Effect of Environmental Components On the characteristic of Al-Daura Gasoline

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Abstract. An evaluation was conducted by adding two chemical blends to gasoline produced from Al Dorra refinery to study Ictane number of octans and Reid gasoline vapor pressure with different volume compositions. The two mixtures are Di-isopropylether/olive oil (DO) and Di-isopropylether/isopropanol (DI). The gasoline had been mixed with volume percentages of 8, 10 and 15. It was discovered that by adding the two blends of Di-isopropyl Ether / Olive Oil and Di-isopropyl Ether / Isopropanol, the octane number of gasoline risen continuously and linearly. The DI-gasoline blends developed greater gasoline octane number. Compared to the plain gasoline, the two additions observed a substantial reduction in Reid vapor pressure and calorific levels. Reid vapor pressure is shown to rise in the two blends.

Keywords: gasoline, Reid vapor pressure, Octane number, Calorific, olive oil.

1. Introduction

Gasoline (also called as gas and petrol) is a mixture of rapidly volatile liquid mixture of hydrocarbons, that derivative of petroleum and it is used as a fuel for cars because of the high energy resulting from its combustion, and because of its ability to blend rapidly with oxygen in the car carburetor as well as used as fuel for aircraft, compressors and generators. Gasoline does not ignite in its liquid form as other hydrocarbons, as it should evaporate and mix with oxygen[1]. It is still the most common producer where it would be derived from crude oil and forms the bulk of the product gained per barrel of crude oil. [2]. The gasoline formulation (in percent volume) varies widely with the manufacturing methods, the crude oil consumer, and the overall balance of market production. [3]. Table 1 shows the standard hydrocarbon composition in gasoline. Octane number is described as among the most crucial gasoline properties and is defined as the potential of fuel to early combustion resistance (i.e. engine knock).

Another definition of the octane number was the % volume fraction of ioctane when it combined with a blend of nheptane and ioctane that were arising a similar knock incisiveness that is produced from the fuel test in an internal combustion engine, according to the ASTM standard testing conditions. The ASTM specified the number of different types of octane number. The first is the research octane number (RON). RON is commonly assessed using ASTM tests D2699. The second type is the motor octane number (MON). MON is commonly assessed using ASTM tests D2700[3, 4].
Table 1. Chemical constituent of gasoline.

| Chemical constituent | Fraction (% vol.) |
|----------------------|-------------------|
| n-Alkanes            | 4 to 8            |
| n-Alkenes            | 2 to 5            |
| Benzenes             | 0.5 to 2.5        |
| Cyclo-alkanes        | 3 to 7            |
| Cyclo-alkenes        | 1 to 4            |
| Iso-alkanes          | 25 to 40          |
| Aromatics            | 20 to 50          |

The fuel’s self-ignition has a knock-on effect on gasoline engines. While the air-fuel blend burned in the piston, knocking is an extreme, pinging sound; this raises the risk of engine damage and decreases engine performance. In a regulated operation called deflagration, spark-ignition engines are based on gasoline-burning where such a process is important in the rhythm of combustion, which could be adversely influenced by gasoline self-ignition and benefit from the common phenomenon suggested as the engine knock. [5, 6].

When rising the content of the branching chains and aromatics carbon atoms, the octane number tends to increase. The presence of longchain hydrocarbons decreases the octane number. Straight chain alkanes such as heptane, octane, and nonane are quite easy to ignite and eventually burst. Chain-like branching alkanes (such as 2,2,4-trimethyl pentanes and iso-octane) do not tend to self-ignite. Cyclic hydrocarbons have an octane number higher than straight-chains hydrocarbons. [7, 8].

Auto engineers found out in the early 20th century that engines without knock would operate more efficiently and smoother. Thomas Midgley In 1916, a research scientist at the Dayton Research Laboratories in Dayton, Ohio, discovered that the application of iodine to fuel drastically reduced knocks on the engine. A joint research project carried out by Midgley and Charles Kettering (the creator of the electric self-start device) in 1917 to enhance gasoline efficiency. In this research ethyl alcohol (grain alcohol) was combined with gasoline. The results show that alcohols improved fuel efficiency. In December 1921, Midgley discovered the antiknocks characteristics of tetraethyllead (TEL). In 1923, TEL started producing in small companies in Ohio and Dayton, which produced almost 600 L of TEL/day [9].

The research for ethanol-blended fuel persisted until August 1925 when TEL development was alerted by William Mansfield Clark, the head of the laboratories at the U.S. Public Health Service (USPHS). Clark warns that TEL commonly used in gasoline where he spoke to A.M. Stimson, the assistant general surgeon at USPHS. The warning stated that every liter of burning gasoline could generate one gram of lead oxide, which could accumulate on the heavily travelled roads at a serious level.

Ethylene Dibromide (EDB) was briefly applied to leaded gasoline throughout the early 1970s to reduce the adverse effect of lead on car engines. Due to the extreme outlaws, EDB companies find a new use of this compound as a pesticide. The United States imposed a prohibition against the use of gasoline using lead on-highway vehicles on 1 January 1996 [10]. The oxygenates were commonly added to the gasoline throughout 1979 once methyl tert-butyl ether (MTBE) was introduced to substitute TEL and improved the level of gasoline octane. Via intense talks involving members of the oil industry, vehicles and USEPA, state officials, fuel dealers, environmental representatives, distributors of oxygen and consumer groups and as a component of the 1990 revisions to the Clean Air Act. [11].

Ethanol is currently a significant part of the alternate energy market, particularly in Sweden, Australia, Brazil, the United States, and other countries [12]. Blends of ethanol and ethanol-gasoline are smoothly burned and generate higher octane levels than plain gasoline, resulting in lower carbon monoxide and unburned hydrocarbon. Besides precursor ozone, carbon monoxide poses a significant threat to human health. Ethanol fuel provides a large evaporation rate that decreases the temperature inside the engine, lowers NOx pollution, and improves the power of the engine. On the other hand, it has greater
evaporative emissions from distribution equipment and fuel tanks. The emissions of evaporative contribute to the formation of smog and ozone at ground level.[13]. In principle, in new engine emission control schemes, the effect of ethanol on NOx and CO emissions is marginal[14]. As well know, many chemical additives are being utilized to increase the gasoline octane number. Nevertheless, the use of di-isopropyl in a combination of natural substances and chemicals as additives has not yet been checked. The intention of using these additives is to increase the amount of octane engines in internal combustion and to reduce air emissions.

2. Methodology

2.1 Materials
Reformate (Ref.) and Sweet Light Naphtha (SLN) Gasoline were utilized in the current research. The two types of gasoline were supplied firm Al-Doura refinery, Baghdad-Iraq. Gasoline samples have been tested and the properties are specified in Table 2. Analytical reagent grades of Di-isopropyl Ether and Isopropanol (99.95%) were obtained from Sigma-Aldrich. Olive oil has been purchased from local stores.

Table 2. Properties of gasoline fractions from Al-Doura Refinery.

| Sample | LN | Feed | Bottom | HN | Reformete |
|--------|----|------|--------|----|-----------|
| SpGr   | 83.5 | 64.5 | 64.9   | 60.4 | 52.5 |
| RVP    | 17.3 |      |        | 6.6  |           |
| Distillation | | | | | |
| I.B.P  | 32  | 48   | 54     | 82  | 44 |
| 5%     | 36  | 56   | 62     | 92  | 60 |
| 10%    | 40  | 66   | 70     | 98  | 72 |
| 20%    | 46  | 74   | 78     | 104 | 82 |
| 30%    | 54  | 86   | 89     | 110 | 94 |
| 40%    | 62  | 98   | 102    | 116 | 106 |
| 50%    | 68  | 108  | 114    | 124 | 116 |
| 60%    | 76  | 116  | 122    | 132 | 126 |
| 70%    | 84  | 124  | 128    | 140 | 134 |
| 80%    | 90  | 132  | 136    | 144 | 144 |
| 90%    | 94  | 144  | 146    | 148 | 152 |
| 95%    | 98  | 152  | 154    | 158 | 162 |
| E.P    | 120 | 174  | 176    | 180 | 190 |
| RON    | 62  |      |        | 90  |   |

2.2 Experiments Procedure
The first step of the experiments was the preparing of the gasoline and additives mixture. Gasoline mixture comprises equal volumes of Ref and Light Straight Run Naphtha (LSRN). The additives were prepared in two mixtures. The first mixture contains 5% Olive oil and 95% Di-isopropyl Ether (DlPE) (thereafter referred as DO) and the second mixture contain 70% Isopropanol and 30% DIPE (thereafter referred as DI).
Seven liters of gasoline mixture was blended in a bowl. The bowl was at a refrigerated temperature of 5°C to eliminate evaporation of the volatile components. Also, the bowl has a fitting cover and stirred by a rod. A 400 ml of the first and second additives blended to the gasoline bowl respectively. The second stage was preparing research samples. Three samples of gasoline and DO and DI additives were prepared separately. Gasoline fractions in samples were 85, 90, and 92 volume percentages.

CFR engine and Reid vapor pressure (RVP) were utilized by the current research to measure the octane number and the Reid vapor pressure respectively for all samples including pure gasoline blend (before adding the DO and DI additives).

2.3 Analysis
The fuel characteristics of the samples are calculated according to the petroleum products protocols of the American Standard for Testing Materials (ASTM). ASTM D2699 (the Cooperative Fuel Research Engines (CFR)) was utilized to estimate the octane number. To evaluate the Research Octane Number (RON), a standardized test engine in standard operating conditions were utilized. To compare PRF blends samples knock properties with those of known RON, and a spark-ignition engine fuel was used. The fuel-to-air ratio was controlled and quantified using a specific electronic detonator device meter system to produce a standard Antiknock Index (AKI) for fuel specimen. This chosen approach is guided by the routing table to RON stage engine CFR. The oil-to-air ratio of the gas sample and each combination of the standard reference fuel blends are controlled to optimize the AKI for each fuel.

The AKI equilibrium rate for each phase was adjusted to achieve the full AKI by incorporating progressive changes in the mixture's energy and then choosing the conditions that maximize the reading. The power of the combination has been adjusted by choosing the full AKI from either lean-to-rich or rich-to-lean at a constant rate. Figure 1 displays the unit.

ASTM D323 (Vapor Pressure for Products Petroleum (Reid Method)) was utilized to evaluate the pressure of the Reid vapor. The container is filled with 80 percents of its volume and then sealed, put in a water bath until it hits 0°C and then opened and returned to the water bath and repeated this three-fold cycle. The container was filled to 80% in a water bath until it reaches 0°C. The container was opened and covered again for three times to get rid of vapors. Samples were putten inside the tub and checked.
by pressing the test button. Once that is fixed, the measurement for the chamber was obtained from the monitor referring to the same amount. The device is shown in Figure 2.

![Figure 2. Show Reid Vapor Pressure Method Test Engine.](image)

### 3. Results and Discussion

DIPE was picked and combined with other additives (olive oil (as a natural material) and isopropanol (as a synthetic material) in this analysis (95 and 30 vol. percent). The results lead to an increase in fuel mileage and an elimination of pollutants in the case of the olive oil-gasoline combustion engine. Incorporating olive oil to gasoline would improve the performance of combustion, thus reducing CO$_2$ emissions.

Adding DIPE (Oxygenate Compound) increases CO$_2$ as a result of full combustion and reduces CO emissions. This could be attributable to faster combustion resulting in an increase in oxygen content once the DIPE content of the blends rises. Faster combustion decreases the exhaust emissions of carbon monoxide. This implies that the introduction of olive oil with DIPE to gasoline reduces the CO$_2$ that improves gasoline performance\cite{15, 16}.

In contrast, the blend was effective in transporting the "anti-stalling properties" of gasoline in the case of an Isopropanol-gasoline combustion engine. However, when functioning internal combustion engines of the sort used in cars, gasoline evaporates in the carburettor air on cold and humid days and results from inadequate cooling effect throughout the warm-up timespan to condense and freeze air moisture in the carburettor. Adding DIPE to alcohol in a small amount motivates to delay the creation of ice\cite{17}.

The proceeding research focused on the usefulness of adding DO and DI on the octane number, Calorific, and Reid vapor pressure values.

The practical measure demand a specific method to measure of the anti-knocking fuel force. The Octane Research Number (RON) (ASTMD2699) is among the required octane number measurement trials. A single drum engine operating at 600rpm is used for this procedure. Details of the RON tests for the introduction of DO and DI to the gasoline mixture are shown in Table 3.

| Blending Ratio          | Blend Number | RON of DO | Blend Number | RON of DI |
|-------------------------|--------------|-----------|--------------|-----------|
| 100% gasoline+0% DO/DI | 1            | 76        | 1            | 76        |
| 92% gasoline+8% DO/DI  | 2            | 76.9      | 5            | 79.4      |
| 90% gasoline+10% DO/DI | 3            | 77.5      | 6            | 80.6      |
| 85% gasoline+15% DO/DI | 4            | 79.2      | 7            | 82.3      |
As illustrated in Figure 3, the RON values of tested gasoline blends with DO began with 8 percent. It was noticed that in the region of 8 percent of the blending ratio, the octane rate was improved consistently and linearly. A marginal rise in RON was reported to a value of 79.2 at 15 percent DO.

![Figure 3. RON value of the gasoline mixture blended with DO.](image)

Raising the DI fraction through up to 15% resulted in a slight uptick in the RON number to a value of 82.3. This uptick is due to the influence of Isopropanol with DIPE, in which Isopropanol has elevated levels of octane and thus could achieve designated values for the quality of octane. While the introduction of the ether splits the bond between the C-H and the free root structure, there is a high octane amount applied to it. [17]. RON readings are shown in Figure 4.

![Figure 4. RON value of the gasoline mixture blended with DI.](image)

Table 4 describes the effects of the Reid vapor pressure (RVP) (evaluated in psi) at a temperature of 37.8°C compared to the plain gasoline mixture.

As seen in Figure 5, the introduction of DO and DI to gasoline blends reduced the Reid vapor pressure to a value of 7.15. It has been found that introducing an amount of isopropyl alcohol and DIPE to a gasoline blend from Al-Daura refinery lead increase in vapor pressure associated. Figure 6 shows that the Reid vapor pressure is decreased from 9.7 to 8.6 with eight percentage DI ratio. However, increasing the RVP ratio to 10 percentage lead increase and then decreased finally to 7.5 with 15% additive.

![Figure 6. The effect of DO and DI on the Reid vapor pressure.](image)

**Table 4.** RVP values after blending DO and DI to gasoline mixture.
This reduction in RVP following the introduction of di-isopropyl ether to gasoline as di-isopropyl ether has high molecular weight and low fluctuations. Likewise, because of its high density, the introduction of olive oil also reduced RVP. [18]. The reason for the rise in RVP at 10% of DI is due to the percentage of different compounds in the primary gasoline, some of which will be repelled to some extent by polar alcohol molecules. With increased dissonance, there will be high vapor pressure. However, at 15%, the gasoline samples become lighter and RVP decreased [17].

Table 5 displays the calorific value (CV) outcomes (measured in Kcal/kg). The theoretically values were calculated from the following equation [19]:

\[
CV = 12400 - 2100 \times (\text{sp. gr.})^2
\]  

(1)
The specific gravity of the gasoline/additives mixture was calculated using the ASTM (D287) test density measurements of the samples. As seen in Figure 7, the CV measurements with DO were substantially reduced from about 11350 to 11340. In Figure 8, the CV values after adding DI drop to about 11322.

**Figure 7. CV value of the gasoline mixture blended with DO.**

**Figure 8. CV value of the gasoline mixture blended with DI.**

4. Conclusions
The studies have been conducted in the following terms, based on the analytics discussed above:

- Blends of the preparation element used for constructive measures to improve the number of octans;
- The increase in the number of octans with DI was observed more than most of the inclusion of DO, suggesting a strong raise impact of isopropanol.
- DI is the best-prepared mixture to boost the octane number by rising from 76 to 82 at 15 percent volume fraction.
- The mixtures of the preparation component decrease the RVP.
- RVP for gasoline has been observed within limits allocated by ASTM through enhancements with different additives.
- Due to its high density, the effect of incorporating olive oil was a consistent reduction in the Reid vapor pressure.
- DI's calorific value is reduced. It implies that the additive provides a fuel-like or better feature.
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