Nano emulsified diesel - biodiesel blend selection through a MCDM technique

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Abstract. The populace growth and their expectations for everyday comforts have prompted impressive utilization of renewable energy sources. Biodiesel blends and its nano emulsions is a decent option for engine application. This paper depicts the use of crossover Multi Criteria Decision Making for the determination of best nano emulsion for engine. Here, two MCDM techniques TOPSIS and VIKOR used to get the best Nano biodiesel emulsion. Diesel, Jatropha biodiesel blend of B10, nano emulsions of B10 with 25, 50 and 100 ppm of Al2O3 are used. The Brake thermal efficiency (BTE), Smoke, Carbon monoxide (CO), Carbon dioxide (CO2), Hydrocarbon (HC), Specific Fuel Consumption(SFC), excess Oxygen(O2), Oxides of Nitrogen (NOx) are considered as the assessment criteria. It shows that Diesel is positioned first for 0%,25%,50% and 100% load and fourth for 75% burden using AHP-TOPSIS and Diesel is positioned first for 25% & 50%, second at 0% & 100% and third for 75% load using AHP- VIKOR. Consequently, it is consistent that blending B10+50PPM and B10+25PPM biodiesel is recommended as a decent swap for diesel.

Keywords: AHP, Diesel, Emission, Energy, Engine, Jatropha oil, MCDM

1. Introduction
The world biggest challenge is depletion of fossil fuel and the environmental concerns. A study was performed with various blend proportions for diesel−PFADE and diesel−PFAD−hydrous ethanol [1]. Experiment conducted on an engine, which is fueled with diesel and blends of different proportions, at last MIMO fuzzy modelling, was developed [2]. So finding the suitable and sustainable alternative fuels has become a most important [3]. Most of the nation’s focusing more on the biodiesels extracted from both non-edible and edible oils like Mahua, Karanja, Neem, Jatropha, coconut, sunflower, rapeseed and Neem etc. [4,5]. The suitability of these biodiesels and their blends in an unmodified engine depends on the ease of production, handling and considerable performance within the emission standards [6, 7]. When the biodiesels and their blend, which are extracted from edible oils like palm, tested on the engine, the lower blend (B20) was identified as an optimum blend ratio based on its emissions and performance [8, 9, and 10]. In the present scenario of nano technology, the influence of nanoparticle in biodiesel and its blends was also investigated and reported by different researchers. The nano emulsions has come about in marginally higher BSFC (5.49% expansion in 100% load) at a consistent speed for all types of loads. [11,12]. It is very essential to ensure the stability of nano
particle in biodiesel in order to ensure their influence on the engine emission trends and performance. From available research it was observed that less amount of nano in lower blend ratios like B10 and B20 is stable and exhibiting its relatively good dispersion stability [13, 14]. Compared to nano ZnO, the stability of Al2O3 in biodiesels and their blends is more [15, 16]. Similar to the nano ZnO, the nano Cerium oxide in the blends like Mauve Methyl Ester –diesel is also contributing to the improved performance of CI engine [17, 18]. Irrespective of the biodiesel, its blend with diesel and their nano emulsions, it was observed that there is a continuous increment in efficiency when load increases [19]. Both the proportion of biodiesel and nano particle in biodiesel-diesel blends is the key influencing parameters of the emissions of CI engine and performance too. To predict and optimize theses proportions, few of the researchers have done the numerical analysis [20, 21]. Also, evaluation of beat biodiesel blend for IC engine has done using hybrid MCDM methods like FAHP which is integrated with TOPSIS, VIKOR, ELECTRE and then the results are compared [22,23]. In MCDM techniques like TOPSIS and VIKOR for blend selection, nine criteria’s had taken and different biofuels are mixed with diesel and the results are finally compared [24, 25]. Fuzzy AHP is used to find the criteria weights and then it is combined with TOPSIS to rank the alternatives [26]. In this paper, AHP combined with TOPSIS and VIKOR techniques was proposed for selecting the best suitable nano added blend, which is used for IC engines.

2. Proposed Methodology for Optimum Solution

Experiments conducted on a single cylinder diesel engine with diesel, Jatropha biodiesel blend of B10, nano emulsions of B10 with 25, 50 and 100 ppm of Al2O3. To find out the fuel among tested different alternatives, the criteria weights are estimated using Analytical Hierarchy Process (AHP). Based on the criteria weights the ranking for all the alternatives are estimated by using the MCDM techniques, TOPSIS and VIKOR separately. Finally, the ranks of all alternatives for different loads were compared to select the best blend. The Figure 1, illustrates the process.

![Diagram](Figure 1. Proposed Methodology)

2.1. Analytical Hierarchal Process (AHP)

The criteria weights are estimated using AHP, which involves 3 steps. **Step 1:** Developing a hierarchal structure shown in Figure 2 with a Best fuel selection at the top level, different criteria’s at the second level and the blends at third level. Here the goal is nothing but finding weights for each criterion.
Step 2: To determine the relative significance of different criteria and pair wise comparison matrix is developed based on the scale of relative importance. The Scale of general importance are 1,3,5,7,9 rating low to high whereas 2,4,6,8 - intermediate values. All the elements in the column of pair wise comparison matrix are obtained by dividing the first element in a row with the remaining every elements in that row respectively as in Table 1. Next, normalized matrix is created by adding all elements in a column of pair wise matrix, to get a value for every criteria in every column. Then every element in a column of pair wise matrix is divided with respective sum value of that column. The prepared normalized matrix is as in Table 2.

Step 3: Calculating the consistency to check whether the obtained criteria weights are right or not, for this pair wise matrix (Table 1) is taken and the column elements are multiplied with the weight from (Table 2). The Consistency matrix is to be calculated. Then the weighted sum value is calculated by adding all the values in the particular row. Then the ratio of weighted sum value to the criteria weight are calculated for each row. By considering the average of these values the lambda max is calculated. Then consistency index (CI) and consistency ratio are estimated.

Using equation (1) the resulting value shown in Table 3

Consistency index (C.I) = \( \frac{\lambda_{\text{max}} - n}{n-1} \)  

To estimate the Consistency Ratio, Random Consistency Index (RCI) is to be considered.

Consistency Ratio = \( \frac{C.I}{R.C.I} \) 

Random index is given Table 4. The obtained criteria weights are considered as correct when the consistency ratio is less than 0.1.

2.2. TOPSIS Method

Technique for order preference by similarity to ideal solution is established on the idea of finest alternative, which is having ideal distance. This research deals with the selection of best blend out of all 5 alternatives and for which the CO%, HC (ppm), CO2%, \( O_2 \)%, NOx ppm, Smoke Mg/m3, BTE and Sfc (Kg/kWh) are considered as criteria.

The process of TOPSIS method:

Step 1: Normalized matrix:
It is aimed to convert various units in different criteria into same units to do comparisons among the criteria’s. The matrix is formed as in Table 6.

For the elective j on criteria I, of normalized values of alternatives Xij Xij is defined below:

\[ \bar{X}_{ij} = \frac{x_{ij}}{\sum_{i=1}^{n}(x_{ij})^2}, \quad i = 1,2,\ldots;p; \quad j = 1,2,\ldots,q. \] (4)

**Step 2:** Creating a weighted normalized matrix:
This matrix will be prepared by multiplying the normalized matrix Xij with its associated weight wj

\[ V_{ij} = \bar{X}_{ij} \times W_j \] (5)

**Step 3:** To determine the positive and negative ideal solutions:
Positive ideal solution \( V^+ \) shows utmost better blend and the negative ideal solution \( V^- \) indicate the least desirable blend. \( V^+ \) is maximum value as a best alternative for beneficial. \( V^- \) is minimum value as a worst alternative for beneficial.

**Step 4:** Calculation of the separation measure by Euclidean separation:

\[ S_i^+ = \sqrt{\sum_{j=1}^{m} (v_{ij} - v_{ij}^+)^2} \] (6)

\[ S_i^- = \sqrt{\sum_{j=1}^{m} (v_{ij} - v_{ij}^-)^2} \] (7)

Using equations (6) & (7), \( S_i^+ \) & \( S_i^- \) is shown in Table 7.

**Step 5:** To calculate Performance score:

\[ P_i = \frac{S_i^-}{S_i^+ + S_i^-} \] (8)

Using equation (8) \( P_i \) is shown in Table 8.

**Step 6:** Ranking the best blend:
Ranked based on descending order of \( P_i \).

2.3. VIKOR Method

This method is to find the best one among the blends. Similar to TOPSIS, an initial decision matrix is formed Table 6 to identity beneficial (whose higher value is desired) and non-beneficial criteria. Let \( W_j \) is the weightage of that particular criteria \( x_i^* \) that is the best value for that particular criteria. \( x_i \) is the value in the alternatives up on \( x_i^* - x_i \) (best –worst). Next we have to calculate \( R_i \) which is known as individual regret from the formula the \( R_i \) value is the maximum value among all the criteria of that particular.

The step by step procedure of VIKOR is as follows:

**Step 1:** Determine the Normalized matrix.

\[ \bar{F}_{ij} = \frac{f_{ij}}{\sum_{i=1}^{n}(f_{ij})^2}, \quad i = 1,2,\ldots;m; \quad j = 1,2,\ldots,n. \] (9)

**Step 2:** Determine the best \( f_i^+ \) and the worst \( f_i^- \) values for each criteria, \( I = 1,2,\ldots,q. \)

\[ f_i^+ = (\max f_{ij}) \quad f_i^- = (\min f_{ij}) \] (10)

**Step 3:** Find the utility and regret measure

\[ S_i = \sum_{n=0}^{n}(w_i * \frac{f_i^* - f_{ij}}{F_i^* - F_i^-}) \rightarrow \text{Beneficial} \] (11)

\[ S_i = \sum_{n=0}^{n}(w_i * \frac{f_{ij} - f_i^-}{F_i^* - F_i^-}) \rightarrow \text{Non-beneficial} \] (12)

\[ R_i = \max_i(w_i * \frac{f_i^* - f_{ij}}{F_i^* - F_i^-}) \rightarrow \text{Beneficial} \] (13)

\[ R_i = \min_i(w_i * \frac{f_{ij} - f_i^-}{F_i^* - F_i^-}) \rightarrow \text{Non-beneficial} \] (14)

Where \( S_i \) represents the utility measure and \( R_i \) represents the regret measure.
Using equations (11) to (14) $S_i$ and $R_i$ values are shown in Table 9.

**Step 4:** Compute the VIKOR index

\[
Q_j = v \cdot \left( \frac{S_i - S^*}{S^* - S_{\min}} \right) + (1 - v) \cdot \left( \frac{R_i - R^*}{R^* - R_{\min}} \right)
\]

(15)

Using equation (15) VIKOR Index values are shown in Table 10.

Next we have to find out the best value and worst value of $S_i$ and $R_i$, where $S^* = \min s_i$ and $R^* = \min R_i$ whereas $S_{\max}$ and $R_{\max}$ are the maximum values of $S_i$ and $R_i$ respectively. Then we have to calculate $Q_j$.

The decisions makes can select the best alternative based on these ranking in VIKOR a compromise solution is proposed.

**Step 5:** Ranking order of preference

Ranked based on increasing order of $Q_j$ value.

### 3. Computations Through Proposed Methodology

Firstly, the weights of each criteria has to find using AHP method. Next, these weights will be used in TOPSIS and VIKOR methods to rank the blends.

#### 3.1. Different Criteria’s for selecting a best blend

For selecting a best blend among 5 alternatives, below criteria’s had considered.

1. Carbon monoxide
2. Hydrocarbon
3. Carbon dioxide
4. Oxygen
5. Oxides of Nitrogen
6. Smoke
7. Brake thermal efficiency
8. Specific Fuel Consumption

#### 3.2. AHP Computations

| Criteria       | CO % | HC (PPM) | CO₂ % | O₂ % | NOₓ PPM | Smoke Mg/m³ | BTE   | Sfc (Kg/KWh) |
|----------------|------|----------|-------|------|---------|-------------|-------|--------------|
| CO %           | 1    | 3        | 4     | 5    | 4       | 2           | 0.333 | 2            |
| HC (PPM)       | 0.333| 1        | 2     | 4    | 3       | 2           | 0.5   | 4            |
| CO₂ %          | 0.25 | 0.5      | 1     | 0.5  | 0.5     | 0.333       | 0.333 | 0.25         |
| O₂ %           | 0.2  | 0.25     | 2     | 1    | 0.333   | 0.333       | 0.333 | 0.333        |
| NOₓ PPM        | 0.25 | 0.333    | 2     | 3    | 1       | 2           | 0.5   | 2            |
| Smoke Mg/m³    | 0.5  | 0.5      | 3     | 3    | 0.5     | 1           | 0.333 | 0.5          |
| BTE            | 3    | 2        | 4     | 3    | 2       | 3           | 1     | 2            |
| Sfc (Kg/KWh)   | 0.5  | 0.25     | 2     | 3    | 0.5     | 2           | 0.5   | 1            |

**Table 1.** Pair-wise comparison matrix

**Table 2.** Normalised Pair-wise matrix
| Criteria        | CO %  | HC (PPM) | CO₂ % | O₂ % | NOx PPM | Smoke Mg/m³ | BTE     | Sfc (Kg/KWh) | Criteria Weights |
|-----------------|-------|----------|-------|------|---------|-------------|---------|--------------|------------------|
| CO %            | 0.1657| 0.3829   | 0.2   | 0.2222| 0.3380  | 0.1579      | 0.0888  | 0.1621       | 0.2147           |
| HC (PPM)        | 0.0551| 0.1276   | 0.1   | 0.1777| 0.2535  | 0.1579      | 0.1333  | 0.3243       | 0.1662           |
| CO₂ %           | 0.0414| 0.0638   | 0.05  | 0.0222| 0.0422  | 0.0262      | 0.0666  | 0.0405       | 0.0441           |
| O₂ %            | 0.0331| 0.0319   | 0.1   | 0.0444| 0.0281  | 0.0262      | 0.0888  | 0.0270       | 0.0474           |
| NOx PPM         | 0.0414| 0.0425   | 0.1   | 0.1333| 0.0845  | 0.1579      | 0.1333  | 0.1621       | 0.1069           |
| Smoke Mg/m³     | 0.0828| 0.0638   | 0.15  | 0.1333| 0.0422  | 0.0789      | 0.0888  | 0.0405       | 0.0850           |
| BTE             | 0.4972| 0.2553   | 0.2   | 0.1333| 0.1690  | 0.2368      | 0.2667  | 0.1621       | 0.2400           |
| Sfc (Kg/KW h)   | 0.0828| 0.0319   | 0.1   | 0.1333| 0.0422  | 0.1579      | 0.1333  | 0.0810       | 0.0953           |

**Table 3. Calculation of λ**

| Criteria        | Weighted Sum Value | Criteria Weights | λ    |
|-----------------|--------------------|------------------|------|
| CO %            | 1.995794141        | 0.214737903      | 9.294093445 |
| HC (PPM)        | 1.508208413        | 0.16621564       | 9.073482284 |
| CO₂ %           | 0.394164692        | 0.044158142      | 8.926206509 |
| O₂ %            | 0.395918299        | 0.047471076      | 8.340206065 |
| NOx PPM         | 0.92755194         | 0.106904056      | 8.676489693 |
| Smoke Mg/m³     | 0.731516735        | 0.08507683       | 8.598304077 |
| BTE             | 2.195513857        | 0.24008269       | 9.144611149 |
| Sfc (Kg/KW h)   | 0.81864587         | 0.095342128      | 8.586402356 |

λ_max = Average Value of λ = 8.829973765
From equation (2),
Consistency index (C.I) = 0.1185677
n – number of criteria = 8
Random index is given in Table 4. The obtained criteria weights are considered as correct when the consistency ratio is less than 0.1.

**Table 4. Random Consistency Index**
From equation (3),
Consistency Ratio = 0.0840906 < 0.10, the error is 8.40906% which is less than 10%.
The criteria weights got from AHP method used in TOPSIS and VIKOR method for computations to
rank the blends.

3.3. TOPSIS Computations

Table 5. Beneficial and Non-beneficial criterion values calculated using AHP

| Criteria | CO % | HC (PPM) | CO2 % | O2 % | NOx PPM | Smoke Mg/m3 | BTE | Sfc (Kg/KWh) |
|----------|------|----------|-------|------|---------|-------------|-----|--------------|
| Non Ben. | Ben. | Non Ben. | Non Ben. | Benf. | Non Ben. | Non Ben. | Non Ben. |
| Weight(W_j) | 0.2147 | 0.1662 | 0.0441 | 0.0474 | 0.1069 | 0.0850 | 0.2400 | 0.0953 |

Table 6. Decision Matrix for alternative blends using AHP

| CRITERIA LOAD | BLENDS | CO % | HC (PPM) | CO2 % | O2 % | NOx PPM | Smoke Mg/m3 | BTE | Sfc (Kg/KWh) |
|---------------|--------|------|----------|-------|------|---------|-------------|-----|--------------|
| Diesel 0 % | B10     | 0.03 | 18       | 2.5   | 17.3 | 6   | 231        | 1   | 0.7927       | 10.560 |
| B10+25PP M | 0.02 | 10  | 2.1   | 17.9 | 2 | 231 | 1 | 0.7885 | 10.895 |
| B10+50PP M | 0.02 | 8   | 2.3   | 17.7 | 5 | 207 | 0 | 0.9131 | 9.2762 |
| B10+100PP M | 0.01 | 1   | 2 | 18.1 | 7 | 219 | 1 | 0.8699 | 9.6681 |
| Diesel 25 % | B10     | 0.02 | 19 | 3.2 | 16.3 | 4 | 407 | 1 | 15.5093 | 0.5398 |
| B10+25PP M | 0.02 | 8   | 3.1   | 16.5 | 7 | 385 | 1 | 15.9164 | 0.5398 |
| B10+50PP M | 0.02 | 9   | 3.2   | 16.5 | 4 | 363 | 1 | 14.3152 | 0.5917 |
### Table 7. Ideal best S_i+ and from Ideal worst S_i-

| BLENDS       | 0 % Load | 25 % Load | 50 % Load | 75 % Load | 100 % Load | 0 % Load | 25 % Load | 50 % Load | 75 % Load | 100 % Load |
|--------------|----------|-----------|-----------|-----------|------------|----------|-----------|-----------|-----------|------------|
| Diesel       | 0.1039   | 0.0527    | 0.0070    | 0.1736    | 0.1272     | 0.1271   | 0.0687    | 0.0267    | 0.0738    |
| B10          | 0.0825   | 0.0939    | 0.0586    | 0.1743    | 0.0769     | 0.0892   | 0.0601    | 0.0264    | 0.0104    | 0.0399     |
| B10+25PPM    | 0.1264   | 0.1322    | 0.0530    | 0.0369    | 0.0432     | 0.1041   | 0.0236    | 0.0219    | 0.1614    | 0.0450     |
| B10+50PPM    | 0.1032   | 0.0955    | 0.0592    | 0.0267    | 0.0415     | 0.1079   | 0.0631    | 0.0152    | 0.1736    | 0.0758     |
| B10+100PPM   | 0.05190  | 0.3902    | 0.3111    | 0.0563    | 0.3418     | 0.5856   | 3         |           |           |            |

### Table 8. Performance score using TOPSIS

| BLENDS       | 0 % Load | Rank | 25 % Load | Rank | 50 % Load | Rank | 75 % Load | Rank | 100 % Load | Rank |
|--------------|----------|------|-----------|------|-----------|------|-----------|------|------------|------|
| Diesel       | 0.5503   | 1    | 0.7065    | 1    | 0.9070    | 1    | 0.1334    | 4    | 0.8149     | 1    |
| B10          | 0.5194   | 2    | 0.3902    | 4    | 0.3111    | 2    | 0.0563    | 5    | 0.3418     | 5    |
| B10+25PPM    | 0.5190   | 3    | 0.4302    | 2    | 0.3383    | 3    | 0.7722    | 3    | 0.5856     | 3    |
The below histogram was drawn using Table 8.

![TOPSIS Ranking](image)

**Figure 3.** Histogram of different load rankings using TOPSIS Method

### 3.4. VIKOR Computations

**Table 9.** Utility measure $S_i$ and regret measure $R_i$ using AHP

| Blends  | 0% Load | 25% Load | 50% Load | 75% Load | 100% Load | 0% Load | 25% Load | 50% Load | 75% Load | 100% Load | 0% Load | 25% Load | 50% Load | 75% Load | 100% Load |
|---------|---------|----------|----------|----------|-----------|---------|----------|----------|----------|-----------|---------|----------|----------|----------|-----------|
| Diesel  | 0.1532  | 0.2743   | 0.0901   | 0.2228   | 0.1040    | 0.2147  | 0.2147   | 0.2147   | 0.2147   | 0.2147    | 0.1563  |
| B10     | 0.1411  | 0.5091   | 0.3065   | 0.4973   | 0.4633    | 0.1073  | 0.2147   | 0.2147   | 0.2147   | 0.2147    | 0.2400  |
| B10+25PPM | 0.4568 | 0.3544   | 0.4489   | 0.2728   | 0.4120    | 0.2161  | 0.2147   | 0.2147   | 0.2147   | 0.1069    | 0.2147  |
| B10+50PPM | 0.3489 | 0.5018   | 0.3307   | 0.1222   | 0.1746    | 0.1662  | 0.2147   | 0.2400   | 0.0850   | 0.1073    | 0.2287  |
| B10+100PPM | 0.4472 | 0.4918   | 0.5253   | 0.2741   | 0.5068    | 0.2400  | 0.2400   | 0.2400   | 0.2400   | 0.2400    | 0.2287  |

**Table 10.** VIKOR Index $Q_j$ and its ranking using AHP

| Blends   | 0% Load | Rank | 25% Load | Rank | 50% Load | Rank | 75% Load | Rank | 100% Load | Rank |
|----------|---------|------|----------|------|----------|------|----------|------|-----------|------|
| Diesel   | 0.4235  | 2    | 0        | 1    | 0        | 1    | 0.5524   | 3    | 0.1845    | 2    |
| B10      | 0       | 1    | 0.5      | 4    | 0.2485   | 2    | 0.9182   | 5    | 0.9460    | 4    |
| B10+25PPM | 0.9099 | 4    | 0.1706   | 2    | 0.4121   | 3    | 0.2712   | 2    | 0.7868    | 3    |
| B10+50PPM | 0.5508 | 3    | 0.4844   | 3    | 0.7763   | 5    | 0        | 1    | 0.0875    | 1    |
| B10+100PPM | 0.9847 | 5    | 0.9631   | 5    | 0.5      | 4    | 0.7025   | 4    | 0.9574    | 5    |

The below histogram was drawn using Table 10.
From the computations of AHP integrated with TOPSIS and VIKOR, our findings are as follows:

- At 0% load Diesel positioned first in ranking with a score of 0.5503 with AHP-TOPSIS, whereas B10 positioned first for the same load with a relative closeness of 1(1-0) with AHP-VIKOR.
  
  TOPSIS Ranking order (Diesel<B10<B10+25<B10+100<B10+50)
  
  VIKOR Ranking order (B10>Diesel>B10+50>B10+25>B10+100)

- At 25% load Diesel positioned first in ranking for both the methods.
  
  TOPSIS Ranking order (Diesel<B10+25<B10+100<B10+50)
  
  VIKOR Ranking order (Diesel>B10+25>B10+50>B10+100)

- At 50% load Diesel positioned first in ranking for both the methods.
  
  TOPSIS Ranking order (Diesel<B10+25<B10+100<B10+50)
  
  VIKOR Ranking order (Diesel>B10+25>B10+50>B10+100)

- At 75% load B10+100PPM positioned first in ranking with a score of 0.8665 with AHP-TOPSIS, whereas B10+50PPM positioned first for the same load with a relative closeness of 1(1-0) with AHP-VIKOR.
  
  TOPSIS Ranking order (B10+100<B10+50<B10+25<Diesel<B10)
  
  VIKOR Ranking order (B10+50>B10+25>Diesel>B10+100>B10)

- At 100% load Diesel positioned first in ranking with a score of 0.8149 with AHP-TOPSIS, whereas B10+50PPM positioned first for the same load with a relative closeness of 0.9125(1-0.0875) with AHP-VIKOR.
  
  TOPSIS Ranking order (Diesel<B10+100<B10+25<B10+50<B10)
  
  VIKOR Ranking order (B10+50>Diesel>B10+25>B10+100)

The mathematical model of AHP-TOPSIS and AHP VIKOR was proposed and compared to select the best blend. The process timing is more for TOPSIS if the quantity of blends and criteria’s increases and this problem will be minimised by VIKOR. In TOPSIS, the closeness coefficients of blends are
not continuously nearest to ideal solution i.e., 1. From the results, it is observed that for different types of loads AHP-VIKOR had much better nearest ideal value when compares to AHP-TOPSIS.

4. Conclusion
Overall, it is observed that B10+50 PPM are the best suitable blend among the considered blends for various loads to mitigate the emissions to improve the efficiency of the engine. To overcome the above issue, the mathematical model of AHP-VIKOR method was proposed for the identification of best suitable fuel blend.

The obtained order of ranking for both methods is B10+50> Diesel> B10+25> B10>B10+100.

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