



## Discussion of the Parameters Affecting the Boiling Point in the Distillation Test of the Kerosene Product

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ORIGINAL STUDY

# Discussion of the Parameters Affecting the Boiling Point in the Distillation Test of the Kerosene Product

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## ABSTRACT

Currently the kerosene fuel is very important for use in the heating, cooking, and fuel of the jet engines. The study aims effected of mixing different lite bit and same of gasoil to three different type of kerosene samples, and study the initial boiling point (IPB) during of distillation test. This study focused on targeting the IPB of the kerosene samples by finding the specific gravity (Sp.gr) test, the American Petroleum Institute (API) degree, and distillation test. However, these samples of kerosene were characterized and labeled (kero-01, kero-02, and kero-03, respectively) before the dealing processes, while the samples after the adding processes were labeled (kero-11, kero-12, and kero-13, respectively). The results showed that the IBPs were reached 151 °C, 161 °C, before, and after blending processes respectively. Then study addition percentage (5 to 95 %) of gasoil to kerosene was affected to the IPB. The addition rate showed that the increase was approximately 8 % of the boiling point. Finally, via finding sp.gr, API degree and distillation of final products it was found that the mentioned mixing ratio was very small, yet it was effective in examining the IPB in the distillation test during this work.

**Keywords:** Kerosene, Fuel, Specific gravity, Distillation, Initial boiling point

## 1. Introduction

Alternative fuels have attracted growing attention as renewable sources of energy, in combination with the imperatives to reduce greenhouse gas emissions and diminish global dependency on conventional fossil fuels [1]. The usage of fossil fuels in many sectors for fuel and electricity generation continues to pose a threat to global stability and sustainability, as do low kerosene, gasoline, and diesel requirements. Be-

cause of the reduction in quantity, these three fuels have much more negative consequences [2]. Liquid hydrocarbons consist of carbon atoms ranging from 5 to 18 carbon atoms, while gaseous hydrocarbons consist of 1–4 or more carbon atoms [3]. The most important distillates in the distillation tower are liquid and the most important liquid distillates used in transportation are known by the size of their short straight chains classified from alkane. Gasoline consists from C5–C8, kerosene from C9–C14, and

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diesel from C15–C20 [4]. Kerosene is an important petroleum derivative and can be referred to by different names such as kerosene, paraffin, paraffin oil that boil between 150 °C and 275 °C [5]. Kerosene is a flammable liquid that is colorless or close to light yellow and has a distinctive smell [6]. Kerosene contains to the different group of material called hydrocarbons.

These heterogeneous hydrocarbons are groups of aliphatic and aromatic compounds which are generally divided as either paraffin, naphthene, or aromatics with a small percentage of aromatic compounds by weight (3.9 %, w/w) The length of the hydrocarbon chains varies 6 and 16 carbon atoms [7]. Kerosene has wide and varied uses worldwide. It is used in high-pressure lighting, heating and cooking [8]. Although access to electricity and natural gas has improved, kerosene is still widely used in developing countries for cooking, heating and lighting. Kerosene is a good alternative to solid fuels, biomass and coal, and kerosene lanterns are used for lighting in places where access to electricity is not available. Kerosene is considered a clean fuel depending on how it is used. Kerosene can be divided into two classes. The first class is typing 1-K and the second class is type 2-K, according to the sulfur content. The first class 1-K contains 0.04% sulfur by weight. This type is used in solar heaters, while the second class contains a high percentage of sulfur at 0.3% because it contains a high percentage of sulfur [9]. Three grades of kerosene are produced for use as jet fuel in addition to the fuel used in military aircraft. They are Jet A-1, Jet A and Jet B. Jet A- 1 is used as jet fuel and has a minimum flash point of 37.7 °C and an effective point of –47 °C. Most civil aircraft use Jet A-1 fuel. Jet A fuel is similar to Jet A-1 fuel except that Jet A fuel has a higher freezing point of –40 °C. Jet A fuel is mostly used in the United States. Jet B is a cut fuel consisting mainly of naphtha and kerosene and can be used as a substitute for Jet A-1 fuel. It is difficult to handle due to its low flash point and high flammability [10].

The composition of petroleum derivatives can be known through the refining process in the distillation tower. Therefore, kerosene and diesel are considered intermediate derivatives in the fractionation tower to distill crude oil [11]. Kerosene produced from crude oil refining processes produces jet fuel with detailed quality specifications. To achieve high quality specifications, kerosene with high specifications is produced by desulfurization with hydrogen, by converting sulfur compounds into hydrogen sulfide which is then converted into elemental sulfur through the desulfurization unit [12].

The catalyst used, operating conditions (temperature and pressure), and the type of oil used result in

different chemical fraction compositions of kerosene, which is used as a basic requirement for aircraft fuel construction. The catalyst used, operating conditions (temperature and pressure), and the type of oil used result in different chemical compositions of kerosene fractions. Physical and chemical grays influence the quality of kerosene, which is a basic requirement for aircraft fuel [13]. As for the ratio (5% of kerosene fuel blended to 95% of gasoil fuel), it depends on the ratio of gasoline to kerosene, especially in the summer, which is always called maximizing production, due to the low need for heating in the summer and the increased need for diesel fuel consumption in that season. The distillation profile which included initial boiling point (IBP), temperature at which 10% of the distilled volume is recovered (T10), final boiling point (FBP), flash point, density, viscosity, and sulfur content [14]. The most important advantages of evaluating kerosene fractions to extract high-quality, usable jet fuel and increase the profits of existing refineries [15]. The aim of this study was to study the effect of the mixing ratio of gasoil fuel to kerosene and to study the ratio in known, which indicates its effect specifically on the initial boiling point test in the distillation test.

## 2. Materials and methods

### 2.1. Kerosene samples preparation

In this study different three samples of kerosene were brought from oil products distribution (OPDC) company, Western authority, Salahuddin branch laboratory (Baiji) to University of Mosul, College of Petroleum and Mining Engineering, Oil and Gas Refining Engineering Department. They are brought in sealed plastic containers prepared for this purpose according to the modeling system ASTM D4052 [16].

### 2.2. Distillation processes

Fig. 1 shown the distillation instrument, which was used to distillate kerosene to demonstrate its boiling points range (Distillation Apparatus, Model GD-6536 C, serial number AT2024090901(2023)). In this research, three samples of kerosene, distillation flask (round bottom flask 125 ml), thermometer 300 c, cylinder as a material were used. Placed the distillation flask containing the kerosene sample on the heating source. Connected the flask to a condenser using a still head. Connected the condenser to a cylinder 100 ml to collect the distillate. Inserted a thermometer into the still head to monitor the vapor temperature. Heated the mixture, gently heated the distillation flask using the heating mantle. Ensured



Fig. 1. Distillation apparatus.

the heating is gradual to allow for proper separation. Observed the thermometer reading. As the kerosene started to boil, the temperature raised and then stabilize at the boiling point of the lowest boiling component present in the mixture. Collected the distillate, the vapor which raised, passed through the condenser where it will cool and condense back into a liquid, collected this liquid (the distillate) in the receiving cylinder. Then record the distilled volume as result in the results section.

### 2.3. Addition processes

Fig. 2 shown the blending processes of gasoil to kerosene. The blending processes were carried out by adding 5 % of gasoil to 95 % of kerosene product. The physical specifications of the samples before addition and the final samples (after addition) were found and their results were compared.

### 2.4. Laboratory test methods

The kerosene samples were analyzed via (Sp. gr) according to ASTM D 4052 [17]. Eq. (1) shown the (API) degree depending on the ASTM. However, the distillation tests were included initial boiling point (I.B.P) by C, and boiling point (E.B.P) by (C), volume distilled (ml), total distillation (T.D), residual volume

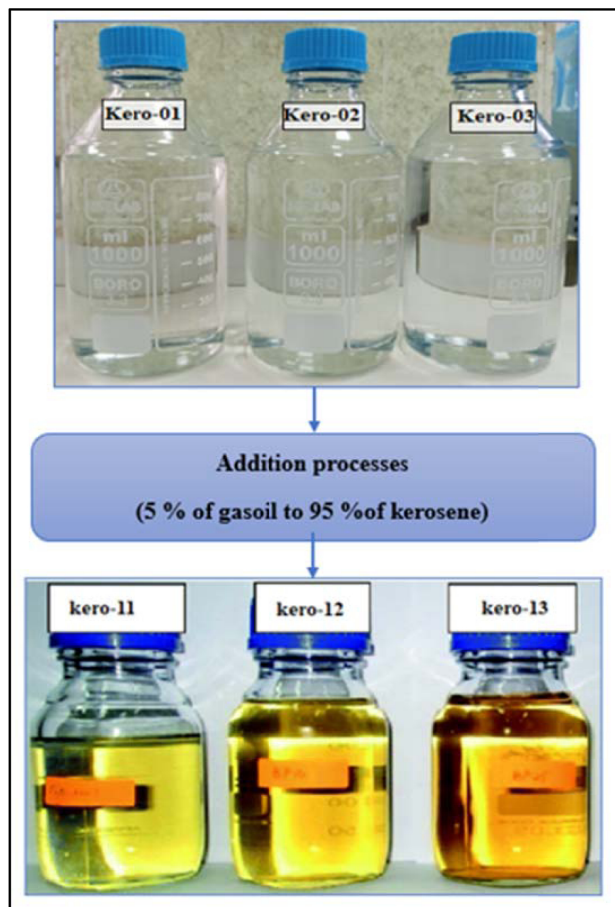


Fig. 2. Schematic diagram of addition of kerosene process.

ml, and loss volume ml during ASTM D86 [18].

$$\text{API} = \frac{141.5}{\text{Sp. gr}} - 131.5 \quad (1)$$

## 3. Results and discussions

### 3.1. Kerosene specification (as received)

Table 1 and Fig. 3 shown the Sp. gr, API, F.P and distillation of kerosene samples before dealing process (as received) were called kero-01, kero-02, and kero-03 respectively, report error bars to prove the significance of the data. The results showed the IBP were close each other one and less than 160 °C, that's mean the results were agreed to the Iraqi local marketing specifications guide for the year (2025) [19].

#### 3.1.1. Specific gravity of kerosene

Table 1 and Fig. 3 shown the specific gravity (Sp.gr) tests of kerosene samples named kero-1, kero-2, and kero-3 respectively (as received). As a result, the showed the specific gravity between (0.800 to 0.850). The specific gravity of kerosene typically falls within

**Table 1.** Physical properties tests of kerosene samples (as received, before adding process).

Tests	Kero-01	Kero-02	Kero-03
Density	794.1	814.2	783.5
Sp. gr	0.7941	0.8142	0.7835
API	46.7	42.3	49.1
F. P °C	53	54	51
Distillation			
I.B.P °C	145	151	140
Volume 5 % °C	170	175	179
Volume 10 % °C	184	183	184
Volume 20 % °C	192	190	191
Volume 30 % °C	200	200	196
Volume 40 % °C	205	204	200
Volume 50 % °C	211	206	206
Volume 60 % °C	218	208	216
Volume 70 % °C	225	219	219
Volume 80 % °C	230	223	225
Volume 90 % °C	241	236	237
Volume 95 % °C	248	240	245
E.B.P °C	264	257	256
T.D volume % ml	99	98.5	99
Res volume % ml	1.0	1.2	1.0
Loss volume % ml	0.0	0.3	0.0

a range, but it's generally around 0.800 This means that kerosene is less dense than water [20].

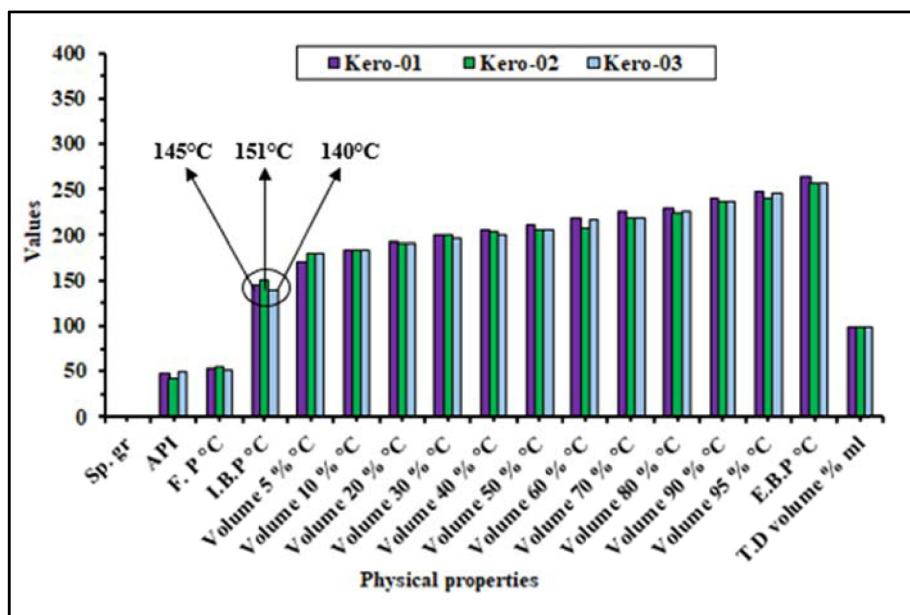
### 3.1.2. American petroleum institute (API)

Table 1 shown the Amerce petroleum institute (API) tests of kerosene samples named kero-01, kero-02, and kero-03 respectively (as received). The American Petroleum Institute (API) gravity is a relevant measurement. It's a measure of how heavy or

light a petroleum liquid is compared to water. A higher API gravity indicates that the liquid is lighter and less dense. The API gravity is calculated using a formula that relates it to the specific gravity of the liquid. Kerosene typically has an API gravity in the range of roughly 40 to 50 degrees. This indicates that kerosene is relatively light compared to water. The relationship to Specific Gravity API gravity and specific gravity are inversely related. API gravity is a standard measure in the petroleum industry. kerosene has a relatively high API gravity, meaning it is a light petroleum product [21].

### 3.1.3. Distillation

Table 1 and Fig. 3 shown the distillation tests of kerosene samples which named kero-1, kero-2, and kero-3 respectively (as received). Crude oil is a complex mixture of hydrocarbons. Kerosene is a product of crude oil distillation, specifically obtained through a process called fractional distillation. Fractional distillation involves heating kerosene, causing it to vaporize. The vapor then rises through a distillation tower, where it cools. Different hydrocarbons condense at different temperatures, allowing them to be separated. Kerosene condenses at a specific temperature range within this tower. Kerosene is a "middle distillate," meaning it condenses at a temperature between lighter products like gasoline and heavier products like diesel. Specifically, kerosene is generally collected within a temperature range of approximately 150 °C to 275 °C [22]. The resulting



**Fig. 3.** Physical properties tests of kerosene samples (as received, before adding process).

**Table 2.** Sp.gr, API, and distillation tests of kerosene samples (after the dealing processes).

Tests	Kero-11	Kero-12	Kero-13
Density	794.1	814.2	783.5
Sp. gr	0.7941	0.8142	0.7835
API	46.7	42.3	49.1
F. P °C	53	54	51
Distillation			
I.B.P °C	160	162	159
Volume 5 % °C	170	171	171
Volume 10 % °C	175	176	174
Volume 20 % °C	180	179	178
Volume 30 % °C	185	186	183
Volume 40 % °C	190	188	186
Volume 50 % °C	193	194	193
Volume 60 % °C	196	197	199
Volume 70 % °C	204	204	206
Volume 80 % °C	210	211	213
Volume 90 % °C	220	221	226
Volume 95 % °C	236	225	245
E.B.P °C	245	250	255
T.D volume % ml	98	99	98
Res volume % ml	1.0	1.0	1.6
Loss volume % ml	1.0	0.0	0.4

kerosene is a relatively light, clear liquid mixture of hydrocarbons. The distillation process allows for the separation of crude oil into various useful products. Fractional distillation is the industrial method used to produce kerosene. The boiling point ranges within the distillation tower, are what allows the separation of the Kerosene from the other petroleum products [23].

### 3.2. Kerosene specification (after adding process)

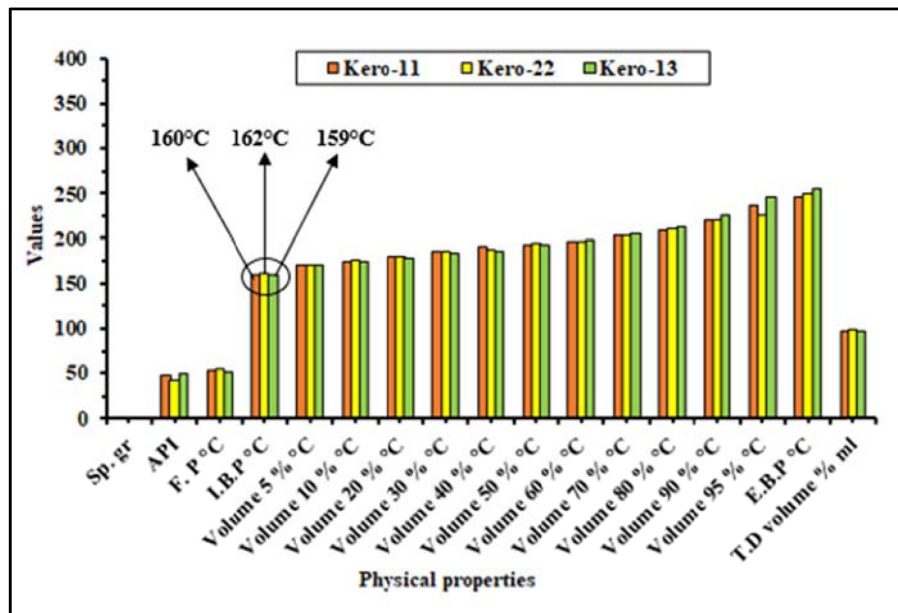
Table 2 and Fig. 4 shown the shown the specification results, which included the Sp. gr, API, F.P, and distillation of kerosene samples (after the dealing processes) they were called kero-11, kero-12, and kero-13 respectively. As a results in Table 2 the testes has been done among these testes the F.P is a critical test of the kerosene fuel [24].

#### 3.2.1. Specific gravity

Table 2 and Fig. 4 shown the specific gravity (Sp. gr) of kerosene samples (after the dealing processes) which named kero-11, kero-12, and kero-13 respectively. As result, the Sp.gr after adding process this finding indicates that the Sp.gr test was not affected because the mixing ratio (5 % to 95 %) was low [25]. Furthermore, the results showed that the density testing rate was within the expected range and in accordance with the Iraqi Local Marketing Specifications Guide for 2025 [26].

#### 3.2.2. American petroleum institute gravity

Table 2 and Fig. 4 shown the American petroleum institute (API) of kerosene samples (after the dealing processes) which named kero-11, kero-12, and kero-13 respectively. The results showed that the API gravity was not affected because this test was similar between the products of gasoil and kerosene, so the percentage of influence was not noticeable [27]. According to [1] study, the oil graduation rate was in



**Fig. 4.** Physical properties tests of kerosene samples (after adding process).

accordance with local standard specifications for gas oil products.

### 3.2.3. Distillation

Table 2 and Fig. 4 shown the distillation profile of kerosene samples (after the dealing processes) which named kero-11, kero-12, and kero-13 respectively. In this experiment, with regard to the distillation test, the IBP test had a clear and noticeable effect due to the effect of the mixing ratio, which indicates that when mixing any ratio of gasoil to kerosene, it will affect IBP. Therefore, the accuracy of the distillation test results must be confirmed to make sour actual results, during distillation processes the main point found is boiling point also known as a (initial boiling point I.B.P and end boiling point [28].

## 4. Conclusion

In this study, three samples of kerosene product were compared and the factors affecting the (IPB) result were successfully identified in the distillation test. In this study, it was found that the boiling point before the blending process was close to each other and was less than 160 °C, which indicates that the product conforms to the local marketing specifications. The blending percentage of gasoil was constant 5% of all additions, while it were affected to the specifications. However, after the mixing process, the mixing process did not really affect it, as it was insufficient at a rate of 5% to 95%. Therefore, the relative mixing process does not affect or contaminate the process of the kerosene product. For the future work this mixing ratio shows the strict limitation to a small ratio not exceeding five times that of kerosene to kerosene, so as not to affect the boiling point.

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## Conflict of interest

The author declares no conflict interest.

## Ethical approval

Not applicable.

## Data availability

The data will be available upon request.

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This research received no external funding.

## Author contributions

Semaa I. Khaleel: data curation, writing-original, Ahmad A. Aabid: data curation, conceptualization, Islam K. Saeed: research administration methodology, writing-review and editing, Muneef Mahjoob Mohammed: supervision, research administration, Ali Mohammed Saleh: formal analysis, validation, writing-original, Ibrahim Awad Mohammed: writing and editing, Omar abed Habeeb: writing and editing, Mahmud A. Abdulqader: conceptualization, methodology, writing review and editing.

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