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Data Article

Data set for effect of cetane enhancer on ceramic coated diesel engine fuelled with neat Moringa oleifera methyl ester

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ABSTRACT

The present data article is based on the research work which investigates the effect of cetane enhancer on thermally coated engine fuelled with Moringa oleifera methyl ester (MOME). In this experimental work, Kirloskar TV1 model direct injection water cooled diesel engine with eddy current dynamometer was used. MOME was produced by two-stage transesterification process. The physio-chemical properties of Moringa oleifera methyl ester (MOME) were analysed based on American Standards for Testing Materials (ASTM) standards and data's were presented. Further, the fuel properties were enhanced with the addition of 1% of cetane enhancer (namely Pyrogallol) to MOME and data's related to improved fuel properties were presented. Engine was loaded from minimum load to maximum load using eddy current dynamometer. The combustion chamber components such as piston head, cylinder head and intake and exhaust valves were coated with Yttria Stabilized Zirconia (YSZ) to transfigure the normal engine into low heat rejection engine. Engine tail pipe emissions were determined using AVL, Austria make 444 di-gas analyser and AVL, Austria make 437C smoke meter equipment. Data related to fuel samples like diesel, MOME with and without Cetane enhancer in normal and ceramic engines were presented.

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1. Data

The data presented in this article was based on the experimental study on the effect of cetane enhancer on Moringa oleifera methyl ester in normal and ceramic coated engine. Table 1 represents the data regarding fuel properties of diesel, MOME and MOME+PY based on ASTM testing procedure. Fig. 1 represents the performance characteristics of Moringa oleifera methyl ester depends on the physio-chemical properties like calorific value, cetane number, flash point, kinematic viscosity and density. Engine emission characteristics of Moringa oleifera methyl ester depends on oxygen presence, CHO (Carbon, Hydrogen and Oxygen) and fuel viscosity. Raw Moringa oleifera oil was converted into Moringa oleifera methyl ester using two-stage transesterification process. The physio-chemical properties of MOME were analysed based on ASTM standards. In addition, the fuel properties were improved with the addition of 1% of cetane enhancer namely Pyrogallol (PY) to biodiesel. Low heat rejection was achieved by coating the combustion chamber components using YSZ ceramic material.

2. Experimental design, materials, and methods

Raw Moringa oleifera oil was converted into Moringa oleifera methyl ester using two-stage transesterification process. As acid value of raw oil was high, two stage esterification process was performed [4–6]. Acid esterification was carried out using 6:1 methanol to oil ratio with the addition of 0.5 (w/w)
Table 1
Properties of fuel.

| Property                        | ASTM standards | Diesel   | MOME    | MOME+PY  |
|---------------------------------|----------------|----------|---------|----------|
| Density (kg/m$^3$)$^a$          | D1298          | 835.1    | 859.3   | 839.42   |
| Kinematic viscosity at 40 °C (cSt)$^a$ | D445          | 2.57     | 5.05    | 3.21     |
| Flash point (°C)$^a$            | D93            | 56       | 150.1   | 91       |
| Fire point (°C)$^a$             | D93            | 62       | 162     | 95       |
| Gross calorific value (MJ/kg)$^a$| D240          | 43.26    | 40.06   | 42.33    |
| Cetane number                   | D613           | 48       | 56      | 62       |
| C (mass %)                      |                | –        | 76.32   | –        |
| H (mass %)                      |                | –        | 12.21   | –        |
| O (mass %)                      |                | –        | 11.46   | –        |
| C/H                             |                | –        | 6.25    | –        |

$^a$ All properties were determined based on ASTM standards under laboratory condition.

Fig. 1. Yttria stabilized zirconia coated engine components.

Table 2
Brake thermal efficiency in-terms of % at all loads.

| Load (%) | Normal engine | Ceramic engine |
|----------|---------------|----------------|
|          | Diesel        | MOME+PY        | Diesel     | MOME+PY  |
| 20       | 5.9           | 5.5            | 6.3        | 6.6      |
| 40       | 12.2          | 11.6           | 13.1       | 13.7     |
| 60       | 16.7          | 16             | 17.8       | 18.5     |
| 80       | 20.1          | 19.8           | 21.9       | 22.8     |
| 100      | 26.9          | 26.3           | 27.3       | 28.1     |

Table 3
Brake specific fuel consumption in-terms of kg/kWh at all loads.

| Load (%) | Normal engine | Ceramic engine |
|----------|---------------|----------------|
|          | Diesel        | MOME+PY        | Diesel     | MOME+PY  |
| 20       | 1.48          | 1.53           | 1.37       | 1.44     |
| 40       | 0.96          | 1.05           | 0.88       | 0.86     |
| 60       | 0.64          | 0.71           | 0.56       | 0.51     |
| 80       | 0.52          | 0.55           | 0.41       | 0.38     |
| 100      | 0.39          | 0.43           | 0.32       | 0.29     |
of H$_2$SO$_4$ to preheated oil [2,3]. The solution was stirred with magnetic stirrer for 1 hour at the speed of 600 rpm incessantly. From the separation funnel, bottom layer as taken and processed with methanol and potassium hydroxide at reaction time of 1 hour and stirring speed of 60 minutes. The last derived component from separation funnel was called as crude *Moringa oleifera* methyl ester. The methyl ester was purified with warm de-ionized water for thrice. The properties of MOME were evaluated based on ASTM [1,7,8] condition under laboratory condition and blended with 1% of PY to achieve improved fuel properties.

![Fig. 2. Variation of carbon monoxide and hydrocarbon against various engine loads.](image)

![Fig. 3. Variation of oxides of nitrogen and smoke against various engine loads.](image)
In the present work, diesel was considered as the baseline fuel and MOME was blended with 1% of PY. Both samples were investigated in normal and ceramic coated engine at various loads. Kirloskar make TV1 model direct injection diesel engine with water cooled eddy current dynamometer was used for the experimental analysis. The main specification of engine were bore x stroke of 87.5 × 110 mm, compression ratio of 17.5:1, injection pressure of 210 bar, injection timing of 21° before top dead centre and speed of 1500 rpm. Air and fuel flow unit was attached to the electronic flow control unit and linked with National Instrument (NI) based data acquisition system (DAQ). Similarly, all other electronic components associated with engine were linked with NI-DAQ. Matlab based EngineSoft Version 4.0 was used for online plotting and data recording purpose. Engine tail pipe emission was measured using AVL 444 di-gas analyser. Carbon monoxide was measured in the range of 0–10% volume, hydrocarbon in the range of 0–10000 ppm and oxides of nitrogen in the range of 0–5000 ppm. An AVL 437C smokemeter was used for the measurement of smoke in terms of HSU in the range of 0–100.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.dib.2019.103932.

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