Influences of Intake Temperature and Bio-Petrol Fuel Temperature on SI Engine: An Overview

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Abstract
Bio-petrol has the potential to be used as an alternative fuel for spark ignition engine in order to introduce renewable fuel and to reduce the total CO\textsubscript{2} emissions. The present study converses the usability of ethanol as a clean and green renewable alternative fuel for spark ignition engine. This review paper emphasizes not only on the inherent properties of ethanol as a fuel but also elaborately reviews about the performance and emission characteristics of the engine considering the influences of different parameters like intake temperature and preheat bio-petrol fuel. The study reveals the understanding of the engine performance characteristics and emissions production under ethanol gas petrol blending ratio and variant types of ethanol. Furthermore, the fuel properties such as blends densities and kinematics viscosity found to increase continuously with increasing percentage of ethanol, while API gravity and heat value decreased with decreasing percentage of ethanol increase. In addition, cloud point and flash points for bio-petrol blends were found to be higher than standard gasoline fuel, while distillation curves were lower. In this paper, the performance and emission analysis carried out by different researchers from their experimental and theoretical results has been presented in brief. The review of the investigation reports found in the literature reveals that the intake temperature and preheat bio-petrol fuel have an influences on engine performance with ethanol as a blended fuel with gasoline.

Introduction
The increasing of petroleum fuel cost have led to actively research and developing the new alternative fuels. An important step in efforts to solve the problem is to replace fossil source energy with bioenergy. In the transport sector this means either introducing biofuels or using adapted vehicles, or blending biofuels with petroleum-based fuels for use with present vehicle fleets. However, blending biofuels with petroleum-based fuels for use by the present conventional vehicle fleets has the advantages that even using quite low blending concentrations will result in substantial total volumes of gasoline being substituted by bio fuels, and that the present infrastructure for distributing fuels can be used [1-3].Ethanol blend has been introduced in the fuel market as a clean and green renewable alternative energy for spark ignition (SI) engine. The ethanol-petrol blend is currently used as a vehicle fuel with a wide of blending ratio. A varied mixture of ethanol and petrol are used depends of the country. A mixture of 10\% ethanol and 90\% petrol is referred to E10 which is the most popular blend due to its interchangeability with petrol without any special arrangement of air-fuel system on a vehicle [4-6]. Ethanol blended petrol has been introduced into Asian countries, such as Thailand (E10), Philippines (E5 and E10) and India (E5) [7].Many researchers and scientists have been studying the effects of ethanol-petrol blends on engine performance and emissions characteristics. Most of the studies reported that ethanol-petrol blend produced lower emissions than unleaded petrol on SI engines [8-12]. Although many studies only evaluated the effect of blending ratio, researches on influences of intake temperature and preheat bio-petrol fuel temperature is rarely.
Fuel Properties of Bio-ethanol

Kheiralla [12] investigated the fuel properties of pure petrol and ethanol-petrol blends. Table 1 showed that blends densities and kinematics viscosity were found to increase continuously and linearly with increasing percentage of ethanol, while API gravity and heat value decreased with decreasing percentage of ethanol increase. Furthermore, cloud point, flash and fire points for blends were found to be higher than gasoline fuel, while distillation curves were lower.

<table>
<thead>
<tr>
<th>Fuel Blend</th>
<th>Density, kg/L</th>
<th>API gravity, deg.</th>
<th>Kinematic viscosity mm²/s @ 30 °C</th>
<th>Flash Point, °C</th>
<th>Fire Point, °C</th>
<th>Cloud Point, °C</th>
<th>Heat of Combustion, MJ/L</th>
<th>Octane number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasoline</td>
<td>0.7460</td>
<td>59.53</td>
<td>0.4872</td>
<td>25.0</td>
<td>&gt;8</td>
<td>&gt;8</td>
<td>34.84</td>
<td>93.2</td>
</tr>
<tr>
<td>E10</td>
<td>0.7394</td>
<td>57.10</td>
<td>0.5183</td>
<td>20.0</td>
<td>&gt;8</td>
<td>&gt;8</td>
<td>33.19</td>
<td>97.1</td>
</tr>
<tr>
<td>E15</td>
<td>0.7465</td>
<td>57.09</td>
<td>0.5619</td>
<td>20.0</td>
<td>&gt;8</td>
<td>&gt;8</td>
<td>32.91</td>
<td>98.6</td>
</tr>
<tr>
<td>E20</td>
<td>0.7541</td>
<td>55.95</td>
<td>0.6007</td>
<td>29.2</td>
<td>30.0</td>
<td>&gt;8</td>
<td>32.43</td>
<td>100.4</td>
</tr>
<tr>
<td>E25</td>
<td>0.7571</td>
<td>55.21</td>
<td>0.6380</td>
<td>30.0</td>
<td>32.0</td>
<td>&gt;8</td>
<td>31.70</td>
<td>99.5</td>
</tr>
<tr>
<td>E30</td>
<td>0.7615</td>
<td>54.30</td>
<td>0.6614</td>
<td>29.2</td>
<td>30.2</td>
<td>&gt;8</td>
<td>31.53</td>
<td>102.5</td>
</tr>
<tr>
<td>E35</td>
<td>0.7653</td>
<td>53.50</td>
<td>0.6914</td>
<td>31.0</td>
<td>32.0</td>
<td>&gt;8</td>
<td>30.92</td>
<td>104.1</td>
</tr>
</tbody>
</table>

Hsieh [13] also investigated the fuel properties of ethanol blends. From the results, with increasing the ethanol content, the heating value of the blended fuels is decreased, while the octane number of the blended fuels increases. It was also found that with increasing the ethanol content, the Reid vapor pressure of the blended fuels initially increases to a maximum at 10% ethanol addition, and then decreases.

Effect of Intake Temperature on Bio-ethanol Engine

Yoon and Lee [14] studied the performance and emissions of undiluted bioethanol on spark ignition engine at various air temperature conditions. They reported that the brake power of the test fuels is increased as the engine speed increased as shown in Fig. 1. The ethanol produced higher brake power than petrol and as the intake air temperature decreased, the brake power of the ethanol fuel is increased. For the brake specific fuel consumption shown in Fig. 2, the gasoline has lower fuel consumption than ethanol. As the intake air temperature decreased, the fuel consumption of the ethanol fuel is increased.

![Fig. 1: Brake power at various air temperature](image1)

![Fig. 2: BSFC at various air temperature](image2)

The investigated results show that as intake ambient air temperatures is decreased, the intake flow rates is increased by the increased density of the intake air. The concentration of NOx emissions tends to increase proportionally with the increase of ambient air temperature and engine speed for all test conditions. However, the HC, and CO emissions from ethanol combustion are improved than those of gasoline combustion.
Effects of Preheat Fuel Temperature on Bio-ethanol Engine

Basavaraju [15] studied the performance and emissions of preheat petrol on spark ignition engine. To avoid vapor locking, they heat the fuel within a temperature limit of 40 °C. The experimental setup consists of a 350cc four stroke, single cylinder petrol engine and a hydraulic dynamometer for loading and to measure the brake power of the engine for different loads. From the result in Tables 2 and 3, the brake power of the engine is increased with engine loads. The brake power are same for preheat and non-preheat fuel. The specific fuel consumption of preheat fuel is lower than non-preheat fuel at different loads. The CO and HC emission level of preheat fuel is lower than non-preheat fuel.

### Table 2: Engine performance by using injector (Preheat fuel)[15]

<table>
<thead>
<tr>
<th>Sl.no</th>
<th>Load (N)</th>
<th>Speed (rpm)</th>
<th>Fuel Consumption(cc)</th>
<th>Time (sec)</th>
<th>Bp (kw)</th>
<th>Sfc Kg/kw-hr</th>
<th>TfC (kg/hr)</th>
<th>η bth</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>1330</td>
<td>50</td>
<td>153</td>
<td>-</td>
<td>-</td>
<td>0.88</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>19.62</td>
<td>1330</td>
<td>50</td>
<td>146</td>
<td>1.912</td>
<td>0.48</td>
<td>0.921</td>
<td>16</td>
</tr>
<tr>
<td>3</td>
<td>39.24</td>
<td>1330</td>
<td>50</td>
<td>136</td>
<td>3.825</td>
<td>0.25</td>
<td>0.9926</td>
<td>31.5</td>
</tr>
<tr>
<td>4</td>
<td>58.86</td>
<td>1330</td>
<td>50</td>
<td>131</td>
<td>3.758</td>
<td>0.17</td>
<td>1.03</td>
<td>45.6</td>
</tr>
<tr>
<td>5</td>
<td>78.48</td>
<td>1330</td>
<td>50</td>
<td>130</td>
<td>7.651</td>
<td>0.13</td>
<td>1.038</td>
<td>60.3</td>
</tr>
</tbody>
</table>

CO= 2.92%vol  HC=292ppm

### Table 3: Engine performance by using injector(Non-preheat fuel) [15]

<table>
<thead>
<tr>
<th>Sl.no</th>
<th>Load (N)</th>
<th>Speed (rpm)</th>
<th>Fuel Consumption(cc)</th>
<th>Time (sec)</th>
<th>Bp (kw)</th>
<th>Sfc Kg/kw-hr</th>
<th>TfC (kg/hr)</th>
<th>η bth</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>1330</td>
<td>50</td>
<td>160</td>
<td>-</td>
<td>-</td>
<td>0.84</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>19.62</td>
<td>1330</td>
<td>50</td>
<td>152</td>
<td>1.912</td>
<td>0.461</td>
<td>0.88</td>
<td>17.78</td>
</tr>
<tr>
<td>3</td>
<td>39.24</td>
<td>1330</td>
<td>50</td>
<td>144</td>
<td>3.825</td>
<td>0.243</td>
<td>0.93</td>
<td>33.67</td>
</tr>
<tr>
<td>4</td>
<td>58.86</td>
<td>1330</td>
<td>50</td>
<td>138</td>
<td>5.738</td>
<td>0.170</td>
<td>0.978</td>
<td>48.01</td>
</tr>
<tr>
<td>5</td>
<td>78.48</td>
<td>1330</td>
<td>50</td>
<td>134</td>
<td>7.651</td>
<td>0.131</td>
<td>1.007</td>
<td>61.05</td>
</tr>
</tbody>
</table>

CO= 2.33%vol  HC=220ppm

Influences of Biodegradable Lubricant on Bio-ethanol Engine

J. Schramm [16] investigated the emissions measurements of a biodegradable lubricant on a chassis dynamometer. The gasoline vehicles were really FFV’s (Flexible Fuel Vehicle), which were operated on gasoline and ethanol (E85) respectively. The driving patterns that were applied in these experiments were the FTP and EU test cycles. Result in Figure 5 - 6 shows that the NOx emissions level is lower with the E85 fuel and CO2 emission level are same for E85 and petrol.

Figure 5: NO emissions from the FFV’s[16]  
Figure 6: CO2 emissions from the FFV’s[16]
Ejilah and Asere[17] are also investigating the performance and emissions of the biodegradable lubricant on single cylinder, four stroke SI engine. All the investigation has been done by three types of lubricant; SAE 40 (monograde), SAE 20w-50 (multigrade) and groundnut oil.

![Graph](image)

**Figure 7:** Effect of groundnut oil blend on brake power [17]

![Graph](image)

**Figure 8:** Effect of groundnut oil blend on specific fuel consumption [17]

From the result, groundnut oil blended lubricant demonstrated higher brake power than monograde and multigrade oils, but for the multigrade oil at the expense of higher fuel consumption. In terms of fuel economy, groundnut oil blended lubricants is slightly higher than multigrade oil and comparable to monograde oil.

**Conclusion**

The significant of this study is the fuel properties such as blends densities and kinematics viscosity found to increase continuously with increasing percentage of ethanol, while API gravity and heat value decreased with decreasing percentage of ethanol increase. Ethanol blend will require preheat to vaporize than gasoline. From the study the influences of intake temperature and preheat bio-petrol fuel temperature on SI engine it is found that, there is effected the engine performance in terms of improved brake power, brake specific fuel consumption and reduced emissions of SI engine.

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**References**


