INVESTIGATION OF EMISSION CHARACTERISTICS OF SI ENGINE GENSET FUELLED WITH PETROL-KEROSENE BLENDS

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ABSTRACT

Due to the continuous consumption of energy resources, the price of conventional fossil fuel is increasing too fast and lead to additional burden on the economy of the importing nations. The scarcity and depletion of conventional petrol sources are cause of great concern worldwide and has promoted research into alternate energy sources for IC engine. Spark Ignition Engine is widely used prime mover due to its smooth operation & low maintenance. The Blending of alternative fuel with the conventional fuel may be the solution of scarcity of conventional fuel for the spark ignition engine.

The present work is mainly concerned with an experimental investigation to study the petrol engine performance, combustion, noise and emission characteristics using blends of petrol & kerosene. The performance characteristics for different blends are evolved in running the engine under steady state conditions.

It is observed that 80% Petrol and 20% Kerosene provides the lesser NOX and emission of HC compared to other blends. 20% and 40% petrol give higher value of CO at lower load but as the load increases, the concentration of CO by volume decreases, and the 20% kerosene can be preferred at higher load as it will give less CO emission. With the overall results of engine performance and emission characteristics the optimum percentage of blend of petrol and kerosene is found out to be 80:20 (80% petrol and 20% kerosene).

Keyword: Petrol, Kerosene, Emissions, Engine Genset, Blends

INTRODUCTION

Due to the present energy crisis there arises a need to develop a clean energy system which can solve the purpose of emission reduction and performance enhancement. Several fuel systems like
blends of alcohol with diesel, hydrogen with LPG, CNG and blends of kerosene and petrol have turned out to be the best alternative to be considered for SI and CI engines without major design change. Recent explorations and experimental investigations have opened the wide area of fuel system for these engines. This work is mainly concerned with the evaluation of the emission characteristics of petrol engine fueled with blend of petrol & kerosene.

**METHODOLOGY**

All research work is described in a very brief manner in the form of thesis methodology. All relevant information were analyzed to construct a precise summary of background information which included the history of petrol and kerosene, advantages and limitations of it, physical and chemical properties of petrol and kerosene and their emissions. At the same time, comparison between petrol and kerosene were also noted. The emissions from the tailpipe of the engine such nitrogen oxide (NO\textsubscript{x}), unburnt hydrocarbon (HC), carbon dioxide (CO\textsubscript{2}) and carbon monoxide (CO) were also being explained.

Department to collect emission data from the exhaust engine and simultaneously engine performance was also be recorded. The experiments were conducted using different loads to collect the emission data. All the data were analyzed to make comparisons between petrol and kerosene and their respective blends. A conclusion was made after analyzing the data collected from the experiments.

**EXPERIMENTAL SETUP & PROCEDURE**

The main objective of the experiment is to investigate the effects of replacing individual petrol and kerosene with their optimum mixture of blends and to prove the reduction of nitrogen oxides, carbon dioxide, carbon monoxide, hydrocarbons in a spark ignition engine. The experimental setup consisting of Honda Portable Genset Model E1000K was attached with Di-gas analyzer, load bank and air measurement box devices. Modifications in the engine fuel supply system were done to use the blends of kerosene and petrol.

An electrical power load circuit was attached to the test engine to allow variation of the engine power using the bulb switches. Combinations of different values of engine load were used in the experiment to evaluate the performance, pollutant emissions of the engine to compare between petrol and kerosene fuels and their blends.

**Engine Specifications**

<table>
<thead>
<tr>
<th>Table 1.1 Specifications of Honda Genset.</th>
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</thead>
<tbody>
<tr>
<td>Ignition system</td>
</tr>
<tr>
<td>Starting system</td>
</tr>
<tr>
<td>Fuel tank capacity (L) (Kerosene Rum)</td>
</tr>
<tr>
<td>Fuel tank capacity (L) (Petrol Rum)</td>
</tr>
<tr>
<td>Continuing Running Hrs</td>
</tr>
<tr>
<td>Frequency (Hz)</td>
</tr>
<tr>
<td>Rated Output (VA)</td>
</tr>
<tr>
<td>Maximum Output (VA)</td>
</tr>
<tr>
<td>Dry Weight (Kg)</td>
</tr>
<tr>
<td>L X W X H (mm)</td>
</tr>
</tbody>
</table>
Control Panel and Load Bank

Control panel consists of voltmeter (V), ammeter (A), a digital energy meter. Four electrical bulbs act as bank and are controlled by switches which are arranged in rows and columns. Two bulbs consume 100W and another two bulbs consume 200W of power and are controlled by a switch. An electrical power load circuit is attached to the engine control panel to provide the engine with output loads used to power the electric bulbs. In this experiment, the output loads were set to be W, 100W, 200W, 300W, 400W, 500W, and 600W.

AVL Gas Analyzer

The AVL Digas 4000 light is 4/5- gas measuring instrument is used to measure the emissions such as CO, CO₂, HC, NOₓ coming out from the engine during its performance. It meets the requirements for smoke measurement equipment emission of auto ignition combustion engine being tested for approval as stipulated by ministry of Road Transport.

EXPERIMENT PROCEDURES

The analysis was first performed on the petrol fuel system. The engine was up for around five minutes to reach a steady condition using the original petrol fuel from the fuel tank of the engine. As the engine was ready to run, the throttle of the engine was adjusted to be in a fully open position to allow more petrol fuel be supplied into the test engine, thus ensuring the maximum speed. The engine running at maximum speed had been selected as the reference point to compare the performance between petrol and kerosene. In this experiment, the loads were fixed at 0W, 100 W, 200 W, 300 W, 400 W, 500 W, and 600 W for SI engine as the main application of SI engine are for small personal use and usually loads for 200 W to 400 W are connected to them. Figure 1.1 shows the schematic diagram of experimental set up. All the data collected which included the engine speed, body temperature, exhaust temperature, voltage, current and concentration of emissions were recorded when steady-state is reached for each set of load values. Next loads were applied to the system by operating the electric bulbs.

![Experimental set up.](image)

With the help of gas analyzer we get the values of nitrogen oxides, carbon dioxide, carbon monoxide, hydrocarbons, oxygen for kerosene, petrol and their blends at different set of kerosene, petrol and their blends at different set of loads were recorded. After that, the test was performed on the kerosene fuel system. Before kerosene was allowed to flow into the combustion chamber, the
remaining petrol in the carburetor had to be drained. Then, different sets of load were added to the system to evaluate the engine performance. Again, the data were recorded at steady state for each set of load values. All the collected data are then analyzed for comparative performance between petrol and kerosene fuel system.

![Figure 1.2 Line diagram of experimental setup](image)

Then the same procedure was followed with the blends of kerosene and petrol with values of blend engine from 20% petrol and 80% kerosene, 40% petrol and 60% kerosene, 60% petrol and 40% kerosene, 80% petrol and 20% kerosene. Then, different sets of load were added to the system to evaluate the engine performance. Again, the data were recorded at steady state for each set of load values. Figure 1.2 shows the line diagram of experiment setup used in the experiment.

**RESULT & DISCUSSION**

Experiments were conducted on air cooled, single cylinder, spark ignition engine (meant for small generators) using petrol and kerosene as fuels. Different blends of petrol and kerosene were tested. Major parameters like engine performance (brake specific fuel consumption (bsfc), indicated work and efficiency) and emissions (NO_x, CO_2, CO, and HC) were determined and compared for both the fuels at normal load maximum load. The following graphs were obtained from the data recorded.
Figure 1.3 Emission of NO\(_X\) at variable load

Figure 1.4 Emission of HC at variable load
SUMMARY

With the results of engine performance and emission characteristics the optimum percentage of blend of petrol and kerosene is found out to be 80-20 (80% petrol and 20% kerosene). The properties of this optimum blend are shown in the table 1.2 The following properties of optimum blend are similar to petrol and hence the use of this blend in place of petrol in portable genset is justified.
Table 1.2 Properties of optimum blend of petrol and kerosene (80 : 20).

<table>
<thead>
<tr>
<th>Properties</th>
<th>Results</th>
<th>Method Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density at 15°C kg/m³</td>
<td>754.7</td>
<td>P:16 (Density by hydrometer)</td>
</tr>
<tr>
<td>Total sulphur content % mass</td>
<td>0.0407%</td>
<td>IP: 336 (Sulphur by EDXRF)</td>
</tr>
<tr>
<td>Boiling range</td>
<td>43°C-242°C</td>
<td>P:18 (Distillation of petroleum fractions)</td>
</tr>
<tr>
<td>Calorific value</td>
<td>10460 cal/g</td>
<td>P:7 (determination of calorific value by calculation)</td>
</tr>
</tbody>
</table>

(source: Jalandhar Terminal Laboratory, IOCL Jalandhar)

RESULT

- Blend of 80% petrol and 20% kerosene fuel is fully capable of reducing the harmful emissions gases such as nitrogen oxides because NOx emissions of the blend is same as that of petrol and lesser than other blends of kerosene.
- Blend of 80% petrol and 20% kerosene fuel show average reduction in carbon dioxide (CO₂) and carbon monoxide (CO). Emission of CO₂ and CO is less as compare other and is not significantly that of petrol. Same trend is seen in HC also.

CONCLUSIONS

The objective of this research work was to find the optimum blend of kerosene-gasoline fuel mixture to have least emission. Blending kerosene with gasoline in SI engines is more practical than using kerosene alone. However, before using these blends engines, the performance and emission characteristics must be evaluated. An experimental study has been carried out to evaluate performance and exhaust emissions for various concentration of kerosene addition to gasoline in the engine.

Experimental results indicated that using optimum kerosene-gasoline blend, the output torque of the engine increased slightly, the CO and HC emissions decreased dramatically as a result of the leaning effect caused by the kerosene addition, and the CO₂ emission increased because of the improved combustion. CO and HC emissions were reduced approximately by 80% and 50%, respectively, while the CO₂ emission increased 20% depending on the engine conditions. It is further observed that low fraction kerosene/ gasoline blends can be used in SI engines without any modification. Kerosene gasoline blended fuel may lower HC and CO emissions. The most interesting thing is that kerosene addition to gasoline improves the SI engine cold start and lower CO and HC emissions significantly.

REFERENCES


