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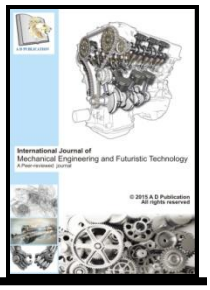

Development of performance test-rig of four stroke single cylinder Diesel Engine

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A B S T R A C T : In the era of today diesel engine become more popular and widely used in automobile industries, power generation and agriculture irrigation. Due to high compression ratio it give better performance than petrol engine. But performance of engine varies with load on engine. It is necessary to find the operating range of diesel engine where its performance is good. This experiment represents the effect of varying load on performance of engine. This experiment carried out on single cylinder 4-stroke diesel engine of compression ratio 15.5:1. Performance parameter like BTE, BP, BSFC and Exhaust temperature are evaluated on different percentage of load which are 2%, 6%, 10%, 14%, 20%, 40%, 60% and 80%. It is observed that maximum BTE is 21.60% at 80% load on engine. Also BP is increase 0.11kW to 3.33kW from 2% to 80% load. Specific fuel consumption of engine decrease and exhaust temperature is increase as load increase on engine.

Keywords: Diesel engine, Load, Engine Performance

1. Introduction

Principle of modern diesel engine comes from the result of internal combustion engine proposed by Sadi Carnot in 19th century. Dr Rudolf Diesel applied Sadi Carnot principle in cycle in which heat generated during compression of air cause ignition of mixture. Then it expand at constant pressure and give full power stroke of engine. His first engine work on coal dust and compression pressure of 1500 psi but it does not have any type of cooling system. Diesel engine is one type of heat engine that use internal combustion process to convert the chemical energy of fuel into useful mechanical energy. This occurs in two steps. First fuel reacts and release energy in form of heat. Second heat cause gas expansion and move the piston. The reciprocation motion of piston is then converted into rotation motion by the crankshaft. To convert the chemical energy of fuel into mechanical energy, all I.C. engine go through four events: intake, compression, power and exhaust.

The diesel engine is the most efficient power plant among all known types of internal combustion engines. Passenger cars, heavy trucks, urban buses, and industrial equipment are powered almost exclusively by diesel engines all over the world. For the foreseeable future, the world's transportation needs will continue to rely on the diesel engine and its gasoline counterpart. The performance of diesel engine varies with operating condition and it is important to identified suitable operation condition for efficient engine operation. There are various parameter effect on the performance of diesel engine needs to calculate and investigate during operation of the engine. Various researchers identify parameter and calculate through experimental procedure for various size of the diesel engine. R. Ravichandran et al.[1] carried out experiment on Kirloskar TV1 engine of 5.1 KW and observed that maximum brake thermal efficiency is 30.29% for diesel at 80% load on engine. The minimum fuel consumption and maximum exhaust temperature observed at full load condition. Ankit Jani et al.[2] carried

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experiment on single cylinder four stroke diesel engine of 3.7 KW with compression ratio of 16:, observed that brake thermal efficiency is maximum 36.72% at 11kg load on engine. Also specific fuel consumption decrease 1.31kg/kWh to 0.23 kg/kWh from no load condition to full load. Brake power increase from 0.2kW to 2.32kW. Mir Mohsin John [3] observed that efficiency of diesel engine is higher at higher load condition with 2.5 KW diesel engine. It is also they observed that fuel consumption increase 0.00023kg/s to 0.00031kg/s from no load to full load condition. Since literature states optimum operating condition varies with the size of the engine. It has to be decide to develop own single cylinder four stroke diesel engine test rig to evaluate performance parameter such as Brake thermal efficiency, exhaust temperature and specific fuel consumption.

2. Development of experimental set up

Experimental set up consist three main system integrated (1) a single cylinder four stroke diesel engine, (2) an engine loading system and (3) various measuring instrument.

A single cylinder four stroke diesel engine of 95mm bore and 115mm stroke is used for conducting this test. Engine is coupled with electrical generator of 5kW. Engine output is measured by using ammeter and voltmeter. The thermocouple is used to measure the exhaust temperature. Engine is also loaded by variable resistance load panel. Burette is mounted on the fuel tank which uses to measure the fuel consumption. Specification of the engine which is used in study is listed below:

Table 1 Engine specification

Model	Swaraj PV-4
Type	4- Stroke water cooled
Fuel	Diesel
Cylinder	1
Displacement volume	780cm^3
Bore	95mm
Stroke	110mm
Compression ratio	15.5:1
Rated output	5.9kW

(a) Single cylinder four stroke diesel engine

(b) Engine loading system

Figure 1 Engine setup with load system

Figure 2 Measurement panel & fuel consumption measurement burette

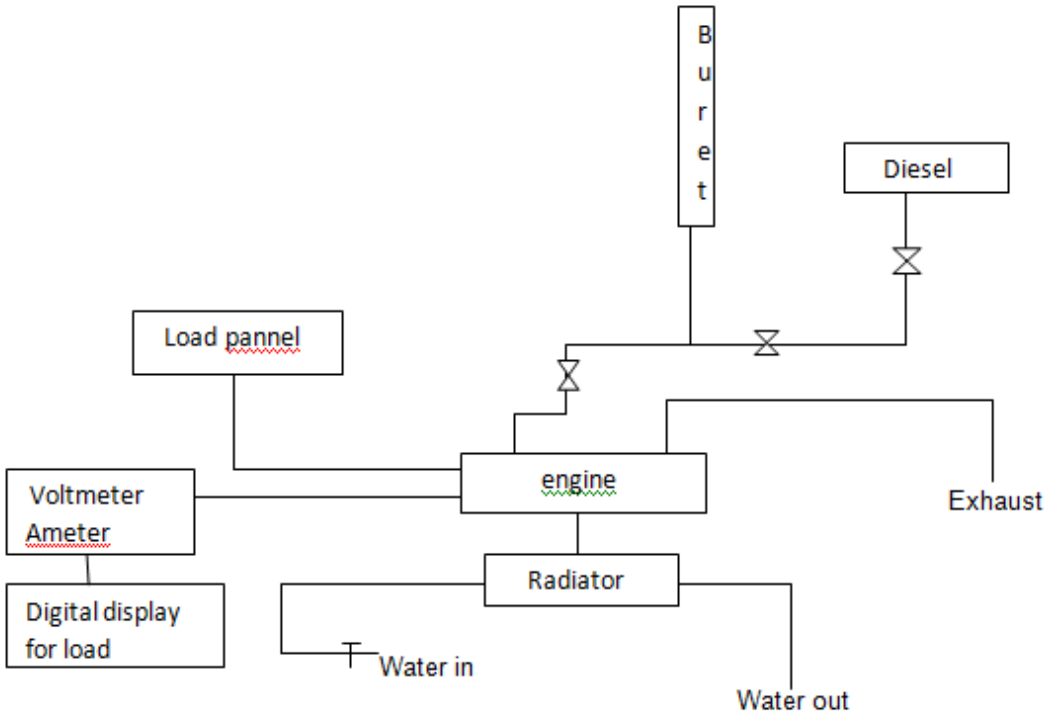

Figure 3 Line diagram of diesel engine experimental test setup

Experiment carried out on the four stroke water cooled diesel engine. Observation is taken at time when exhaust temperature remain steady. Starting from no load condition, observation is taken for nine different loads. Various performance parameters to be measured at each load.

Measuring data are as below

1) Time taken for 20ml fuel consumption,
2) Exhaust gas temperature,
3) Load on engine,
4) Current and voltage.

Using measured data various performance parameter like brake power, brake thermal efficiency and brake specific fuel consumption are to be calculated at different load.

3. Result and Discussion

In this experiment four parameter are calculated i.e. brake power, brake thermal efficiency, brake specific fuel consumption & exhaust gas temperature, are the most important parameter for evaluation of performance of any diesel engine. More over exhaust temperature is indication of emission. In this study this four parameter are compare at different load condition.

(1) BP vs LOAD

Brake power is power output of the drive shaft of engine without power loss cause by the gear, friction etc. As shown in graph brake power is increase as load on the engine is increase. However increment on brake power is almost linear with load. There is rapid increase in brake power from 20% to 60 % load condition. It is show that brake power is maximum 3.3kW at 80% load condition.

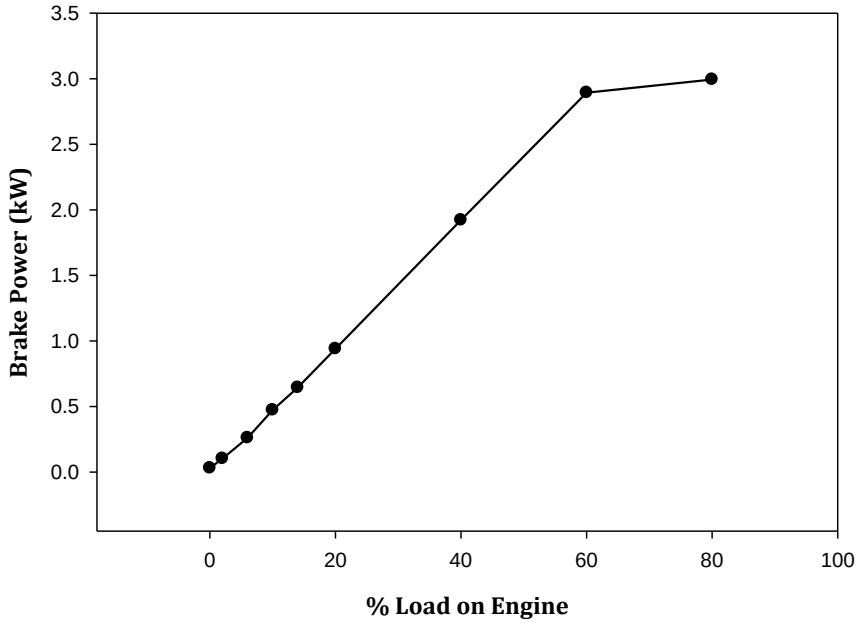

Figure 4 Brake Power vs % Load

(2) BTE vs LOAD

From energy conversion point of view this is the most important parameter which indicate capacity of engine to convert heat energy to work energy. It is the ratio of power developed by the engine and energy release per unit time due to complete combustion of fuel. Brake thermal efficiency is depend on properties of fuel like CV, viscosity, density etc. As shown in figure 5 it is observed that brake thermal efficiency is increase as load on engine is increase. Maximum thermal efficiency of engine is 21.6% and it is at 80% load.

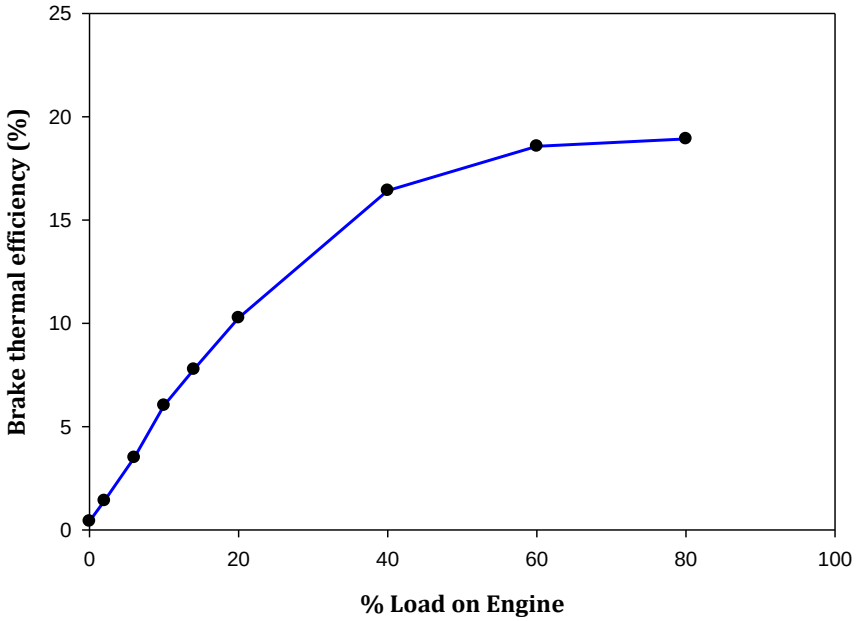

Figure 5 Brake thermal efficiency vs % Load

(3) BSFC vs LOAD

Brake specific fuel consumption is most important parameter to describe the performance of the engine. It is define as fuel consumption rate to produce unit power. Variation of bsfc with load is shown as below. As load increase specific fuel consumption is decrease.it happen because at higher load fuel get atomized better and rich mixture of fuel is occurs.

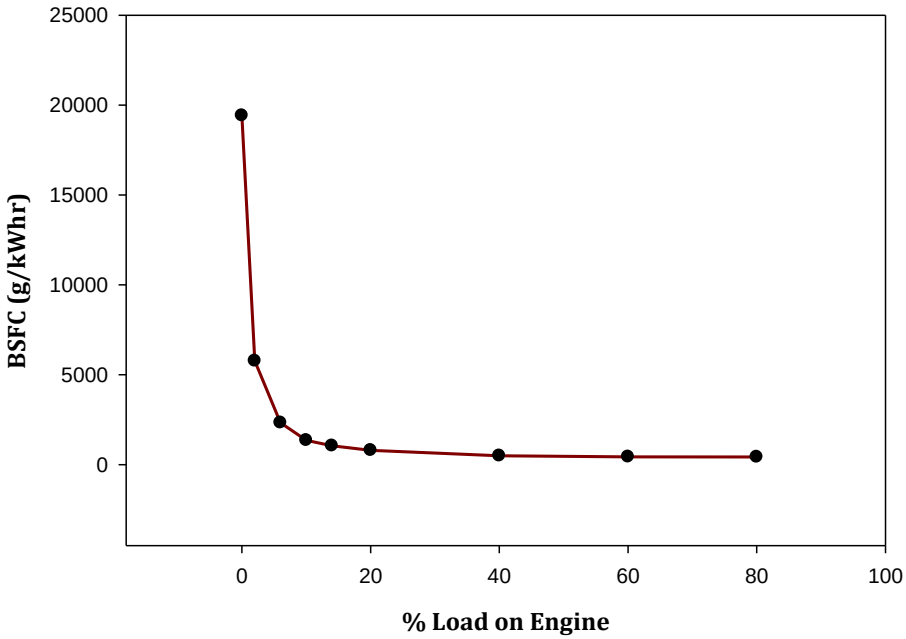

Figure 6 BSFC vs % Load

(4) TEMP vs LOAD

Exhaust temperature is an indicator of heat release rate of fuel during combustion period and its utilization to produce power. It is depended on nature of combustion and heat loss of exhaust. As shown in fig xx the exhaust temperature is increase as load on engine increase. This is because of poor combustion of fuel at higher load.

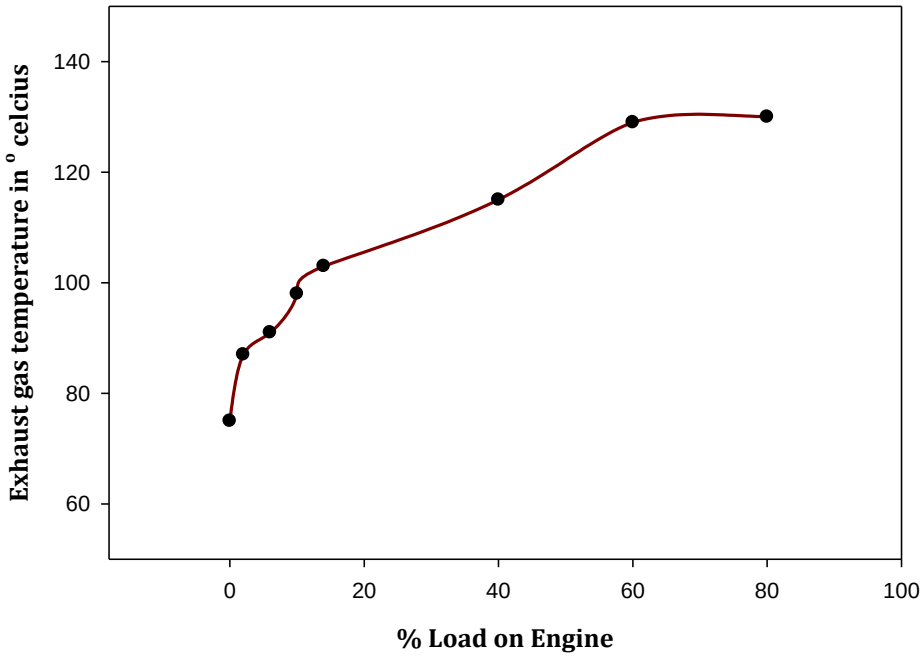

Figure 7 Exhaust gas temperature vs % Load

Conclusion

The study concludes the various range of the load at which engine give best performance. It is observed that at higher load (80%) brake power is maximum, brake thermal efficiency is maximum and brake specific fuel consumption is minimum. The maximum thermal efficiency is 21.6%. so it conclude that at full load condition performance of engine is better than lesser load.

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