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EXPERIMENTAL INVESTIGATION ON PERFORMANCE CHARACTERISTICS OF FOUR STROKE SINGLE CYLINDER PETROL ENGINE USING A PRE-HEATING SET-UP AND FUEL BLENDS

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ABSTRACT

The purpose of the project is to get the performance characteristics of a four stroke spark ignition engine when the inlet air is preheated. The set-up is prepared according to the requirements of the engine. The humidity in the atmospheric air affects the petrol vaporization in the carburetor. Therefore, by preheating the inlet to the carburetor, vaporization can be easy and in turn complete combustion can be achieved. Moreover, by reducing the water vapor to the engine, the steam formation in the engine will be reduced. This prevents the pitting of the engine, piston and exhaust pipe. Here engine operates with petrol-methanol blends of 4 different proportions and pure methanol (100%) as well petrol-ethanol blends of 4 different proportions and pure ethanol (100%) in the experiment without preheating & with preheating conditions. Thus the performance characteristics of the normal engine chosen is compared with that of the developed engine with a preheater setup. The results are thus tabulated and analyzed accordingly.

Key words: Petrol engine, Methanol, Ethanol, Thermal efficiency, Copper pipes.

INTRODUCTION

Generally, gasoline engines are also known as spark-ignition (S.I) engines. Petrol engine takes in a flammable mixture of air and petrol which is ignited by a timed spark when the charge is compressed. The first four stroke spark-ignition engine was built in 1876 by Nicolas August Otto. The work of spark-ignition may be either two-stroke or four-stroke. A four-stroke spark-ignition is an Otto cycle .it consist of following four stroke such as suction or intake stroke, compression stroke, expansion or power stroke, exhaust stroke. Each stroke consists of 180-degree rotation of crank shaft rotation and hence a four stroke cycle is completed through 720 degree of crank rotation. Thus for one complete cycle there is only

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one power stroke while the crankshaft turns by two revolutions. Krishna Perumal et al.[1] studied air-fuel mixture heating using the heat from the exhaust gases so as to reduce the hydrocarbons produced from a spark ignition engine. The new system is attached to a bike and the mileage is tested. A heat exchanger was designed to pre heat the air intake by using the exhaust gases coming out of the exhaust manifold. The main aim is to increase the efficiency of the spark ignition engine[2]. Kumar and Moovandhan[3] reported a two stroke spark ignition engine was used to carry out the experimentation of preheating. Here the fuel efficiency is tested for the normal engine and the modified engine. The pre heater was particularly designed so that it is simple and cheap and does not trouble the engine. The electrolysis process is carried out to use hydrogen as fuel for the S.I engine. Also the inlet air is preheated so as to obtain elevated efficiencies. A heating coil is used for preheating[4]. Azpiazu et al.[5] tested the emissions by pre heating the inlet air of an S.I engine. The pre heating helps the engine to have a cold start in case of cold conditions. A dual fuel engine or diesel-natural gas engine is considered. The concept of exhaust gas heat recovery at part loads is considered and experimented for the effects so obtained[6]. Wang et al.[7] considered a diesel engine which is run on fuel of methanol fumigated diesel and performance test is carried out and compared with normal values. The concept of air pre heating is considered for the project work done. Engine performance and pollutant emissions from different blended fuels in types (ethanol, methanol and gasoline) and rates (3e10 vol.% methanol and/or ethanol in gasoline) have been investigated experimentally[7]. Siwale et al.[9] compared the effects of dual alcohols (n-butanol and methanol) with single alcohol (methanol) blended in gasoline fuel (GF) against performance, combustion and emission characteristics. Najafi et al.[10] used RSM (response surface methodology) to optimize the performance parameters and exhaust emissions of a SI (spark ignition) engine which operates with ethanol gasoline blends of 5%, 7.5%, 10%, 12.5% and 15% called E5, E7.5, E10, E12.5 and E15.S. Phuangwongtrakula et al.[11] experimentally determined the optimal blend rate of ethanol-gasoline fuels in order to maximize brake thermal efficiency of a commercial SI engine.in term of brake torque and brake specific fuel consumption with variation of volumetric mixing ratio between 87.5-octane gasoline and 99.5%-purity ethanol (E10, E20, E30, E40, E50, E60, E70, E85, and E100).

Engine specification

General review

Through the papers air preheating for a four stroke spark ignition engine has been found to be effective in enhancing the performance characteristics at different loads. Most of the journals throw light on different types of pre heating set-up. The concept of air pre heating proved to be advantageous. Several of the advantages include, helping the engine for a cold start, heating the atmospheric air will remove most of the vapor present in it which may lead to improper flame propagation. The fuel mixed with the heated air will burn completely in the combustion chamber thereby reducing the amount of unburnt particles. Different papers suggested this method to be important in case particularly for petrol engine. Several papers were discussed on this concept being used dual fuel engines.

Table 1: Pulsar 150cc engine specifications

Engine type	**4-Stroke DTS-I air cooled single cylinder**
Engine displacement (cc)	149.01CC
Power (PS@rpm)	15.06PS
Torque (Nm@rpm)	12.5Nm
Bore	57
Stroke	56.4
No of cylinders	1
Drive type	Chain Drive
Valves (per cylinder)	4

EXPERIMENTAL

The experimental setup had to be fabricated so as to obtain the performance parameters. The performance test is conducted on the four stroke spark ignition engine under normal condition and modified condition. The various individual parts required for the fabrication of the experimental set-up are as follows:

(i) Internal combustion (4-stroke spark ignition)

(ii) Air filter

(iii) Carburetor

(iv) Fuel tank

(v) Silencer

(vi) Angular rods

(vii) Brake drum

(viii) Transmission shaft

(ix) Chain and sprockets

(x) Bearings

(xi) Rope brake dynamometer

(xii) Different weights

(xiii) Copper pipes of different sizes

(xiv) Insulation material – ceramic glass wool

The description of these components is as shown below:

Fig. 1: Internal combustion engine

Fig. 1 internal combustion engine: The main component of the experimental set-up on which the performance test is done. We chose a pulsar 150cc engine. It is a four stroke spark ignition type engine.

Air filter: The atmospheric air is sucked in and filtered in the air filter and sent into the carburetor to be mixed with fuel. It is a plastic container with air filters fitted inside.

Carburetor: In the carburetor the air and fuel are mixed in proper proportion so that the mixture enters into the engine cylinder for combustion.

Fuel tank: The fuel tank used is of 5 liters' capacity. This provides fuel (petrol) into the carburetor via small tubes.

Silencer: The exhaust gases emitted after combustion inside the combustion chamber come out of the exhaust valve and through the silencer and into the atmosphere. The silencer reduces most of the noise produced during emission. Also the mufflers present inside the silencer filter out the harmful gases from the exhaust.

Angular bars: The angular bars made of cast iron were used to make the main frame for the engine set-up. Different sizes were available for this purpose. The main frame or the base frame should be strong enough to handle the vibrations produced when the engine is run. The frame was fabricated at the workshop using welding

Brake Drum: The brake drum is used as flywheel. It is rotated using chain drive from the engine. This is an important component of the experimental set-up. This is attached to the shaft. Loading is done by attaching a dynamometer to the brake drum.

Bearings: The bearings are used to hold the shaft firmly to the main frame. Also they help the shaft to rotate smoothly without any misplacement.

Rope brake Dynamometer: A rope brake dynamometer is used to provide loading to the engine. Different loads are given to obtain initial readings for further calculations.

Loads: Masses of 2, 4, 6, and 8 were loaded in the engine. Hence suitable weights are used.

Fig. 2: Copper tubes

Fig. 2 copper tubes: The pre heating set up consists of a copper tube through which air flows into the carburetor. The different sized copper pipes are used to transfer heat from the exhaust gases flowing through the silencer, to the air being fed into the carburetor.

Insulation material: The insulation material used is ceramic glass wool. The insulation is provided so that the heat of the copper tube should not damage the rubber boot and the components like air filter which is made of plastic. Also the high temperature may damage the material of the carburetor leading to under performance of the carburetor.

The general sketch of experimental set-up is as follows:

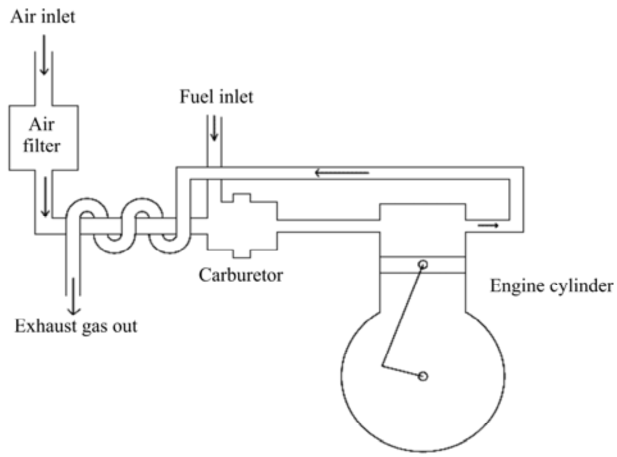


Fig. 3: Line diagram of experimental set-up

The fabricated set up of the engine is shown below:

Fig. 4: Set up of normal engine

Fig. 4 a four stroke spark ignition engine is mounted on the fabricated frame. The frame as shown above has a provision for a rope brake dynamometer to be fitted. The engine used in this case is a Pulsar 150cc engine. Performance test is conducted on the engine under normal condition and the observations are used to calculate the efficiencies in this case.

The above figure shows the modified engine set-up mounted on the main frame. As shown above we use a copper tube in between the carburetor and the air filter. Now another copper tube of smaller diameter is wound around this tube. The other end is connecting to the silencer frame so that the heat of the exhaust gases is transferred to the copper tube. We use copper as it has high thermal conductivity. Hence using copper reduces the time of initial heating, before which the experiment is conducted.

Fig. 5: Modified engine experimental set up

Methanol & ethanol blends with petrol

We are using two different blended fuels. Methanol-petrol and ethanol-petrol blends. The methanol-petrol blend was first prepared at five different concentrations 20:80, 40:60, 60:40, 80:20 and pure methanol 100% and Ethanol-petrol blend also prepared in the same concentrations. These two blends are used in the normal engine and also used in modified engine then we compare the both results with initial petrol results.

Comparison graphs

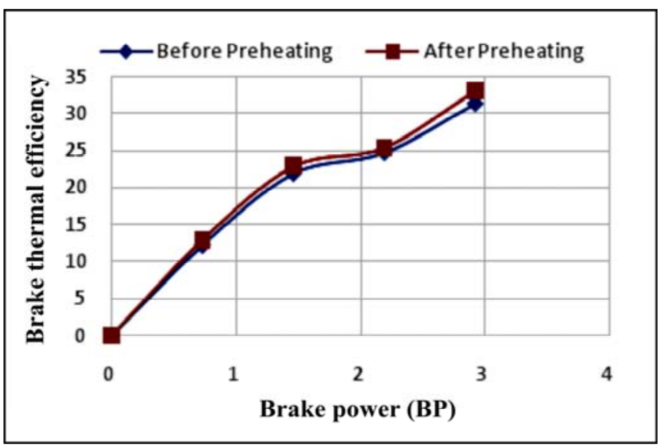


Fig. 6: Comparison of petrol

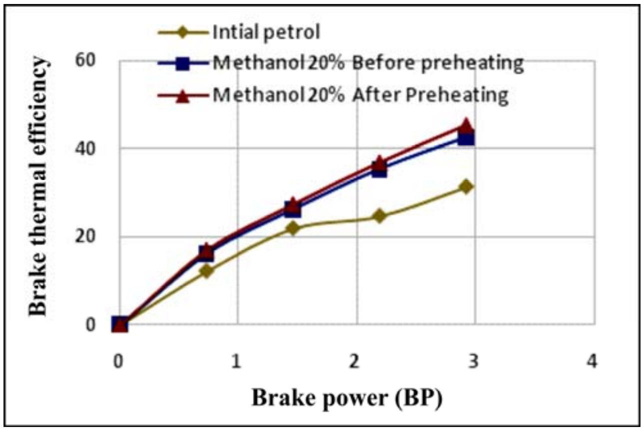
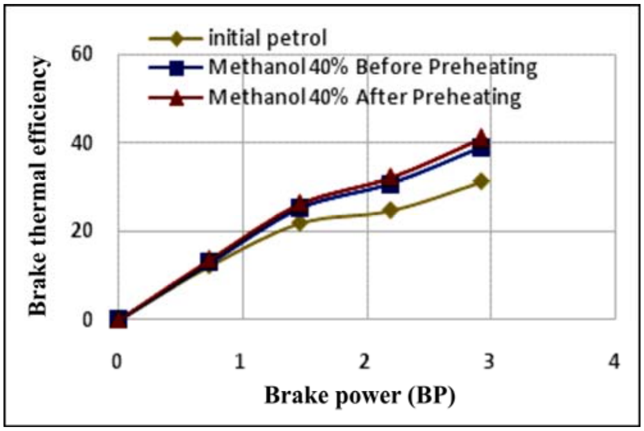


Fig. 7: Comparison of 20% methanol blend



Graph 4.3 comparison of 40% methanol blend

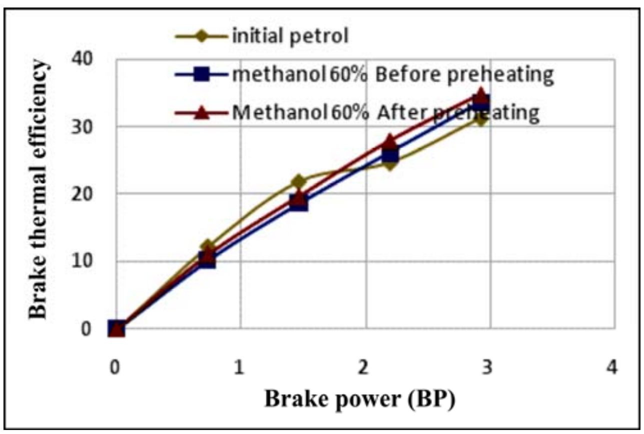


Fig. 9: Comparison of 60% methanol blend

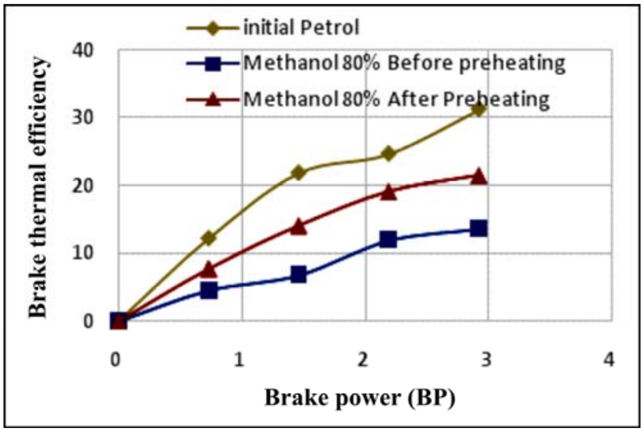


Fig. 10: Comparison of 80% methanol blend

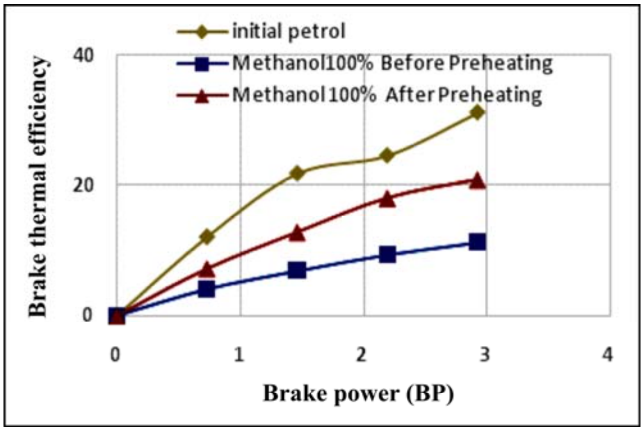


Fig. 11: Comparison of 100% methanol

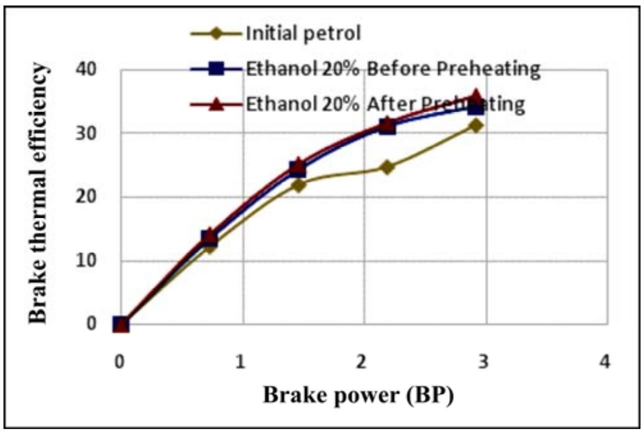


Fig. 12: Comparison of 20% ethanol blend

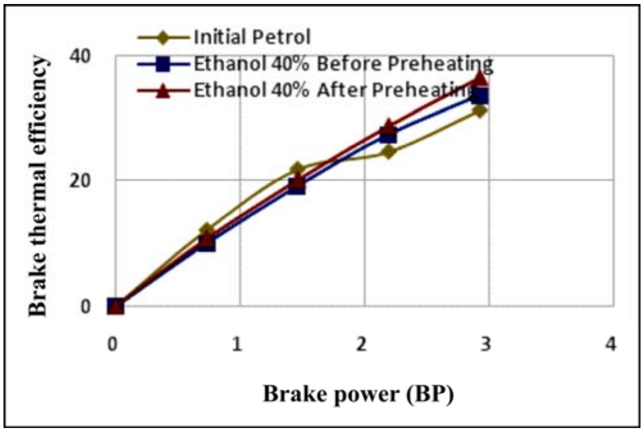


Fig. 13: Comparison of 40% ethanol blend

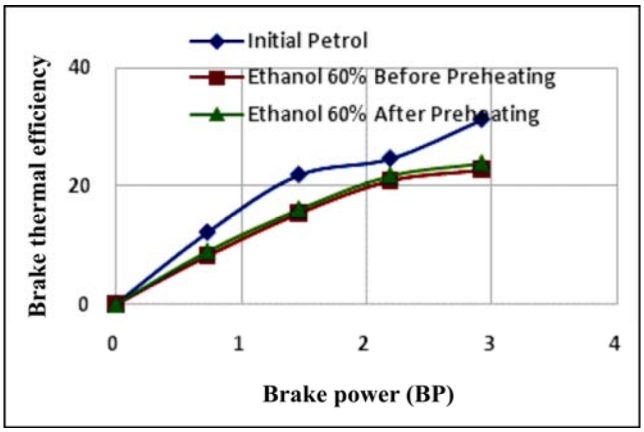


Fig. 14: Comparison of 60% ethanol blend

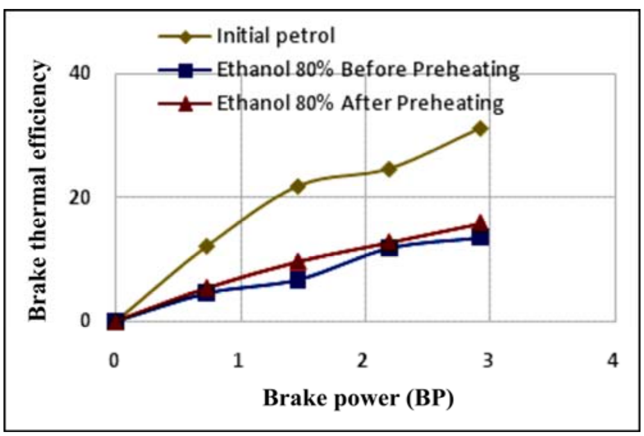


Fig. 15: Comparison of 80% ethanol blend

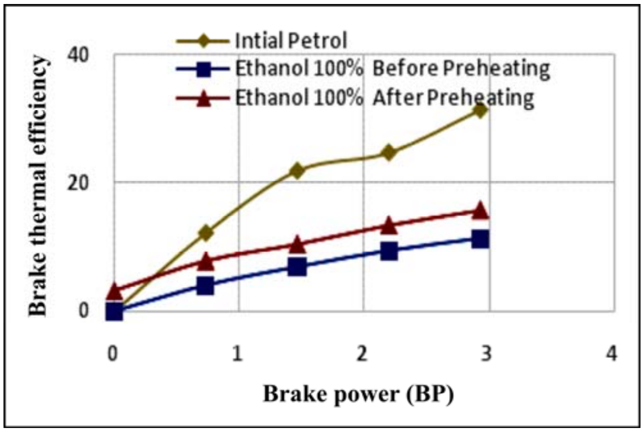


Fig. 16: Comparison of 100% ethanol

The above graphs show the performance comparison between different blends of ethanol & methanol with petrol. The propositions are 20%, 40%, 60%, 80%, and 100% of methanol & ethanol. By all these performance graph's 20% of methanol with petrol (before preheating & after preheating) have given better results than that of the petrol and other blended propositions.

CONCLUSION

(i) On experimentation with normal mode engine, the results show the performance characteristics BSFC is 0.23956 and brake thermal efficiency is 31.3%. And the modified engine get BSFC is 0.2272 brake thermal efficiency is 33%. By using pre heating 5.4% improvement in BSFC is observed.

(ii) The BSFC of a normal engine for methanol 20% blend's is 0.1949 and brake thermal efficiency is 42.6%,40% methanol blend 0.2424 and 39.07%, 60% methanol blend gets 0.3237 and 33.6%, 80% methanol blend gets 0.6375 and 20.16%, and 100% pure methanol gets 0.8853 and 17.67%.

(iii) The methanol blends for modified engine gets BSFC and brake thermal efficiency was 20% methanol bends 0.1844, 45.3%, 40% methanol blend gets 0.23024, 41.12%, 60% methanol blend 0.31295, 34.8%, 80% methanol blend gets 0.5977, 21.51%, and 100% pure methanol gets 0.7491, 20.89%.

(iv) The BSFC of a normal engine for ethanol 20% blend's is 0.2376 and brake thermal efficiency is 34.16%,40% ethanol blend 0.2626 and 33.68%, 60% ethanol blend gets 0.4254 and 22.85%, 80% ethanol blend gets 0.7936 and 13.59%, and 100% pure ethanol gets 1.070 and 11.26%.

(v) The ethanol blends for modified engine gets BSFC and brake thermal efficiency was 20% ethanol bends 0.2257, 35.96, 40% ethanol blend gets 0.2419, 36.5%, 60% ethanol blend 0.4069, 23.89%, 80% ethanol blend gets 0.6802, 15.86%, and 100% pure ethanol gets 0.8808, 13.76%.

(vi) In modified engine BSFC results are decreased when comparing with normal engine performances. As well as the break thermal efficiency was increased in modified engine when compared with normal engine.

(vii) Finally, when compared to all these experiments 20% of methanol blend gives best results.

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