitting of bearings due to foreign particles, defective bearing seals, soot deposition, valve leakage, blow-by losses due to wear in piston rings and low injection pressure. Thus based on the research and the observations, it can be concluded that the research has validated the primary assumption and the research has also re-enforced the importance of service and maintenance in Automobiles.

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REFERENCES

[1] Bedajangam S.K. and N.P. Jadhav. “Friction Losses between Piston Ring-Liner Assembly of Internal Combustion Engine: A Review”, *International Journal of Scientific and Research Publications*, Volume 3, Issue 6, June 2013

[2] B.J. Chalmers and B.J. Dukes. “High Performance Eddy Current Dynamometers”, in *IEE Proceedings B (Electric Power Applications)*, Volume 127, Issue 1, January 1980, pp. 20-28

[3,4] V. Ganesan. *Internal Combustion Engines*. New Delhi, India: Tata McGraw Hill Education Private Limited, 2007, pp. 25, 564

[5] V. Balaji Raman and X. Alexander. “Emission and Performance Test on Petrol Engine using Fuel modification”, *International Journal of Emerging Technology and Advanced Engineering*, Volume 3, Isuue 6, June 2013

[6] LoveKush Prasad and Dr. Alka Agarwal, “Experimental Investigation of Performance of Diesel Engine Working on Diesel and Neem Oil Blends”, *IOSR Journal of Mechanical and Civil Engineering*, Volume 1, Issue 4, July-August 2012

[7] V. Ganesan. *Internal Combustion Engines*. New Delhi, India: Tata McGraw Hill Education Private Limited, 2007, pp. 529-530