CHAPTER 6

STUDIES ON FUEL PROPERTIES OF NEEM, RICE BRAN, PONGAMIA PINNATA, COTTON, RUBBER SEED OIL METHYL ESTERS AND THEIR CONVENTIONAL DIESEL AND KEROSENE OIL BLENDS

6.1 Introduction

In this work fuel properties of unrefined neem, unrefined rice bran, unrefined pongamia pinnata, unrefined cotton, unrefined rubber seed oil methyl ester and their blends with domestic kerosene oil and conventional diesel oil in the proportions (Methyl ester: Conventional diesel : Kerosene of 20:75:5, 40:50:10, 60:25:15, and 80:0:20 respectively were studied.

The relative densities of all test samples were determined in accordance with IS: 1448 [P: 32]:1992. Redwood viscometer number 1 was used for the measurement of kinematic viscosity in cSt was calculated from time units as per IS No. 1448[P: 25]:1976. Heating value was determined as per IS No 1448[P: 6]:1984 by using Isothermal bomb calorimeter. Pour point was determined as per IS No, 1448 [P: 10]: 1970. Pensky–Martens closed cup was used to find flash and fire point of test samples as per IS No 1448 [P: 21]: 1992.

6.2 Study of fuel properties of neem methyl ester and its blends with kerosene

6.2.1 Introduction

In this section characteristic fuel properties such as density, specific gravity, viscosity, flash point and heating values of neem oil, neem oil methyl ester, B20K5, B40K10, B60K15, B80K20 were determined experimentally and compared with diesel and kerosene oil.

Table 6.1 shows the fuel properties of neem oil, neem oil methyl ester (B100), diesel oil, B20K5, B40K10, B60K15, B80K20 and kerosene. Table 6.1 also indicates that density, viscosity, specific gravity and flash point of neem oil are greater than neem oil methyl ester and diesel oil. While heating value is less than the methyl ester and diesel.
6.2.2 Results and Discussion

Table 6.1 Properties of neem oil, neem oil methyl ester (B100), diesel oil and kerosene blend (B20K5, B40K10, B60K15, B80K20)

<table>
<thead>
<tr>
<th>Property</th>
<th>Neem oil</th>
<th>Diesel</th>
<th>B20K5</th>
<th>B40K10</th>
<th>B60K15</th>
<th>B80K20</th>
<th>B100</th>
<th>Kerosene</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density in kg/m³</td>
<td>910</td>
<td>816</td>
<td>826.5</td>
<td>837.0</td>
<td>847.5</td>
<td>858.0</td>
<td>870</td>
<td>810</td>
</tr>
<tr>
<td>Specific gravity</td>
<td>0.91</td>
<td>0.816</td>
<td>0.8265</td>
<td>0.837</td>
<td>0.847</td>
<td>0.858</td>
<td>0.87</td>
<td>0.810</td>
</tr>
<tr>
<td>Viscosity at 40 °C in cSt</td>
<td>40.75</td>
<td>4.3</td>
<td>4.181</td>
<td>4.062</td>
<td>3.943</td>
<td>3.824</td>
<td>4.5</td>
<td>1.12</td>
</tr>
<tr>
<td>Flash point in °C</td>
<td>250</td>
<td>53</td>
<td>77.35</td>
<td>101.7</td>
<td>126.05</td>
<td>150.4</td>
<td>175</td>
<td>52</td>
</tr>
<tr>
<td>Pour point in °C</td>
<td>7</td>
<td>-8</td>
<td>-4.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>-51</td>
</tr>
<tr>
<td>Heating value MJ/kg</td>
<td>39.82</td>
<td>45.7</td>
<td>44.725</td>
<td>43.75</td>
<td>42.775</td>
<td>41.8</td>
<td>41.5</td>
<td>41.5</td>
</tr>
</tbody>
</table>

6.2.2.1 Effect of specific gravity

Figure 6.1 shows the specific gravity of neem oil, B20K5, B40K10, B60K15, B80K20 and B100. Neem oil has highest specific gravity (0.910) which is reduced to 0.870 after transesterification. Specific gravity of B20K5 is very close to that of conventional diesel which is 1.012 times higher than that of the conventional diesel oil. B100 has specific gravity of 0.870 which is 1.066 times higher than that of the conventional diesel oil. Figure 6.1 indicates that specific gravity increases with the increase in percentage of methyl ester in the blend. Specific gravity of biodiesel, conventional diesel oil and kerosene blends increases with the increase in percentage of kerosene and corresponding decrease in conventional diesel oil in the given percentage of biodiesel.

![Fig 6.1 Flash point of neem oil, neem oil methyl ester and its blends with conventional diesel oil and kerosene](image-url)
6.2.2. Effect of viscosity

Figure 6.2 shows the kinematic viscosity of neem oil, neem oil methyl ester, diesel oil and B20K5, B40K10, B60K15, B80K20 and kerosene. Neem oil has highest viscosity (40.75 cSt at 40°C) which is 9.477 times higher than that of the conventional diesel oil after transesterification viscosity has decreased from 40.75 cSt to 4.5 cSt which is 1.0465 times higher than diesel oil.

From figure 6.2 it is observed that, B20K5 has kinematic viscosity of 4.181 cSt which is lower than conventional diesel oil (4.3 cSt). Kinematic viscosity of biodiesel, conventional diesel oil and kerosene blends decreases with the increase in percentage of kerosene and corresponding decrease in conventional diesel oil in the given percentage of biodiesel.

![Figure 6.2 Viscosity of neem oil, neem oil methyl ester and its blends with conventional diesel oil and kerosene](image)

6.2.2.3 Effect of heating value

Table 6.3 shows the heating value of neem oil, neem oil methyl ester, diesel oil, B100, kerosene, B20K5, B40K10, B60K15 and B80K20. Figure 6.3 shows that heating value decreases with the increase in percentage of methyl ester in the blend.

From figure 6.3 it is observed that, biodiesel, conventional diesel oil and kerosene blends have lower heating value than conventional diesel oil. Blend B20K5 has heating value of 44.725MJ/kg which is lower than conventional diesel oil (45.7 MJ/kg). Heating value of biodiesel, conventional diesel oil and kerosene blends decreases with the increase in percentage of kerosene and corresponding decrease in conventional diesel oil in the given percentage of biodiesel.
Figure 6.3 Heating value of neem oil, neem oil methyl ester and its blends with conventional diesel oil and kerosene

6.2.2.4 Effect of flash point

Table 6.3 shows the flash point of neem oil, neem oil methyl ester, diesel oil, kerosene, B20K5, B40K10, B60K15 and B80K20. Figure 6.4 shows that flash point increases with the increase in percentage of methyl ester in the blend.

From figure 6.4 it is observed that, biodiesel, conventional diesel oil and kerosene blends have higher flash point than conventional diesel oil. B20K5 has flash point of 77.35°C which is higher than that of the conventional diesel oil (53°C). Flash point of biodiesel, conventional diesel oil and kerosene blends increases with the increase in percentage of kerosene and corresponding decrease in the percentage of conventional diesel oil in the given percentage of biodiesel.
6.3 Study of fuel properties of rice bran oil methyl ester and its blends with kerosene

6.3.1 Introduction

In this section characteristic fuel properties such as density, specific gravity, viscosity, flash point and heating values of rice bran oil, rice bran oil methyl ester, B20K5, B40K10, B60K15, B80K20 were determined experimentally and compared with diesel and kerosene oil.

Table 6.2 shows the fuel properties of rice bran, rice bran oil methyl ester (B100), diesel oil, B20K5, B40K10, B60K15,B80K20, B100, and kerosene. Table 6.1 also indicates that density, viscosity, specific gravity and flash point of rice bran oil is greater than rice bran oil methyl ester and diesel oil.

<table>
<thead>
<tr>
<th>Property</th>
<th>Rice bran</th>
<th>Diesel</th>
<th>B20K5</th>
<th>B40K10</th>
<th>B60K15</th>
<th>B80K20</th>
<th>B100</th>
<th>Kerosene</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density in kg/m³</td>
<td>914</td>
<td>816</td>
<td>827.5</td>
<td>839.0</td>
<td>850.5</td>
<td>862</td>
<td>875</td>
<td>810</td>
</tr>
<tr>
<td>Specific gravity</td>
<td>0.914</td>
<td>0.816</td>
<td>0.8275</td>
<td>0.839</td>
<td>0.850</td>
<td>0.862</td>
<td>0.875</td>
<td>0.810</td>
</tr>
<tr>
<td>Viscosity at 40°C in cSt</td>
<td>12.3</td>
<td>4.3</td>
<td>4.453</td>
<td>4.606</td>
<td>4.759</td>
<td>4.912</td>
<td>5.86</td>
<td>1.12</td>
</tr>
<tr>
<td>Flash point in 0°C</td>
<td>260</td>
<td>53</td>
<td>79.35</td>
<td>105.7</td>
<td>132.05</td>
<td>158.4</td>
<td>185</td>
<td>52</td>
</tr>
<tr>
<td>Pour point in 0°C</td>
<td>-5</td>
<td>-8</td>
<td>-9.75</td>
<td>-11.5</td>
<td>-13.25</td>
<td>-15</td>
<td>-6</td>
<td>-51</td>
</tr>
<tr>
<td>Heating value MJ/kg</td>
<td>36.16</td>
<td>45.7</td>
<td>44.625</td>
<td>43.55</td>
<td>42.47</td>
<td>41.4</td>
<td>41.0</td>
<td>41.5</td>
</tr>
</tbody>
</table>

6.3.2 Results and discussion

6.3.2.1 Effect of specific gravity

Figure 6.5 shows the specific gravity of rice bran oil, rice bran oil methyl ester B20K5, B40K10, B60K15, B80K20 diesel and kerosene. Rice bran oil has highest specific gravity (0.914) which is reduced to 0.875 after transesterification. Specific gravity of B20K5 is very close to that of conventional diesel which is 1.014 times higher than that of the conventional diesel oil. B100 has specific gravity of 0.870
which is 1.072 times higher than that of the conventional diesel oil. Figure 6.5 indicates that specific gravity increases with the increase in percentage of methyl ester in the blend. Specific gravity of biodiesel, conventional diesel oil and kerosene blends increases with the increase in percentage of kerosene and corresponding decrease in conventional diesel oil in the given percentage of biodiesel.

![Figure 6.5 Specific gravity of rice bran oil, rice bran oil methyl ester and its blends with conventional diesel and kerosene](image)

### 6.3.2.2 Effect of viscosity

Table 6.2 shows the kinematic viscosity of rice bran oil, rice bran oil methyl ester, diesel oil and B20K5, B40K10, B60K15, B80K20 and kerosene. Rice bran oil has highest viscosity (12.3 cSt at 40°C) which is 2.860 times higher than that of the conventional diesel oil, after transesterification viscosity has decreased from 12.3 cSt to 5.86 cSt which is 1.36 times higher than diesel oil.

From figure 6.2 it is observed that, B20K5 has kinematic viscosity of 4.453cSt which is higher than conventional diesel oil (4.3cSt). Kinematic viscosity of biodiesel, conventional diesel oil and kerosene blends increases with the increase in percentage of kerosene and corresponding decrease in conventional diesel oil in the given percentage of biodiesel.

![Figure 6.6 Kinematic viscosity of rice bran oil and its blends with conventional diesel and kerosene](image)
6.3.2.3 Effect of flash point

Table 6.2 shows the flash point of rice bran oil, rice bran oil methyl ester, diesel oil, kerosene, B20K5, B40K10, B60K15 and B80K20. Figure 6.7 shows that flash point increases with the increase in percentage of methyl ester in the blend.

From figure 6.7 it is observed that, biodiesel, conventional diesel oil and kerosene blends have higher flash point than biodiesel-conventional diesel oil. B20K5 has flash point of 79.35°C which is higher than that of the conventional diesel oil (53°C). Flash point of biodiesel, conventional diesel oil and kerosene blends increases with the increase in percentage of kerosene and corresponding decrease in the percentage of conventional diesel oil in the given percentage of biodiesel.

6.3.2.4 Effect of heating value

Table 6.3 shows the heating value of rice bran oil, rice bran oil methyl ester, diesel oil, B100, kerosene, B20K5, B40K10, B60K15 and B80K20. Figure 6.8 shows that heating value decreases with the increase in percentage of methyl ester in the blend.

From figure 6.8 it is observed that, biodiesel, conventional diesel oil and kerosene blends have lower heating value than biodiesel-conventional diesel oil blends. B20K5 has heating value of 44.625MJ/kg which is lower than conventional diesel oil (45.7 MJ/kg). Heating value of biodiesel, conventional diesel oil and kerosene blends decreases with the increase in percentage of kerosene and corresponding decrease in conventional diesel oil in the given percentage of biodiesel.
6.4 Study of fuel properties of pongamia pinnata oil methyl ester and its blends with kerosene

6.4.1 Introduction

In this section characteristic fuel properties such as density, specific gravity, viscosity, flash point and heating values of pongamia pinnata oil, pongamia pinnata oil methyl ester, B20K5, B40K10, B60K15, B80K20 were determined experimentally and compared with diesel and kerosene oil.

Table 6.3 shows the fuel properties of pongamia pinnata, pongamia pinnate oil methyl ester (B100), diesel oil, B20K5, B40K10, B60K15, B80K20, B100 and kerosene. Table 6.3 also indicates that density, viscosity, specific gravity and flash point of pongamia pinnata oil is greater than pongamia pinnata oil methyl ester and diesel oil.

Table 6.3 Properties of pongamia pinnata, pongamia pinnata oil methyl ester (B100), diesel oil and kerosene blends (B20K5, B40K10, B60K15, B80K20)

<table>
<thead>
<tr>
<th>Property</th>
<th>Pongamia pinnata</th>
<th>Diesel</th>
<th>B20K5</th>
<th>B40K10</th>
<th>B60K15</th>
<th>B80K20</th>
<th>B100</th>
<th>Kerosene</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density in kg/m$^3$</td>
<td>912</td>
<td>816</td>
<td>824.5</td>
<td>833.0</td>
<td>841.5</td>
<td>850</td>
<td>860</td>
<td>810</td>
</tr>
<tr>
<td>Specific gravity</td>
<td>0.912</td>
<td>0.816</td>
<td>0.8245</td>
<td>0.833</td>
<td>0.841</td>
<td>0.850</td>
<td>0.860</td>
<td>0.810</td>
</tr>
<tr>
<td>Viscosity at 40 °C in cSt</td>
<td>10.5</td>
<td>4.3</td>
<td>4.241</td>
<td>4.182</td>
<td>4.12</td>
<td>4.064</td>
<td>4.8</td>
<td>1.12</td>
</tr>
<tr>
<td>Flash point in °C</td>
<td>210</td>
<td>53</td>
<td>78.35</td>
<td>103.7</td>
<td>129.05</td>
<td>154.4</td>
<td>180</td>
<td>52</td>
</tr>
<tr>
<td>Pour point in °C</td>
<td>-6</td>
<td>-8</td>
<td>-9.95</td>
<td>-11.9</td>
<td>-13.85</td>
<td>-15.8</td>
<td>-7</td>
<td>-51</td>
</tr>
<tr>
<td>Heating value MJ/kg</td>
<td>38.5</td>
<td>45.7</td>
<td>44.82</td>
<td>43.95</td>
<td>43.075</td>
<td>42.2</td>
<td>42.0</td>
<td>41.5</td>
</tr>
</tbody>
</table>
6.4.2 Results and discussion

6.4.2.1 Effect of specific gravity

Figure 6.9 shows the specific gravity of pongamia pinnata oil, pongamia pinnata methyl ester B20K5, B40K10, B60K15, B80K20, diesel and kerosene. Pongamia pinnata oil has highest specific gravity (0.912) which is reduced to 0.860 after transesterification. Specific gravity of B20K5 is very close to that of the conventional diesel which is 1.0104 times higher than that of the conventional diesel oil. B100 has specific gravity of 0.860 which is 1.053 times higher than that of the conventional diesel oil. Figure 6.9 indicates that specific gravity increases with the increase in percentage of methyl ester in the blend. Specific gravity of biodiesel, conventional diesel oil and kerosene blends increases with the increase in percentage of kerosene and corresponding decrease in conventional diesel oil in the given percentage of biodiesel.

![Bar chart showing specific gravity of pongamia pinnata oil and its blends with conventional diesel and kerosene.]

6.4.2.2 Effect of viscosity

Figure 6.10 shows the viscosity of pongamia pinnata, pongamia pinnata methyl ester, diesel oil, B20K5, B40K10, B60K15, B80K20 and kerosene. Pongamia pinnata has highest viscosity (10.5 cSt at 40°C) which is 2.441 times higher than that of the conventional diesel oil, after transesterification viscosity has decreased to 4.8 cSt which is 1.116 times higher than that of the diesel oil.

From figure 6.10 it is observed that, B20K5 has viscosity of 4.241 cSt which is lower than that of the conventional diesel oil (4.3cSt). Viscosity of biodiesel, conventional diesel oil and kerosene blends decreases with the increase in percentage of kerosene and corresponding decrease in conventional diesel oil in the given percentage of biodiesel.
6.4.2.3 Effect of flash point

Table 6.3 shows the flash point of pongamia pinnata oil, pongamia pinnata oil methyl ester, diesel oil, B20K5, B40K10, B60K15, B80K20 and kerosene. Figure 6.11 shows that flash point increases with the increase in percentage of methyl ester in the blend.

From figure 6.11 it is observed that, biodiesel, conventional diesel oil and kerosene blends have higher flash point than diesel oil blends. B20K5 has flash point of $78.35^0\text{C}$ which is higher than conventional diesel oil ($53^0\text{C}$). Flash point of biodiesel, conventional diesel oil and kerosene blends increases with the increase in percentage of kerosene and corresponding decrease in the percentage of conventional diesel oil in the given percentage of biodiesel.

6.4.2.4 Effect of heating value

Table 6.3 shows the heating value of pongamia pinnata oil, pongamia pinnata oil methyl ester, diesel oil, kerosene, B20K5, B40K10, B60K15 and B80K20. Figure 6.12 shows that heating value decreases with the increase in percentage of methyl ester in the blend.
From figure 6.12 it is observed that, biodiesel, conventional diesel oil and kerosene blends have lower heating value than conventional diesel oil. B20K5 has heating value of 44.82MJ/kg which is lower than that of the conventional diesel oil (45.7 MJ/kg). Heating value of biodiesel, conventional diesel oil and kerosene blends decreases with the increase in percentage of kerosene and corresponding decrease in conventional diesel oil in the given percentage of biodiesel.

![Graph showing heating value of Pongamia pinnata oil and its blends with conventional diesel and kerosene](image)

**Figure 6.12 Heating value of pongamia pinnata oil and its blends with conventional diesel and kerosene**

### 6.5 Study of fuel properties of cotton seed oil methyl ester and its blends with kerosene

#### 6.5.1 Introduction

In this section characteristic fuel properties such as density, specific gravity, viscosity, flash point, and heating values of cotton seed oil, cotton seed oil methyl ester, B20K5, B40K10, B60K15, B80K20 were determined experimentally and compared with diesel and kerosene oil.

Table 6.4 shows the fuel properties of cotton seed oil, cotton seed oil methyl ester (B100), diesel oil, B20K5, B40K10, B60K15, B80K20 and kerosene. Table 6.4 also indicates that density, viscosity, specific gravity and flash point of cotton seed oil are greater than cotton seed oil methyl ester and diesel oil.
Table 6.4 Properties of cotton seed oil, cotton seed oil methyl ester, diesel oil and kerosene blend (B20K5, B40K10, B60K15, B80K20)

<table>
<thead>
<tr>
<th>Property</th>
<th>Cotton seed oil</th>
<th>Diesel</th>
<th>B20K5</th>
<th>B40K10</th>
<th>B60K15</th>
<th>B80K20</th>
<th>B100</th>
<th>Kerosene</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density in kg/m³</td>
<td>890</td>
<td>816</td>
<td>816.5</td>
<td>817.0</td>
<td>817.5</td>
<td>818</td>
<td>820</td>
<td>810</td>
</tr>
<tr>
<td>Specific gravity</td>
<td>0.890</td>
<td>0.816</td>
<td>0.816</td>
<td>0.817</td>
<td>0.817</td>
<td>0.818</td>
<td>0.820</td>
<td>0.810</td>
</tr>
<tr>
<td>Viscosity at 40 °C in cSt</td>
<td>9.5</td>
<td>4.3</td>
<td>4.181</td>
<td>4.062</td>
<td>3.943</td>
<td>3.943</td>
<td>4.5</td>
<td>1.12</td>
</tr>
<tr>
<td>Flash point in °C</td>
<td>200</td>
<td>53</td>
<td>77.35</td>
<td>101.7</td>
<td>126.05</td>
<td>150.4</td>
<td>175</td>
<td>52</td>
</tr>
<tr>
<td>Pour point in °C</td>
<td>-6</td>
<td>-8</td>
<td>-9.95</td>
<td>-11.9</td>
<td>-13.85</td>
<td>-15.8</td>
<td>-7</td>
<td>-51</td>
</tr>
<tr>
<td>Heating value MJ/kg</td>
<td>40</td>
<td>45.7</td>
<td>45.025</td>
<td>44.35</td>
<td>43.67</td>
<td>423</td>
<td>43.0</td>
<td>41.5</td>
</tr>
</tbody>
</table>

6.5.2 Results and discussion

6.5.2.1 Effect of specific gravity

Figure 6.13 shows the specific gravity of cotton seed oil, B20K5, B40K10, B60K15, B80K20 and B100. Cotton seed oil has highest specific gravity (0.890) which is reduced to 0.820 after transesterification. Specific gravity of B20K5 is very close to that of conventional diesel which is 1.0006 times higher than that of the conventional diesel oil. B100 has specific gravity of 0.820 which is 1.0049 times higher than that of the conventional diesel oil. Figure 6.13 indicates that specific gravity increases with the increase in percentage of methyl ester in the blend. Specific gravity of biodiesel, conventional diesel oil and kerosene blends increases with the increase in percentage of kerosene and corresponding decrease in conventional diesel oil in the given percentage of biodiesel.

![Figure 6.13 Specific gravity of cotton seed oil and its blends with conventional diesel and kerosene](image-url)
6.5.2.2 Effect of viscosity

Figure 6.14 shows the viscosity of cotton seed oil, diesel oil, B20K5, B40K10, B60K15, B80K20, B100 and kerosene. Cotton seed oil has highest viscosity (9.5cSt at 40°C) which is 2.20 times higher than that of the conventional diesel oil after transesterification viscosity has decreased from 9.5 cSt to 4.5 cSt which is 1.046 times higher than that of the diesel oil.

From figure 6.14 it is observed that, B20K5 has kinematic viscosity of 4.181cSt which is lower than conventional diesel oil (4.3cSt). Viscosity of biodiesel, conventional diesel oil and kerosene blends decreases with the increase in percentage of kerosene and corresponding decrease in conventional diesel oil in the given percentage of biodiesel.

![Viscosity of cotton seed oil and its blends with conventional diesel and kerosene](image)

6.5.2.3 Effect of flash point

Table 6.3 shows the flash point of cotton seed oil, cotton seed oil methyl ester, diesel oil, kerosene, B20K5, B40K10, B60K15 and B80K20. Figure 6.15 shows that flash point increases with the increase in percentage of methyl ester in the blend.

From figure 6.15 it is observed that, biodiesel has higher flash point than conventional diesel oil but kerosene has lower flash point than conventional diesel oil. B20K5 has flash point of 77.35°C which is higher than conventional diesel oil (53°C). Flash point of biodiesel, conventional diesel oil and kerosene blends increases with the increase in percentage of kerosene and corresponding decrease in the percentage of conventional diesel oil in the given percentage of biodiesel.
Figure 6.15 Flash point of cotton seed oil and its blends with conventional diesel and kerosene

6.5.2.4 Effect of heating value

Table 6.3 shows the heating value of cotton seed oil, cotton seed oil methyl ester, diesel oil, B100, kerosene, B20K5, B40K10, B60K15 and B80K20. Figure 6.16 shows that heating value decreases with the increase in percentage of methyl ester in the blend.

From figure 6.16 it is observed that, biodiesel, conventional diesel oil and kerosene blends have lower heating value than conventional diesel oil. B20K5 has heating value of 45.025 MJ/kg which is lower than that of the conventional diesel oil (45.7 MJ/kg). Heating value of biodiesel, conventional diesel oil and kerosene blends decreases with the increase in percentage of kerosene and corresponding decrease in conventional diesel oil in the given percentage of biodiesel.

Figure 6.16 Heating value of cotton seed oil and its blends with conventional diesel and kerosene
6.6 Study of fuel properties of rubber seed oil methyl ester and its blends with kerosene

6.6.1 Introduction

In this section characteristic fuel properties such as density, specific gravity, viscosity, flash point and heating values of rubber seed oil, rubber seed oil methyl ester, B20K5, B40K10, B60K15, B80K20 were determined experimentally and compared with diesel and kerosene oil. Table 6.5 shows the fuel properties of rubber seed oil, rubber seed oil methyl ester (B100), diesel oil, B20K5, B40K10, B60K15, B80K20 and kerosene. Table 6.5 also indicates that density, viscosity, specific gravity and flash point of rubber seed oil is greater than rubber seed oil methyl ester and diesel oil.

Table 6.5 Properties of rubber seed oil, rubber seed oil methyl ester, diesel oil and kerosene blend (B20K5, B4010, B60K15, B80K20)

<table>
<thead>
<tr>
<th>Property</th>
<th>Rubber seed oil</th>
<th>Diesel</th>
<th>B20K5</th>
<th>B40K10</th>
<th>B60K15</th>
<th>B80K20</th>
<th>B100</th>
<th>Kerosene</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density in kg/m³</td>
<td>860</td>
<td>816</td>
<td>816.1</td>
<td>816.2</td>
<td>816.3</td>
<td>816.4</td>
<td>818</td>
<td>810</td>
</tr>
<tr>
<td>Specific gravity</td>
<td>0.860</td>
<td>0.816</td>
<td>0.8161</td>
<td>0.8162</td>
<td>0.8163</td>
<td>0.8164</td>
<td>0.818</td>
<td>0.810</td>
</tr>
<tr>
<td>Viscosity at 40 °C in cSt</td>
<td>8.5</td>
<td>4.3</td>
<td>4.161</td>
<td>4.022</td>
<td>3.883</td>
<td>3.744</td>
<td>4.4</td>
<td>1.12</td>
</tr>
<tr>
<td>Flash point in °C</td>
<td>190</td>
<td>53</td>
<td>75.35</td>
<td>97.7</td>
<td>120.05</td>
<td>142.4</td>
<td>165</td>
<td>52</td>
</tr>
<tr>
<td>Pour point in °C</td>
<td>-6</td>
<td>-8</td>
<td>-9.95</td>
<td>-11.9</td>
<td>-13.85</td>
<td>-15.8</td>
<td>-7</td>
<td>-51</td>
</tr>
<tr>
<td>Heating value MJ/kg</td>
<td>40.5</td>
<td>45.7</td>
<td>45.125</td>
<td>44.55</td>
<td>43.975</td>
<td>43.8</td>
<td>43.5</td>
<td>41.5</td>
</tr>
</tbody>
</table>

6.6.2 Results and discussion

6.6.2.1 Effect of specific gravity

Figure 6.17 shows the specific gravity of rubber seed oil, B20K5, B40K10, B60K15, B80K20 and B100. Rubber seed oil has highest specific gravity (0.860) which is reduced to 0.816 after transesterification. Specific gravity of B20K5 is very close to that of the conventional diesel which is 1.0001 times higher than conventional diesel oil. B100 has specific gravity of 0.818 which is 1.0024 times higher than the conventional diesel oil. Figure 6.17 indicates that specific gravity increases with the increase in percentage of methyl ester in the blend. Specific gravity of biodiesel, conventional diesel oil and kerosene blends increases with the increase in percentage.
of kerosene and corresponding decrease in conventional diesel oil in the given percentage of biodiesel.

![Figure 6.17 Specific gravity of rubber seed oil and its blends with conventional diesel and kerosene](image)

**6.6.2.2 Effect of viscosity**

Figure 6.18 shows the viscosity of rubber seed oil, rubber seed oil methyl ester, diesel oil, B20K5, B40K10, B60K15, B80K20 and, kerosene. Rubber seed oil has highest viscosity (8.5 cSt at 40°C) which is 1.97 times higher than conventional diesel oil, after transesterification viscosity has decreased from 8.5 cSt to 4.4 cSt which is 1.023 times higher than diesel oil.

From figure 6.18 it is observed that, B20K5 has kinematic viscosity of 4.161 cSt which is lower than conventional diesel oil (4.3 cSt). Viscosity of biodiesel, conventional diesel oil and kerosene blends decreases with the increase in percentage of kerosene and corresponding decrease in conventional diesel oil in the given percentage of biodiesel.

![Figure 6.18 Viscosity of rubber seed oil and its blends with conventional diesel and kerosene](image)
6.6.2.3 Effect of flash point

Table 6.5 shows the flash point of rubber seed oil, rubber seed oil methyl ester, diesel oil, kerosene, B20K5, B40K10, B60K15 and B80K20. Figure 6.19 shows that flash point increases with the increase in percentage of methyl ester in the blend. From figure 6.19 it is observed that, biodiesel, conventional diesel oil and kerosene blends have higher flash point than conventional diesel oil. B20K5 has flash point of 75.35°C which is higher than conventional diesel oil (53°C). Flash point of biodiesel, conventional diesel oil and kerosene blends increases with the increase in percentage of kerosene and corresponding decrease in the percentage of conventional diesel oil in the given percentage of biodiesel.

![Figure 6.19 Flash point of rubber seed oil and its blends with conventional diesel and kerosene]

6.6.2.4 Effect of heating value

Table 6.5 shows the heating value of rubber seed oil, rubber seed oil methyl ester, diesel oil, kerosene, B20K5, B40K10, B60K15 and B80K20. Figure 6.20 shows that heating value decreases with the increase in percentage of methyl ester in the blend. From Figure 6.20 it is observed that, biodiesel, conventional diesel oil and kerosene blends have lower heating value than conventional diesel oil. B20K5 has heating value of 45.125 MJ/kg which is lower than conventional diesel oil (45.7 MJ/kg). Heating value of biodiesel, conventional diesel oil and kerosene blends decreases with the increase in percentage of kerosene and corresponding decrease in conventional diesel oil in the given percentage of biodiesel.
Figure 6.20 Heating value of rubber seed oil and its blends with conventional diesel and kerosene