Original Research Article

Testing of two different powered stationary diesel engines and analysis of changes in performance over usage time

ABSTRACT

The engine performance affected by the it's running life or say total working hours of its utilization. As the engine gets used over the time, the performance of the engine also reduces due to two main factors i.e. mechanical losses and wear and tear. This study was conducted with the hypothesis that even the engine is properly maintained considerable losses are occurred in engine performance as the usage increases. Two engines having power 5 HP and 10 HP were selected for the study. The heat balance method was used and different performance characteristics parameter were analyzed. The maximum rated power of 5 HP engine was found 3.72 kW and the maximum rated power of 10 HP engine equal to 7.4 kW. The main reason of this lower performance are due to poor governing, thermal and mechanical losses. This study helps to analyze and predict the performance of the engine over the years. The maximum rated power of 5 HP engine and 10 HP engine was found to be 3.1 kW and 5.8 kW against the declared value of 3.72 kW and 7.4 kW respectively which may be due to poor governing, thermal and mechanical losses.

Keywords - Engine, Fuel consumption, Losses, Performance, Power

INTRODUCTION

Agriculture is the backbone of Indian economy and majority of the Indian population depends on agriculture. Technological improvement in Indian agriculture since mid-sixties has brought about revolutionary increases in agricultural production. The farm power availability in Indian agriculture and productivity increased from 0.25 to 1.84kW ha^{-1} and from 0.52 t ha^{-1} to 1.92 t ha^{-1}, respectively over the years from 1951 to 2012. The predicted values of farm power availability and productivity in India for the year 2020 is going to be increased to 2.2 kW ha^{-1} and 2.3 t ha^{-1}, respectively (Sinha et al.2016 and Mehta et al, 2014). On Indian farms productivity depends considerably on the farm power availability and its efficient use. Over these years there was rapid shift in farm power uses from animal power to mechanical power (Sinha et al. 2016 and Patel et al, 2018). Mechanical power helps in timely farm operations with low requirement of labour and cost. Diesel engine availability registered an increasing trend from 1.62 units/1000 ha of net cultivated area to 59.67 units\1000 ha during the period of 1960-61 to 2013-14. Power from diesel engines increased from 0.009 kW/ha in 1960-61 to 0.247 kW/ha in 2000-01 and 0.335 kW/ha in 2013-14 (Shrivastava et al. 2008). The engine performance is a function of the millage of the engines. As the numbers of years usage increase, the performance of the engine also reduces due to numbers of factors like mechanical losses and wear and tear. The basic objective in design and development of engine was depends on three main factors i.e. cost of production, improve the efficiency and power output. In order to achieve the above task, the development engineer has to compare the engine develop with other engine in terms of its output and efficiency. This paper stressed on the importance of proper maintenance of engine by proving that there are considerable losses even in well maintain engine. The performance parameters of engines worked out viz. the power develop, break specific fuel consumption at different speed, and losses in power. The power drop due to engine millage has been quantified and the factors that affect this power loss have been enumerated.

METHODOLOGY

Selection of engines

Single cylinder stationary diesel engines of two different horse power range were selected randomly from the work site (Department of FMPE, JNKVV Jabalpur, MP India). The engine were belongs to different make and model which are coded as engine A and engine B. Engine A having declared rated power of 3.72 kW at 1500 rated engine speed. This engine was run for about 350 hours till the time of selection and was 3 years old and engine B having declared rated power of 7.4 kW at 1500 rated engine speed. This engine was run for about 1800 hours till the time of selection and was 4year old. Brief specification of engine was given in table I.

Testing process

The performance of diesel engine I assessed in the laboratory under controlled condition by eddy current dynamometer having specifications: Water cooled Eddy Current Dynamometer which is shown in plate 1, Normal Rating: 10HP/7.5kW @ 1500 RPM, Minimum Water Pressure: 1.6 bar, Cooling Water Flow Rate: 14 to 15 L/min. To conduct the test engine was bolted onto the test rig. The engines were properly coupled to the dynamometer with the help of standard flanged shaft. The dynamometer rotor was driven by the engine under test and it was electromagnetically engaged to stator. The break load was applied with the help of electrical circuit on control panel shown in plate 2 and was displayed on the screen at the setup. The data logger software was used for calculation sheet for heat balance during performance test of diesel engine. The engine was started and let the engine run for 20 minute so, that it can achieve its steady state. Than load was increased gradually in steps of 10 to 100% load was achieved. The torque output was taken from the test rig. The dynamometer also gives the values of total fuel consumption. Eddy current dynamometer requires an electric conductive core, shaft or disc moving across a magnetic field to produce resistance to movement. The observation was taken after sufficient warm-up and stabilized condition. The same procedure was used for both the engines.

RESULT AND DISCUSSION

In figure 1, it was found that as the brake load was increased from no load engine speed (1590 rpm) for 5 HP engine up-to the 10% over load engine rpm (1448 rpm), whereas the engine brake power was also increased gradually. The maximum rated power was found to be 3.1 kW at the rated engine rpm of 1500 which was considered lower side as compare to the declared value of 3.72 kW. Hence, the rated power was found to be reduced by 16.7% after completing part of engine life for the 5 HP engine.rpm (1448 rpm) the engine brake power was also increased gradually. The maximum rated power was found to be 3.1 kW at the rated engine rpm of 1500 which was considered lower side as compare to the declared value of 3.72 kW. Hence, the rated power was found to be reduced by 16.7% after completing part of engine lifeforthe5 HP engine. This engine was run for about 350 hours (as per the record) till the time of selection and was assumed to be 2-3 year old.

The brake thermal efficiency (BTE) gives an idea of the output generated by the engine with respect to heat supply from the fuel. In modern diesel engines the indicated thermal efficiency for compression ignition engine was estimated by the researchers about 36% and even more with high compression ratio. Figure 2 represented brake thermal efficiency in percentage with respect to brake load. For the engine tested, the increase in brake thermal efficiency was found with increases in brake load and consequently the power.

The BTE was found less (11.93%) at low load and increased at rated output of tested engine (22.13%). Further increase in load caused slightly increased in power but total fuel consumption is comparatively higher and due to this the BTE was found to be reduced (20.48%).

In the figure 3 it was found that as the brake load was increased from no load engine speed (1618 rpm) for engine "B" up-to the further load engine rpm (1493 rpm) the engine brake power was also increased gradually. The maximum rated power was found to be 5.8 kW at the rated engine rpm of 1493 which was considered lower side as compare to the declared value of 7.4 kW. Hence, the rated power was found to be reduced by 21.62% after completing part of engine life. The further loading of engine beyond 1500 rpm brake load that was treated as 100%, the sudden drop of engine rpm was noticed and was reached up-to 1493 rpm. It may be due to governing action which was not able to maintain the rpm and load. In case of sudden over load the engine must maintain the rpm and produce sufficient power to cope-up this situation.

The brake thermal efficiency (BTE) gives an idea of the output generated by the engine with respect to heat supply form of the fuel. In modern diesel engines the indicated thermal efficiency for compression ignition engine was estimated by the researchers about 36% and even more with high compression ratio. The figure 4 represented brake thermal efficiency in percentage with respect to brake load. For the engine tested the increase in brake thermal efficiency was found with increases in brake load and consequently the power. The BTE was found less (3.84 %) at low load and increased at rated output of tested engine (28%). Further increase in load caused slightly increased in power but total fuel consumption is comparatively higher and due to this the BTE was found to be reduced (32.88%).

CONCLUSION

The maximum rated power of engine A and engine B was found to be 3.1 kW and 5.8 kW against the declared value of 3.72 kW and 7.4 kW respectively which may be due to poor governing, thermal and mechanical losses.

The rated brake thermal efficiency of engine A and engine B was found to be 22.13% and 28.34%. The brake thermal efficiency of engine A and B was considerably low due to higher fuel consumption and loss of input energy in various systems.

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 bearing due to foreign particles, defective bearing seals, valve leakage, blow-by losses due to wear in piston rings and low injection pressure. Thus based on the research has validated and assumption and the research has also re-enforced the importance of service and its faulty maintenance practice in automobiles as well as the replacement of the engine for getting maximum out put with lower operating and maintenance cost.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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Table I Specification of selected engine

S.N0	Particular specification	Engine ‘A’	Engine ‘B’
1	Engine type	Air cooled	Water cooled
2	Number of cylinder	1	1
3	Maximum power, KW	3.72	7.45
4	Engine speed, RPM	1500	1500
5	Bore, mm	87.5	102
6	Stroke, mm	80	116
7	Compression ratio	16.7:1	17.5:1
8	Specific Fuel consumption, g/bhp-hr (SFC)	169	190
9	Lub. Oil sump capacity (at higher level on dipstick), L	3.7	3.7
10	Governing	Class “B1”	Class “A2/B1”
11	Over loading capacity of engine	10%	10%
12	Crank shaft center height, mm	203	203
13	Torque at full load (crank shaft drive), kg-m	2.387	4.775
14	Cubic capacity, L	0.553	0.948

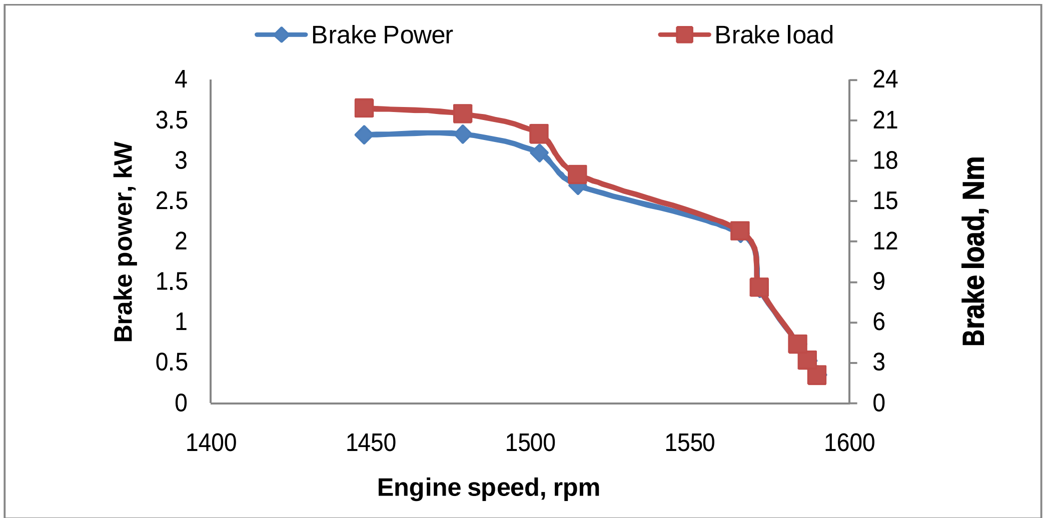

Fig. 1. Break Power kW and Break Load Nm with respect to Engine Speed rpm (For Engine A)

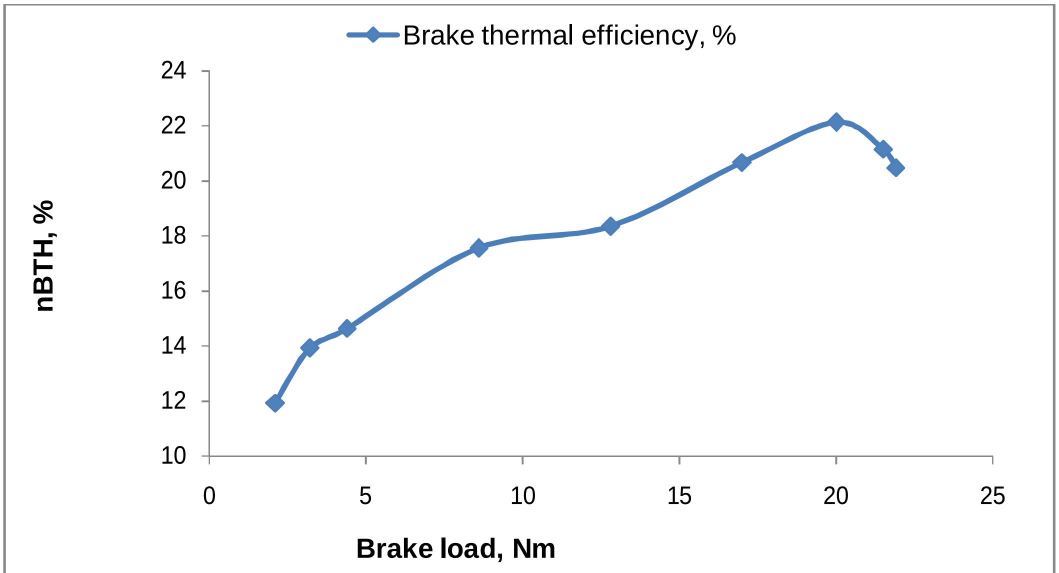

Fig. 2 Break thermal efficiency, % Vs Brake Load, Nm (For Engine A)

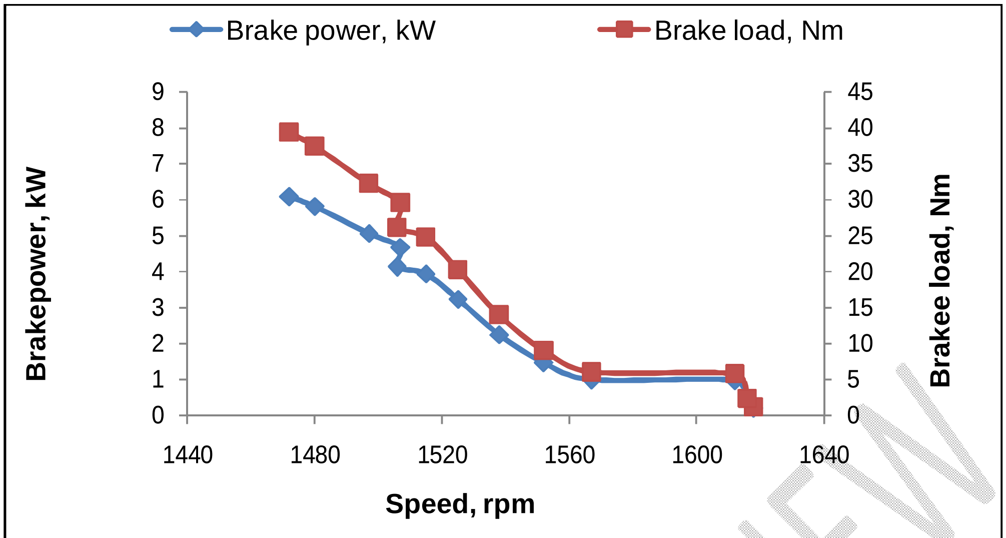

Fig. 3 Break power kW and Break load Nm with respect to engine speed rpm (For Engine B)

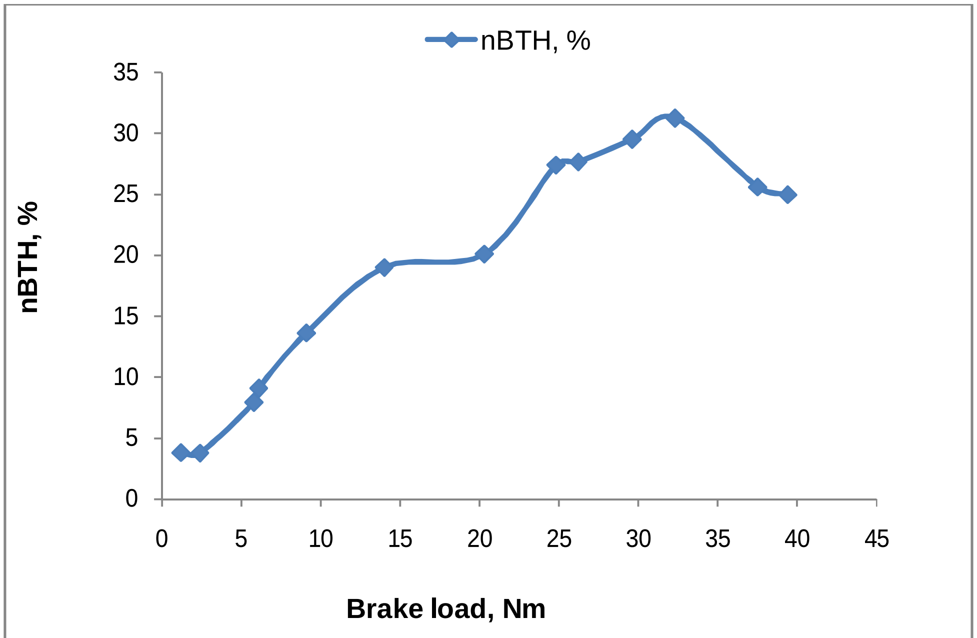

Fig. 4 Break thermal efficiency, % Vs brake load, Nm (For Engine B)

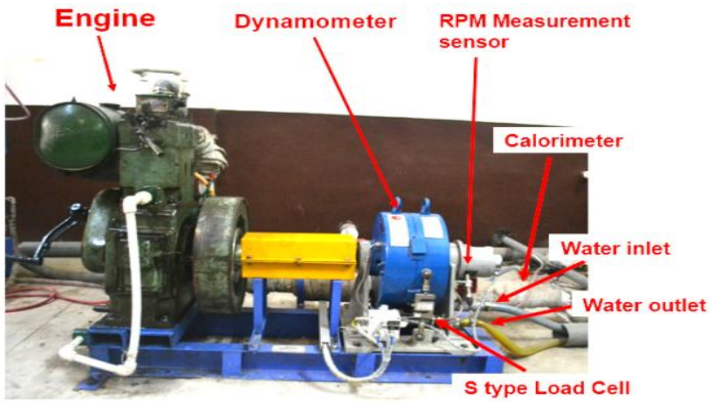

Plate 1. Engine with Eddy Current Dynamometer

Plate 2. Control Panel