The reduction of gas emissions from the use of bioethanol

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Abstract: This work deals with the examination of farm Tractor with Diesel engine from the viewpoint of power and gas emissions, using as fuel Diesel-ethanol mixtures. A series of laboratory instruments was used for the realization of the experiments. The tractor engine is functioning under full load conditions.

Key-Words: Gas emissions, Bioethanol, Biofuels

1. INTRODUCTION

Tractors must burn fuel to produce power. Petroleum became the accepted source of engine fuel. Early spark-ignited tractor engines used kerosene and a low-volatility, low-octane, petroleum distillate fuel called tractor fuel. Tractors could not be operated on these low-grade fuels until the engine had been started and warmed on gasoline. The low-grade fuels gave way to gasoline, and, for a time, liquid petroleum gas (LPG) also was popular fuel for tractors. In recent years, the use of diesel engines has displaced all of these fuels for farm tractors[1].

All of the petroleum-based fuels are fossil fuels that have been stored in the earth for many centuries. They are nonrenewable and will be depleted at some future date. Production of crude oil in United States is already declining, and it is expected that world petroleum reserves will be depleted in the twenty-first century. Other sources of fuel energy for engines are being sought.

Solar energy is the most inexhaustible energy source, and it may be used directly or may be stored for later use. Petroleum is an extreme example of stored solar energy. The energy was trapped by plants growing thousands of years ago, and, these plants were eventually transformed into petroleum. In direct use, solar energy is used as soon as it is collected[2]. Direct use of solar energy to supply power to a farm tractor is impractical for two reasons. The energy is not concentrated enough to supply a tractor with a reasonably sized collector, and it is unavailable at night or on cloudy days.

Coal, oil shale, and tar sands are fossil fuels that are available in much larger reserves than is petroleum. If these fossil fuels could be extracted from the earth and converted to petroleum-like liquids, the duration of the fossil-fuel era could be greatly extended. The extraction and conversion processes have been demonstrated on a pilot scale. The enormous capital costs of full-scale plants have delayed their construction in the United States, but South Africa produces large quantities of liquid fuel from coal.

Engines can be operated on liquid fuels produced from biomass. Alcohol fermented from farm crops has been used as a fuel for spark-ignition engines. Soybean, sunflower, and other vegetable oils have been used as fuel for diesel engines. Such fuels might become available in sufficient quantities to supply the fuel needs of farm tractors, but not enough would be available to fulfill the needs of transportation, manufacturing, and other industries.

The possible increases of the price of crude oil, the abrupt oil market changes, the finite of reserves, as well as the environmental pollution led to the reevaluation of the importance of the rural and forestall factor as a renewable resources supplier.

Important quantities of ethanol are produced every year to be used as fuel [3]. Bioethanol has a high octane number, which means it can be used as an fuel additive, or as a substitute either as pure alcohol or as mixture of gasoline-alcohol[4]. Alcohol is produced in laboratories in many ways. Practical interest occurs in producing ethanol from the
rich in sugar plants. “Alcoholic fragmentation” is the splitting of single sugars, type \( C_6H_{12}O_6 \), mainly glucose and fructose, to \( CO_2 \) which is catalysed by the zymasse enzyme. Raisins, molasses and starchy roots or fruits like potatoes, corn, barley and others are used for this purpose.

Nowadays mixtures of gasoline - alcohol are used in USA mainly as car fuel (gasohol), either to fight the energy crisis or to decrease environmental pollution, because of the limited \( CO_2 \), \( HC \) emissions. Compared to pure gasoline, the gasoline-alcohol mixtures produce smaller calorific value. This is why the use of these mixtures in petrol engines reduces the power of the engine\[2,5\]. The power decrease, in principle, increases in proportion to the alcohol percentage in gasoline. The question is how a diesel tractor engine behaves, from the viewpoint of pollution and power, when diesel-alcohol mixtures are used.

2. INSTRUMENTATION

The experimental measurements were carried out on a model John Deere tractor engine. This is a four cylinder engine with an approximate 60 CV output at 2300 rpm. During the tests measurements, the engine rpm, and exhaust gas composition were also monitored. For this purpose, the HP 3497A Data Acquisition Unit was used with a HP 44422A multiplexer. For the rpm measurements an ignition pulse detector was used. The data acquisition unit was interfaced with an PC in the HP-IB 82990A Command Library IEEE-488 interface card. This particular measuring system and software completed a scanning cycle per channel approximately every 0.1s. This measuring speed was considered adequate for the purpose of the experiment and the sampling capabilities of the chemical sensors. For the exhaust gas measurements a HORIBA MEXA-574GE infrared analyzer was used. This unit has the following ranges:

- \( CO : 0-10\% \) Volume
- \( CO_2 : 0-20\% \) Volume
- \( HC : 0-10000 \) ppm.

The unit has a \( \pm 2\% \) accuracy and \( \pm 2\% \) repeatability. The operating principle for the \( CO_2 \), \( CO \), \( HC \) measurements is Infrared Non Dispersive Spectrometry and the time response for the \( CO_2 \), \( CO \), \( HC \) measurements is less than 10s. For the \( O_2 \) measurement a galvanic type cell is used with a time response of less than 25s. These delays are not caused only by the actual sensors, but also by the time required for the exhaust gas to reach the sensing area via the connecting tubes and filters. The analyzer was calibrated using a gas mixture provided by HORIBA. \( HC \) exhaust gas concentration calibration was based on n-hexane (n-\( C_6H_{14} \) ). The unit was considered adequate for the steady state operation measurements required. The tests were carried out on various engine speeds at full load conditions with different fuel mixtures\[pure Diesel and Diesel - 10\% ethanol mixture in volume\]. The engine speeds were 1000rpm, 1700rpm, 1900rpm and 2300rpm, without any adjustment in the fraction air/exhaust gas during the use of diesel - 10\% ethanol mixture in volume. The instrumentation included hydraulic power brake. During all tests the engine had a cold start in a temperature of (15-20\(^{\circ}\)C).

3.EXPERIMENTAL RESULTS

Table 1 shows the average values of \( CO \) and \( HC \) emissions, in relation to revolutions and the ethanol percentage in the fuel:

<table>
<thead>
<tr>
<th>Rpm</th>
<th>( CO% )</th>
<th>( HC(\text{ppm}) )</th>
<th>( CO% )</th>
<th>( HC(\text{ppm}) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>2.5</td>
<td>155</td>
<td>1.9</td>
<td>135</td>
</tr>
<tr>
<td>1700</td>
<td>5.1</td>
<td>181</td>
<td>4.1</td>
<td>162</td>
</tr>
<tr>
<td>1900</td>
<td>5.8</td>
<td>194</td>
<td>4.9</td>
<td>181</td>
</tr>
<tr>
<td>2300</td>
<td>2.9</td>
<td>163</td>
<td>2.1</td>
<td>142</td>
</tr>
</tbody>
</table>

Table 1. Average \( CO \), \( HC \) under full load conditions

In the following figures 1, 2 the average values of \( CO \), \( HC \) in the exhaust gas under full load conditions.

Figure 1 shows the \( CO \) variation in relation to rounds and the fuel. The \( CO \) emission reduction when using mixture of Diesel-ethanol:
Figure 1. The average CO variation under full load conditions.

Figure 2. The average HC variation under full load conditions.

The variation of power between the two fuels is represented in the following table 2:
Table 2. The power variation

The results from the above table are shown in the figure 3:

Figure 3. The power variation

Is been observed in figure 3 a small reduction of power in case diesel-10%ethanol is used as fuel. But, the use of ethanol has as result the reduction of CO and HC emissions, as it is represented in figure 1 and 2.
4. CONCLUSIONS

The results of full load tests using Diesel and Diesel-ethanol mixtures in Diesel Tractor engine, indicate that the CO exhaust gas content tends to decrease in case ethanol is used as fuel. This is probably caused by the presence of oxygen in the ethanol that participates in the combustion process.

In the case of full load tests the combustion temperatures are sufficient for efficient combustion in all the cases of engine rpm. Therefore, the reduction of exhaust emissions with the ethanol content is natural.

The power decrease in case of ethanol is due to the small calorific value of ethanol.

References:


