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A study of sulfur content in crude oil, gasoline and kerosene in some Iraqi oil fields and refineries

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***Abstract*---**Sulfur content in crude oil and petroleum products is a major problem, as the high content of sulfur in fuel leads to harmful emissions and leads to serious environmental and health risks as a result of emissions from sources that use gasoline as fuel for cars or kerosene as fuel for household heaters, causing serious emissions harmful to health. It is necessary to determine the sulfur content in crude oil, and to determine the type of crude oil (acid or sweet). comparing gasoline and kerosene sulphur content to international regulations to determine the extent to which oil refineries comply with internationally permitted limits and the extent to which sulphur content is linked to API Gravity sampling of several oil fields and refineries at varying intervals and distributed to nine provinces (Muthanna, Diwaniyah, Dhi Qar), Basra-Shuaiba, Maysan, Wasit, Baghdad-Dora refinery, Baiji refinery,The huss. It was concluded that Iraqi crude oil is sour, and laboratory tests showed that all refineries do not adhere to the limits allowed globally and domestically in terms of gasoline and kiros production, and the results showed a strong relationship between sulfur content and API Gravity.

***Keywords*---**health, sulfur compounds fuel, environment, pollution.

Introduction

The total sulphur content of petroleum products is significant because sulfur compounds are linked to issues in storage, processing, transportation, and fuel product quality. (Bender et al., 1989; Yin, 2001). Furthermore, the primary human source of sulfur compounds in the atmosphere is the combustion of fossil

fuels. When sulphur compounds are burned, large amounts of sulphur oxides are released into the atmosphere, causing serious problems and pollutants such as human poisoning and acid rain (O'Neil et al., 1993). Sulphur levels allowed in motor fuel have been significantly reduced in recent years due to government regulations to reduce air pollution (Dauzacker & Palombo, 2003). According to this theory, information on the total sulphur concentration in petroleum products is required for quality control and emission of this pollutant into the atmosphere. This demand increases the need to develop fast and accurate methods to estimate the concentration of sulfur content. There are several standard ways to determine the sulphur content of crude oil and petroleum products, proposed by agencies such as the American Testing Association and the materials. This method includes ASTM D 6920-07, ASTMD ASTM3120-06, ASTM D 5453-06, and ASTM D 5494 (ASTM,2009)Sulfur dioxide emissions are caused by naturally occurring sulfur compounds that remain in fuel, causing sulfur dioxide gas emissions. Water reacts with atmospheric compounds, forming majorities and causing acid rain, which destroys buildings. (Fang, 2004). Sulfur emissions cause a variety of health issues, including heart disease, asthma, and respiratory diseases. Furthermore, the presence of sulphur in liquid fuels has a negative impact on vehicles. (Chandra Srivastava, 2012; Sadare et al., 2017).Internal combustion engines in most cars run on refined fuels derived from crude oil, such as gasoline. As a result of the high temperatures caused by incomplete fuel combustion, hydrocarbons, airborne toxins, and sulfur oxides (SOx) are emitted. Early health damage and chronic diseases caused by these pollutants can eventually lead to death. (Sharaf, 2013). oxidation. Early fine particles are the most dangerous among vehicle emissions. Furthermore, chronic exposure to concentration 5.2 causes a number of chronic diseases in adults. These include respiratory infections, asthma flare-ups, lung cancer, heart disease, chronic bronchitis, and diseases. (Chambliss et al., 2013). cerebrovascular Reducing sulphur-containing compounds in transportation fuel is critical in the production of petroleum derivatives, as the International Agency for Research on Cancer (IAEA) confirmed that the concentration of 5.2 fine particles is carcinogenic, primarily caused by diesel exhaust in transportation fuels (20, Meclellan). (Chien,2017))

Materials and Methods

Sample collection

The samples were taken from several oil fields and several refineries at varying periods of time and distributed to nine provinces, namely refineries (Muthanna, Diwaniyah, Dhi Qar, Basra-Shuaiba, Maysan, Wasit, Baghdad-Al-Dora refinery, Baiji refinery, and Kirkuk refinery). The samples were divided into four groups: the Kazolin group, kerosene, crude oil reaching refineries through the strategic line supplied from crude oil from most Iraqi fields, which cuts Iraq from south to north, as well as the crude oil group from the fields, including (Al-Ahdab field, Al-Gharaf field, east of Baghdad field, West Qurna field, Al-Ka'afa field, Al-Ka'afa field, Badra field).

Devices used

- JHAG Sulfur Analyzer X-Ray Content Analysis
- API Gravity Petroleum Products Meter

Materials

Materials used to analyse samples in the sulphur analysis device and in the density meter: -Special cells for modelling cells sample, inner circular paper, holder holder holder, model transfer syringe, plastic cover, toloin, estonian

Preparing samples

X-ray sulfur test (ASTM D4294)

This method will be used to measure the sulfur content of crude oil and oil derivatives. The form is placed in the form container and placed in the device dedicated to this inspection, and the device settings must be adjusted in advance. The model is placed in the path of a beam of light emitted from a radioactive source within the device. This X-ray It's going to change. At the energy levels of atoms, these atoms lose the energy they have gained in the form of the wavelength light intensity of each element in this device. which the model can calculate the sulfur content,Under international specifications and the x-ray method,

Digital Density Meter mediated by the Api Gravity standard test methodThis test method is specifically used as API Gravity for petroleum distillation products and viscous oils that can be treated normally as liquids at test temperature, which are added either manually or automatically by sample injection equipment. Under pressure, usually less than 100 kg/pa, and viscosity At room temperature, the area is usually less than 15,000 mm2. However, the total steam pressure limit can be more than 100 kilopascal provided that bubbles are not generated in the U-shaped oscillating tube, which can affect density determination. Crude oil, kazolin, and kerosene are among the substances that can be tested using this method

Results

The values of the concentration of sulfur content in crude oil ranged at a maximum of (4.0055 Wt%) at the sixth study site (Najaf refinery), and the density value of the same site (Najaf Refinery) (18) was recorded. The density value of the same site (35.2) was shown through statistical analysis that the Pearson correlation factor between the sulphur content of crude oil and AIP gravity is (-.808**) with a significance value (0.000), which is smaller than (0.01). It was marked with a ** sign to indicate that it is a statistical function at a moral level (0.01) as written below the table (2)e and we conclude from this result that there is a strong inverse relationship between the sulfur content of crude oil and AIP gravity. Based on the above, we reject zero imposition and accept the alternative imposition that provides for a relationship between the two variables.

Table (1) API gravity at Fo 60 and sulfur content for crude oil shows

No sample	Sample locations	API Gravity	Concentration of sulfur content wt%
1	Dhi Qar Refinery	26	3.73
2	Diwaniyah Refinery	28.9	3.44
3	Maysan Refinery	20.8	3.94
4	Dora refinery	28.8	3.18
5	Najaf refinery	18	4.01
6	Muthanna refinery	28.7	3.38
7	Kirkuk refinery	35.6	2.1
8	Shuaiba refinery	31.21	2.95
9	Baiji refinery	35.2	1.72
10	Badra field	23.5	3.81
11	Gourna field	24.4	2.33
12	East Baghdad field	26.8	3.34
13	Garraf field	23	3.81
14	Halfaya field	21	3.92
15	Ahdeb field	25.37	3.68

Figure (1) shows API gravity levels at 60F0 and sulfur content of raw oil

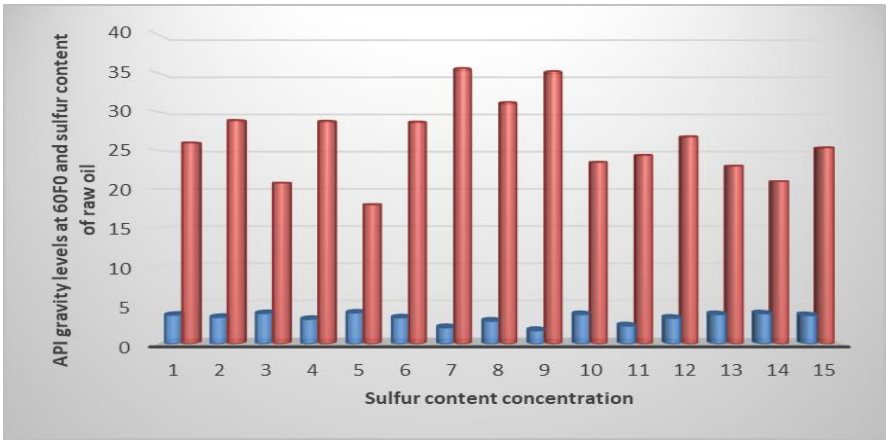

Table (2) Correlation coefficients between the sulfur content of crude oil and the AIP gravity

sulfur content			API gravity
sulfur content	Pearson Correlation	1	-.808-**
	Sig. (2-tailed)	.000	
	N	15	15
API gravity	Pearson Correlation	-.808-**	1
	Sig. (2-tailed)	.000	
	N	15	15

The previous table shows the Pearson correlation coefficients between the sulfur content of crude oil and the AIP gravity, where all the inverse relationships were strong with a correlation coefficient of (-.808**) and both coefficients were statistically significant at the level of significance (0.01). The values of the concentration of sulfur content in gasoline ranged from a maximum (Wt%0.0523) at the second study site (Dhi Qar refinery) and the density value of the same site (Najaf Refinery) (72.6) was recorded, and the lowest value for concentrating the sulfur content of gasoline was recorded at the tenth study site (Baiji Refinery) (0.0095 w). The density value of the same site (58.2) was tabled (3) figure (2) and it was shown through statistical analysis that the Pearson correlation factor between the sulfur content of gasoline and AIP gravity is (0.717) with a significant value (0.03), which is smaller than (0.05) It has been marked * to indicate that it is a statistical function at a moral level (0.05) as written below the table. We conclude from this result the existence of a strong ejection relationship between the sulfur content of gasoline and AIP gravity. Based on the above, we reject zero imposition and accept the alternative imposition that provides for a relationship between the variables.

Table (3) shows the concentration of sulfur content API gravity at 60 F0 for gasoline

No sample	Sample locations	API Gravity	Concentration of sulfur content wt%
1	Shuaiba refinery	62.3	0.05
2	Dhi Qar refinery	72.6	0.05
3	Maysan refinery	65.8	0.04
4	Najaf refinery	63.1	0.03
5	Dora refinery	62.7	0.02
6	Muthanna refinery	61.7	0.02
7	Diwaniyah Refinery	61.5	0.02
8	Baiji refinery	62.1	0.01
9	Kirkuk refinery	58.2	0.01

Figure (2) shows the average API gravity and sulfur content 60 F0 for gasoline

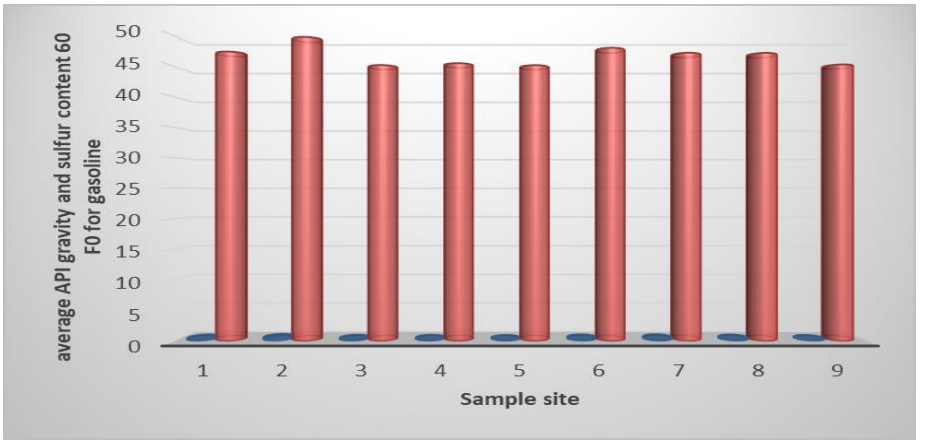

Table (4) Correlations between gasoline sulfur content and AIP gravity

Correlations			
sulfur content		API gravity	
sulfur content	Pearson Correlation	1	.717*
	Sig. (2-tailed)	.030	
	N	9	9
API gravity	Pearson Correlation	.717*	1
	Sig. (2-tailed)	.030	
	N	9	9

The previous table shows Pearson's correlation between the sulfur content of gasoline and AIP gravity, where all strong ejection relationships came with a correlation factor (0.717*) and both transactions with statistical significance at a moral level (0.05). The values of the concentration of sulfur content in kerosene ranged at a maximum (Wt% 0.3185) at the site of the second study (Dhi Qar refinery) and the density value of the same site (Najaf Refinery) (49.75) was recorded with the lowest value of concentrating the sulfur content of kerosene oil at the site of the fifth study (course refinery) (0.75). 1267 wt%) and the density value of the same site (45.12). Table (5), figure (3) It was found through statistical analysis that the Pearson correlation factor between the sulfur content of kerosene and AIP gravityho (0.949)) with a significant value (000) is smaller than (0.01) It has been marked * to indicate that it is a statistical function at a moral level (0.01) as written below the table, and we conclude from this result that there is a strong ejection relationship between the sulfur content of kerosene and AIP gravity. Based on the above, we reject zero imposition and accept the alternative imposition that provides for a relationship between the two variables.

Table (5) shows the concentration of sulfur content API gravity at 60 F0 for kerosene.

No sample	Sample locations	API Gravity	Concentration of sulfur content wt%
1	Shuaiba refinery	47.3	0.2
2	Dhi Qar refinery	49.7	0.3
3	Maysan refinery	45.1	0.1
4	Najaf refinery	45.4	0.1
5	Dora refinery	45.1	0.1
6	Muthanna refinery	47.9	0.2
7	Diwaniyah Refinery	47.1	0.2
8	Baiji refinery	47.1	0.2
9	Kirkuk refinery	45.2	0.1

Figure 3 shows the average API gravity at 60 F0 and sulfur content of kerosene

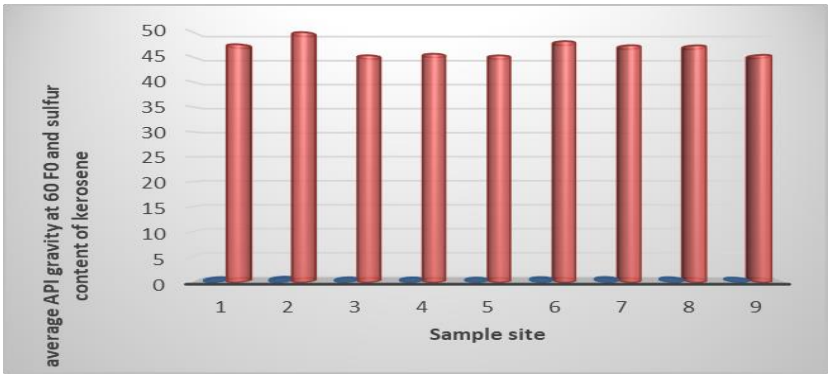

Table (6) Correlations between kerosene sulfur content and AIP gravity

sulfur content		API Gravity	
sulfur content	Pearson Correlation	1	.949**
	Sig. (2-tailed)		.000
	N	9	9
API Gravity	Pearson Correlation	.949**	1
	Sig. (2-tailed)	.000	
	N	9	9
**. Correlation is significant at the 0.01 level (2-tailed).			

The previous table shows Pearson's correlation between the sulfur content of kerosene and AIP Gravity, where all strong ejection relationships came with a correlation factor (0.949*) and both transactions with statistical significance at a moral level (0.01).

Discussions

If the amount of sulfur in crude oil is less than 0.5%, it means that sweet crude oil contains a low sulfur content, while if the sulfur content in crude oil exceeds 0.5%, it is called sour crude (Petroleum.co.uk, 2015). All the results of crude oil samples showed that the sulphur content of Iraqi crude oil is of the acid type, where the values of the concentration of sulfur content in crude oil ranged at a maximum of 4.0055 wt% and recorded the lowest value of concentration. The sulfur content of crude oil at the site of the tenth study (Baiji Refinery, 1.7214 wt%) and the results of our study were consistent with the findings of the researcher's mechanism. (Abdula, 2020). The high concentration of sulfur content in crude oil makes it of poor quality and its use in industrial activities causes emissions of sulphur compounds, affecting air quality (Alkhalili, Yahya, Ibrahim, Ganapathy, & Thwaini, 2020). Sulfur is more present in crude oil and its quality causes many health and environmental problems alike, and the combustion thereof is Crude oil or petroleum derivatives lead to the emission of sulphur oxides, which produce health and environmental effects, as well as fuel containment of a high sulphur content that directly affects vehicles by reducing the life of engines (Saleh, 2020) and is associated with hydrogen sulfide emissions

(H2S) due to concentrations of sulphur content in crude oil. The higher the sulphur content of crude oil, the more hydrogen sulfide (H2S) is released into the atmosphere, causing serious health and environmental consequences (Salih, Hamadamin, & Hama, 2022).Oil refineries are one of the sources of air pollution as they convert crude oil into daily products such as gasoline and kerosene, and the containment of crude oil. A high percentage of crude oil leads to the release of a high amount of sulphur dioxide, which leads to air pollution, which is the most important problem in developing and developed countries (Hussain, 2022). The results of the study also showed a strong reverse relationship between the sulfur content in crude oil and API Gravity, and this result was agreed with by (T. Zhang, Sun, Walters, Sundaram, & Calla, 2022), which concluded that there was a strong relationship between the sulfur content in crude oil and API Gravity and confirmed this relationship researcher (Marafi et al., 2019), who found that the low concentration of sulfur content as a result of an increase in API Gravity and our study was consistent with the study conducted by Hameed, 2016). In his study to determine the total sulphur content in Khormaleh and the Juyar oil fields in the Kurdistan region of Iraq, Hameed proved that there is a strong inverse relationship between the sulphur content in Khormaleh and the Juyar oil fields..

Conclusion

This study showed that the use of sulfur oil analyzer to estimate the concentration of sulfur in crude oil and its derivatives according to the standard specification ASTM D4294, which is an easy, fast, and documented method within the American Society for Hiding and Materials, as the method explained that oil derivatives (gasoline, kerosene) in most Iraqi oil refineries are located outside the legitimate limits in terms of sulfur content, where the study showed that the mechanism of production of gasoline is by mixing puffs with imported high octane gasoline 95, and the absence of hortience towers, which leads to the non-removal of sulfur compounds, which causes the emission of sulfur compounds at high rates. The study also showed a high sulfur content in Iraqi crude oil, making crude oil of the acid type loaded with sulfur compounds that require special processes and reactions to get rid of them. The study also showed a linear relationship between API and sulfur content in both crude oil and kerosene as well as in gasoline, which is one of the reasons for the high sulfur content. This in turn leads to sulphur oxide emissions in the fuel produced, such as gasoline used in vehicles and kerosene used in heaters and others, causing air pollution with sulphur compounds that affect public health..

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