Optimize the quality of Omani diesel fuel using additives of organic compounds

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January 4, 2020

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Abstract

An experimental and optimize study was employed to study the effects of two different additives against pour point and cloud point temperatures of a diesel fuel. Sample mixtures were made in different volumetric percentages of two different additives of ethanol and methanol in the diesel fuel mixture. Pour point and cloud point temperatures of the blends were measured using standard, ASTM D5771 is used to measure cloud point temperature and ASTM D5950 is used to measure pour point temperature methods. In fact, the greatest obtained reduction in cloud point temperature was achieved using 10 Vol% or more of methanol-diesel fuel mixtures. Slightest amounts of additives caused a high reduction in the pour point temperature of the diesel fuel. Ethyl alcohol was the most effective additive in lowering the pour point temperature of the fuel. A 10% grain alcohol-fuel mixture caused nearly about 17 ºC by reductions in the fuel pour point temperature. Thus, the greatest reduction in pour point temperature compared to the cloud point temperature. The simplex optimize algorithm method is applied to optimize high quality results with a minimum cost of the active additive compounds that be used to minimize pour point and cloud point temperatures.

Keywords: Diesel; Pour point; Cloud point; Optimization

1.Introduction

1.4 Literature Review

In that respect are several quality components to define a proper diesel fuel. Volatility, viscosity, ignition quality, cleanness, cold flow properties and Sulphur content are some of these quality factors [1]. Diesel fuels, primarily consist of organic compounds with a carbon number between 8 and 28. Due to its high activity, cost effectiveness, adaptability and reliability, a substantial share of the sum in all universe fuel trade belongs to diesel fuel. Since diesel fuel applications and utilization of commodities and services are increasing every day, its quality must also be amended to guarantee an efficient clean fuel. Diesel fuels contain medium to heavy aliphatic groups. Some research groups are centered on chemical additives to increase the tone and operation of diesel. Wax represents one of the big problem against quality of fuel [1-6]. The pour point is the temperature below which the liquid loses its current characteristics and it presents very important property can be applied to assess the activity of fuel to flow [6-8]. Cloud point is defined as the temperature at which the first crystal is formed [9-14]. Another technique to better cold flow properties of the fuels is to mix diesel fuels with other fuels [13-15]. These additives are divided into two main types: ethanol and other alcohols, biodiesel and other fuels [2,8,11-15]. Numerous studies showed that introducing ethanol to the fuel, changes the properties of the diesel mixtures. Ethyl alcohol has no underlying effect on cloud point temperature whilst it improves diesel viscosity and pour point [11,12]. Thus, the primary aim of this survey is to compare and optimize the effects of 2 different additives on cloud point and pour point temperatures of diesel fuel.

2. Methodology

Methodology can be represented as shown in Figure 1

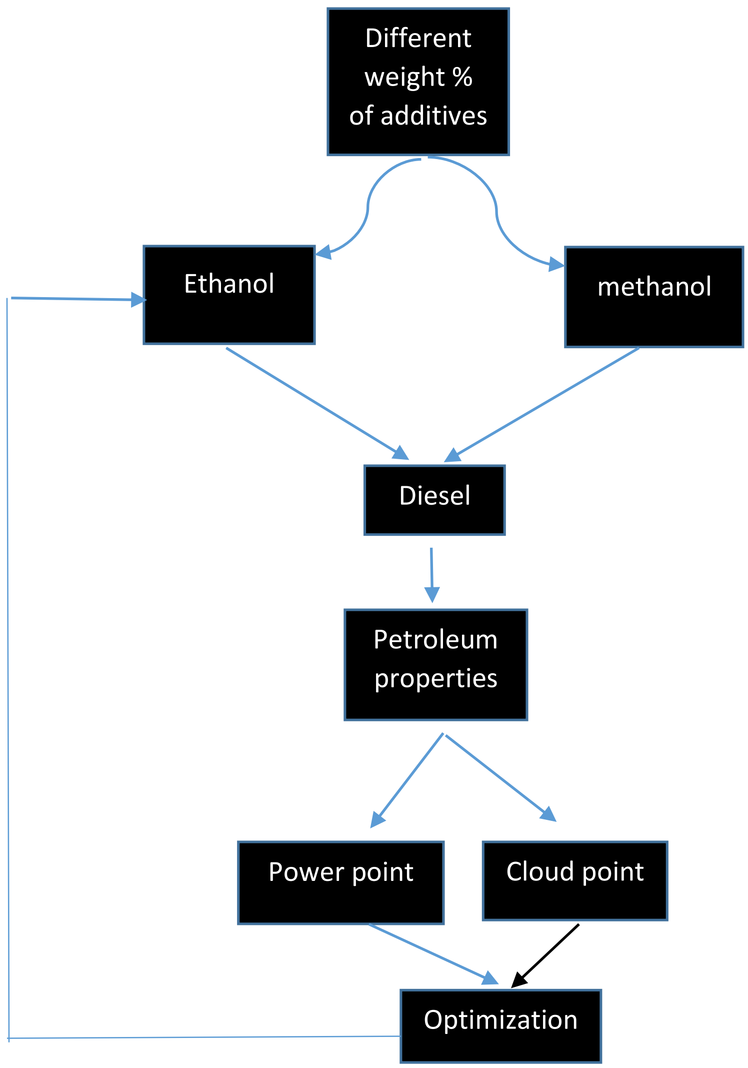

Figure 1: Methodology of this work

3. Results and calculations

Worked out the effects of each additive on cloud point and pour point temperatures changed with the volume percentage of additive. Generally, at volume percentage was equal zero that was mean no additives to the diesel.

3.1 Cloud point temperature

Figure 2 represents the effects of two additives on the cloud point temperature of the diesel. The highest reduction of cloud point temperature is obtained from methanol compare to the ethanol.

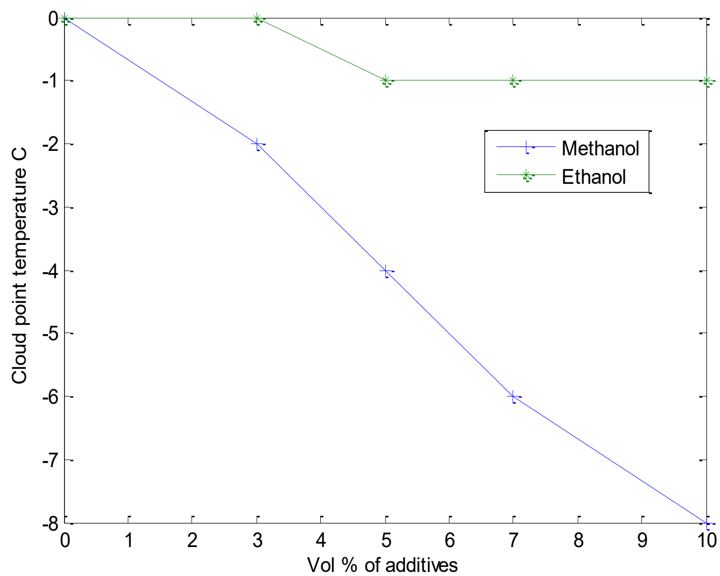

Figure 2: Explains the change of cloud point temperature changes with additive volume

3.2 Pour point temperature

Figure 3 represents the effects of two additives on the pour point temperature of the diesel. The highest reduction of pour point temperature is obtained from ethanol compare to the methanol.

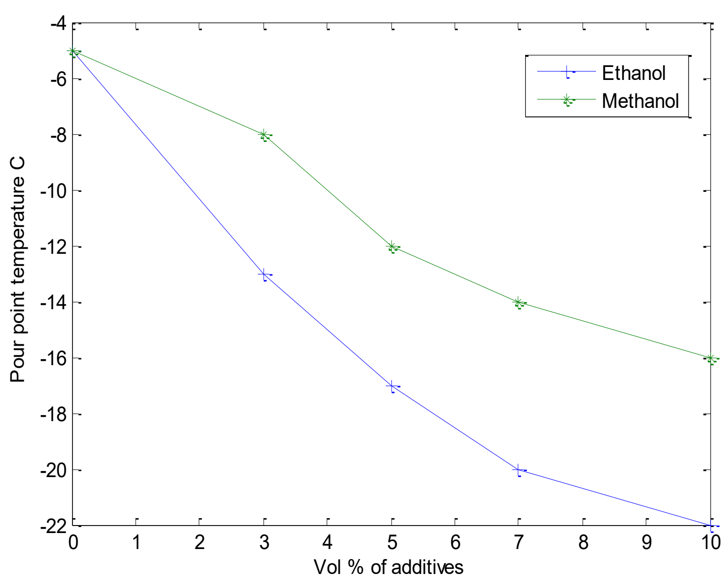

Figure 3: Explains the change of pour point temperature changes with additive volume

3.3 Optimization study

Simplex optimize method is used to make active interaction technique between parameters to handle optimum conditions to make high quality outputs and it is minimizing and maximizing constraint. The main objective of this study is to minimize cloud point and pour point temperatures depends on Simplex optimize algorithm method [12].

3.3.1 Optimize cloud point temperature

Simplex optimize method is used to minimize cloud point temperature depends on experimental outcomes to design objective function as shown in equation (1) and constraint conditions as shown in equations (2-4). Optimize steps and results are represented in Tables 1 and 2. Figure 4 explains the comparison between optimize grade and normal grade outcomes.

Minimize z= $0.8x_1 + 1.1x_2 + 0.1x_3$ (1)

$$0.1x_1 + 0.9x_2 = -8 \quad (2)$$

$$0.9x_2 + 0.1x_3 = -1 \quad (3)$$

$$x_2 = 0 \quad (4)$$

Where

x_1 : Volume percentage of methanol.

x_2: Volume percentage of diesel.

x_3: Volume percentage of ethanol.

Table 1: Step 1 represents the simplex algorithm method of cloud point temperature.

Variable	x_1	x_2	x_3	P
R_1	0.1	0.9	0	-8
R_2	0	0.9	0.1	-1
R_3	0	1	0	0
R_4	0.8	1.1	0.1	0

Mathematical operations can be represented below,

- $R_1/0.1$
- $R_2/0.9$
- $R_2= R_2- 0.111R_3$
- $R_1= R_1-9 R_2$

- Z_1=0.8 R_1-Z
- R_1= R_1+2Z
- R_2= R_2+Z

Table 2: Represents the net results of simplex algorithm method of cloud point temperature.

Variable	x_1	x_2	x_3	P
R_1	1	o	0	51.556
R_2	0	1	0	69.667
R_3	0	0	1	70.778
z	0	0	0	70.778

The optimize condition can be represented as follows,

$Z = x_1 + x_2 + x_3 = 192$

$x_1 = \frac{51.556}{192} = 0.2685$ (Volume % of methanol)

$x_2 = 0.3628$ (Volume % of diesel)

$x_3 = 0.3687$ (Volume % of ethanol)

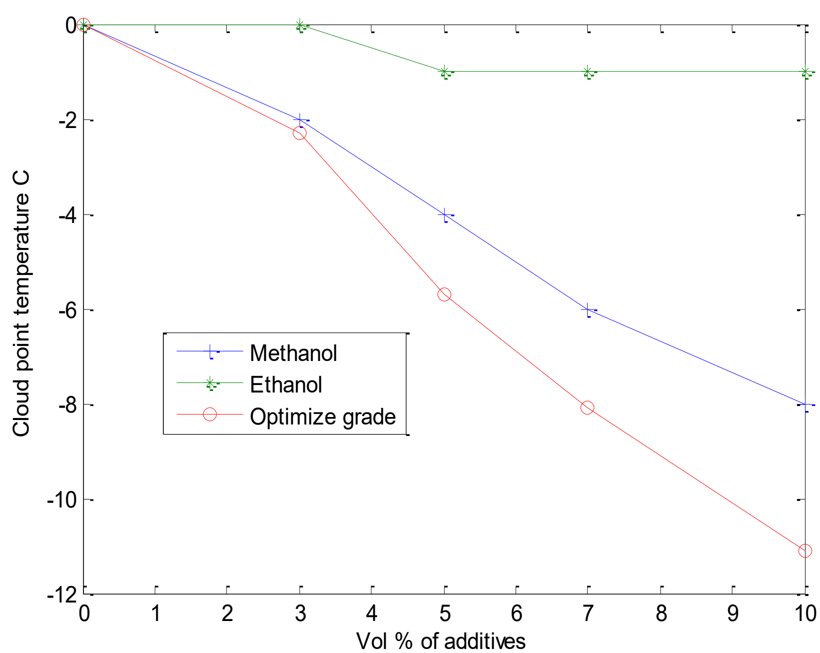

Figure 4: Comparison between optimize grade and normal grid for cloud point temperature

3.3.2 Optimize pour point temperature

The simplex optimize method is used to minimize pour point temperature depends on experimental outcomes to design objective function as shown in equation (5) and constraint conditions as shown in equations (6-8). Optimize steps and results are represented in Tables 3 and 4. Figure 5 explains the comparison between optimize grade and normal grade outcomes.

Minimize z= $2.2x_1 + 1.1x_2 + 3.4x_3$ (5)

$0.9x_2 + 0.1x_3 = -22$ (6)

$0.1x_1 + 0.9x_2 = -16$ (7)

$x_2 = -5$ (8)

Table 3: Step 1 represents the simplex algorithm method of pour point temperature.

Variable	x_1	x_2	x_3	P
R_1	0	0.9	0.1	-22
R_2	0.1	0.9	0	-16
R_3	0	1	0	-5
R_4	2.2	1.1	3.4	0

Mathematical operations can be represented below,

- $R_1/0.1$
- $R_2/0.9$
- $R_2= R_2- 9R_3$
- $R_1= R_1-9 R_3$
- $Z_1=2.2 R_2-Z$
- $R_1= R_1+2 Z_1$
- $R_2= R_2+ Z_1$

Table 4: Represents the net results of simplex algorithm method of pour point temperature.

Variable	x_1	x_2	x_3	P
R_1	1	o	0	172.5
R_2	0	1	0	336
R_3	0	0	1	342.5
z	0	0	0	347.5

The optimize condition can be represented as follows,

$Z = x_1 + x_2 + x_3 = 851$

$x_1 = \frac{172.5}{851} = 0.2027$ (Volume % of methanol)

$x_2 = 0.3948$ (Volume % of diesel)

$x_3 = 0.4025$ (Volume % of ethanol)

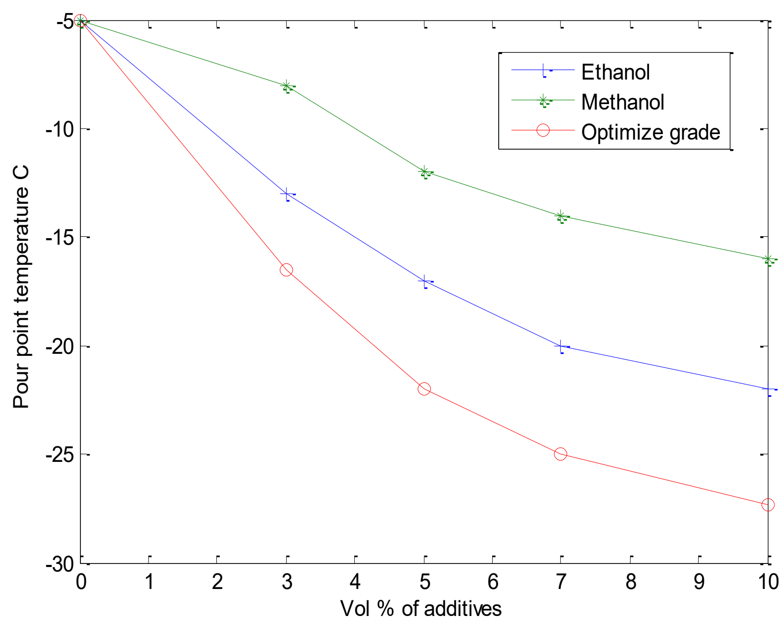

Figure 5: Comparison between optimize grade and normal grid for pour point temperature

4. Conclusions

The main results of this study are as follows,

1. The most active additive to the cloud point temperature of diesel is methanol compare to the ethanol.
2. The most effective additive to the pour point temperature of diesel is ethanol compare to the methanol.
3. The lowest effective additive to the cloud point temperature is ethanol reduced only 1 ºC.
4. The optimize conditions a provide high quality outcomes to reduce cloud point and pour point temperature to -11.1 ºC and -27.3 ºC respectively.

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