The Potential Effects of Alternative Fuels on the Lubricating Condition of Compression-ignition Engines

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The Potential Effects of Alternative Fuels on the Lubricating Condition of Compression-ignition Engines

ABSTRACT

The dielectric constant and the moisture value of the lubricating oil measured from a IC engine running with different alternative fuels on line show a clear difference from the baseline diesel. This demonstrates that alternative fuels will have a noticeable impact on engine lubrication. Further studies should be carried out on clarifying the influences mechanisms and corresponding resolutions.

Table 1. Properties of the tested fuels

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Density (30°C) (g/cm³)</th>
<th>Viscosity (100°C) (m²/s)</th>
<th>Caloric value</th>
<th>Lower heating value (MJ/kg)</th>
<th>Anstrophic content (Volume fraction (%))</th>
<th>C₆% (wt)</th>
<th>H₂% (wt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methanol</td>
<td>0.80</td>
<td>0.76</td>
<td>0.81</td>
<td>79.7</td>
<td>0</td>
<td>37.5</td>
<td>84.3</td>
</tr>
<tr>
<td>FT fuel</td>
<td>0.80</td>
<td>0.76</td>
<td>0.81</td>
<td>44.2</td>
<td>0.1</td>
<td>12.5</td>
<td>55.2</td>
</tr>
<tr>
<td>Standard Diesel</td>
<td>0.80</td>
<td>0.76</td>
<td>0.81</td>
<td>43.0</td>
<td>34.7</td>
<td>85.5</td>
<td>13.9</td>
</tr>
</tbody>
</table>

A great deal of research works have been on finding new alternative fuels for CI engines. However, the impacts of long-term use of the alternative fuels on the reliability and service life of CI engines have not been fully understood. The dielectric constant and the moisture value of the lubricating oil can be used to gain a quantitative understanding of the corresponding relationship between the alternative fuel combustion and the change of lubricating oil condition. Comparing these measurements with that of a normal diesel allows a determination of an influence degree of the alternative fuels under investigation. The dielectric property and moisture content of the lubricating oil are significantly varied in the range of alternative fuels. The results show that these parameters will be used in future to monitor the condition of the engine running with alternative fuels.

The fuels used in the experimental investigation are standard diesel, FT (Pure Fischer-Tropsch diesel fuel), M20 (the methanol proportion in the methanol-diesel blended fuel is 20%), Emulsified diesel (The proportion of water is 15%). The main components of the emulsified diesel: 15% water + additive + catalyst + combustion additive + 80% conventional diesel.

Table 2. Engine operating conditions

<table>
<thead>
<tr>
<th>Engine speed (rpm)</th>
<th>Load (Nm)</th>
<th>Running time (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1200</td>
<td>10/50/100/150</td>
<td>7/3/3/3</td>
</tr>
<tr>
<td>2400</td>
<td>10/50/100/150</td>
<td>9/3/3/3</td>
</tr>
</tbody>
</table>

Fig. 1 Schematic of experimental setup utilising a 4100QGDDL 74kW engine for alternative fuels combustion test.

CONCLUSION

- The dielectric property of lubricants is not change significantly along with the operating conditions.
- The rising rates of the lubricating oil condition of emulsified diesel and methanol are greater than that of diesel.
- Due to the physical characteristic of methanol, the degree of lubricant deterioration of the methanol is more serious than that of other fuels under the same conditions.
- Due to the similar chemical characteristics of FT fuel and diesel, the degradation rates of FT fuel and diesel are closer.
- The water content of the combustion products plays a significant role in promoting the increase of the moisture in lubricating oil.
- The dielectric property and moisture content can be used to characterize the oil deterioration and degradation degree.

Fig. 2 The relationship between the dielectric properties and the engine speed is not clear. In other words, it does not show a linear relationship. With the time goes on, the dielectric property is increased slightly. It can be seen that the dielectric property (DP) can be used to characterize the oil deterioration and degradation degree.

RESULTS

- The correlation between the moisture change and the engine operating conditions can be seen clearly. With the increase of speed and load, the moisture curve is steadily increasing.

FUTURE WORK

- More in-depth understanding and quantitave analysis will be carried out with the application of FT-IR.
- Combining with the acoustic emission monitoring technology, the impact of lubrication deterioration and degradation on the engine condition, especially on the friction and wear of the cylinder will be analyzed quantitatively.
- Physical and chemical models of cylinder friction and wear will be developed to simulate lubricant degradation processes under different fuels combustion.
- A comprehensive method will be developed for on-line prediction of lubrication degradation.

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