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Evaluation and Characterization Parameters of Crude Oils and Petroleum Fractions

Ibrahim M. Abou El Lei1[1] and Adel Al Farjani[2, *]

[1)] Petroleum Engineering Department, Faculty of Engineering, Tobruk University, Tobruk, Libya.

[2)] Chemistry Department, Faculty of Science, Tobruk University, Tobruk, Libya.

[*]**Corresponding author**: adelhase@yahoo.com

مؤشرات التقييم والتوصيف للنفط الخام والمنتجات البترولية

إبراهيم أبو الليل[1] و عادل الفرجاني[2، *]

[1)] قسم هندسة النفط، كلية الهندسة، جامعة طبرق، طبرق، ليبيا.

[2)] قسم الكيمياء، كلية العلوم، جامعة طبرق، طبرق، ليبيا.

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Abstract

Characterization of crude oil has always been an area of interest in the refining field; However, the need to define the properties of crude oil has gained importance in the production and distribution processes, and this is done simply by measuring the properties of crude oil, as the properties of these properties change according to the geological nature in which the oil is found in the traps and thus the physical and chemical properties must be studied and defined for this type Oil or so, from these physical and chemical properties such as API° (American Petroleum Institute), specific weight, pour point, viscosity, total sulfur content, vapor pressure, distillation, initial boiling point (IBP), final boiling point (FBP), were evaluated. The hydrocarbon residue and contents of crude oils were collected from the various oil fields in the Masala, Sarir, and Al Fountain fields using standard ASTM procedures. The results of crude oils in the three oil fields were compared with each other and with other international crude oils. The standards and specifications of their petroleum products were also examined. This study was conducted on the crude oil of the obelisk, bed, and fountain in 2017 that are mixed together to feed the oil refinery in Tobruk. The standards and specifications of the mixture and petroleum products of the refinery, including light Naphtha, heavy Naphtha, Kerosene, and Diesel, were measured and compared with other types of crude oil. According to the evaluation criteria, the examined crude oils can be classified as light sweet crude oil due to the high API value and low sulfur content in it, the percentage of Diesel oil is low and the (K) factor was low. It was also found that light crude oil has a high percentage of light fracture and that the pour point of light crude oil is higher than that of heavy crude oil. The salt content was also shown to be low in the mixture compared to other types. An increase in the boiling point of the distillate was observed with an increase in the percentage of the fraction volume. Moreover, Diesel has a higher boiling point than kerosene which has a higher boiling point than naphtha for all of the combined fractions. It was also found that the water content had few effects on the crude oil.

Keywords: *Crude oils, Petroleum fractions, Characterization parameters, Sweet and sour, Petroleum refinery, Kerosene, Naphtha and Diesel.*

الملخص

لطالما كان توصيف النفط الخام أحد مجالات الاهتمام في مجال التكرير؛ ومع ذلك، فإن الحاجة إلى تحديد خصاص النفط للخام اكتسبت أهمية في عمليات الإنتاج والتوزيع، ويتم القيام بذلك ببساطة عن طريق قياس خواص للنفط الخام حيث تتغير خواص هذه الخواص تبعا للطبيعة الجيولوجية الموجد

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فيه النفط في المصائد وبالتالي يجب دراسة الخواص الفيزيائية والكيميائية وتحديدها لهذا النوع من النفط أو ذلك، من هذه الخصائص الفيزيائية والكيميائية مثل API° (المعهد الأمريكي للبترول) الوزن النوعي، نقطة الانسكاب، اللزوجة، محتوى الكبريت الكلي، الضغط البخاري، التقطير، نقطة الغليان الأولية (I.B.P.)، نقطة الغليان النهائية (F.B.P.)، تم تقييم بقايا ومحتويات الهيدروكربون من الزيوت الخام التي تم جمعها من حقول النفط المختلفة في حقول مسلة والسرير والنافورة باستخدام إجراءات ASTM القياسية. تمت مقارنة نتائج الزيوت الخام في حقول النفط الثلاثة مع بعضها البعض ومع غيرها من النفط الخام العالمية. كما تم فحص معايير وتوصيف المنتجات البترولية الخاصة بهم. وقد أجريت هذه الدراسة على زيوت مسلة والسرير والنافورة الخام في عام 2017 التي يتم خلطها معا لتغذية مصفاة النفط في طبرق. وقد تم قياس المعايير ومواصفات المزيج والمنتجات البترولية للمصفاة بما في ذلك النافثا الخفيفة والنافثا الثقيلة والكيروسين والديزل ومقارنتها مع أنواع النفط الخام الأخرى. وفقا لمعايير التقييم، يمكن تصنيف الزيوت الخام التي تم فحصها على أنها زيت خام حلو خفيف بسبب القيمة العالية للـAPI° وانخفاض محتوى الكبريت فيه، وأن نسبة زيت الديزل منخفض. كما كان عامل (K) منخفض. كما تبين أن النفط الخام الخفيف يتميز بنسبة عالية من الكسر الخفيف، وأن نقطة انسكاب الزيت الخام الخفيف أعلى من تلك الخاصة بالنفط الخام الثقيل. كما وظهر محتوى الملح محتوى منخفضًا في المزيج مقارنة بأنواع أخرى. ولوحظ ازدياد نقطة غليان نواتج التقطير مع زيادة النسبة المئوية لحجم الكسر. علاوة على ذلك، يحتوي الديزل على نقطة غليان أعلى من الكيروسين الذي يحتوي على نقطة غليان أعلى من النافثا لجميع الأجزاء المجمعة. كما وجد أن محتوى الماء له آثار قليلة في النفط الخام.

الكلمات الدالة: النفط الخام، قطفات النفط، توصيف المعلمات، الحلو والحامض، مصفاة البترول، الكيروسين، النافثا والديزل.

1. Introduction

Petroleum (or crude oil) is a complex, naturally occurring liquid mixture containing mostly hydrocarbons, but containing also some compounds of oxygen, nitrogen and sulfur. It is often referred to as the "black gold".

After World War II, the huge oil reserves in the Middle East became available, at a very low cost, and they rapidly revolutionized the way we live. Indeed, the twentieth century with all the dramatic changes that it has brought to society is probably best characterized as the century of oil. For the foreseeable future, oil will remain a critical fuel for the all industrialized nations.

Most of the world's petroleum is to be found in the Middle East, as shown in Figure (1) and in more detail in Figure (2). Figure (1) also illustrates the fact that the world reserves and resources of crude oil are orders of magnitude smaller than those of coal.

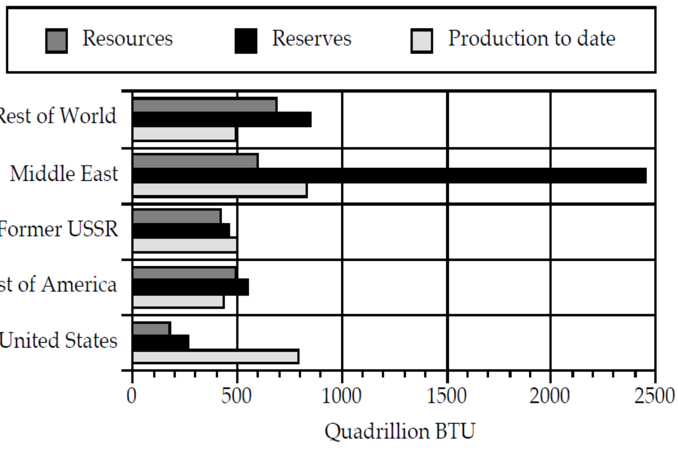

Figure 1. World distribution of petroleum resources and reserves (Fulkerson *et al*., 2005)

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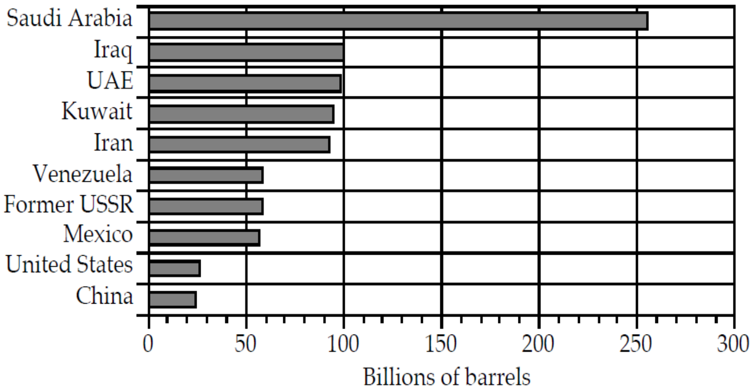

Figure 2. Distribution of major petroleum reserves in the world (Mendez *et al.*, 2006)

2. Crude Oil Characterization

Crude oil characterization is one of the most important tasks in refinery units. This becomes more important when the cut has species with more than 10 carbon atoms. In this case, because of more hydrocarbons which have similar properties, it is difficult to characterize them. To solve this problem some researchers have tried to improve the analyses and databanks**.**

Oil refining is one of the most complex chemical industries, which involves many different and complicated processes with various possible connections. Figure (3) illustration of a standard refinery system (Conaway, 1999).

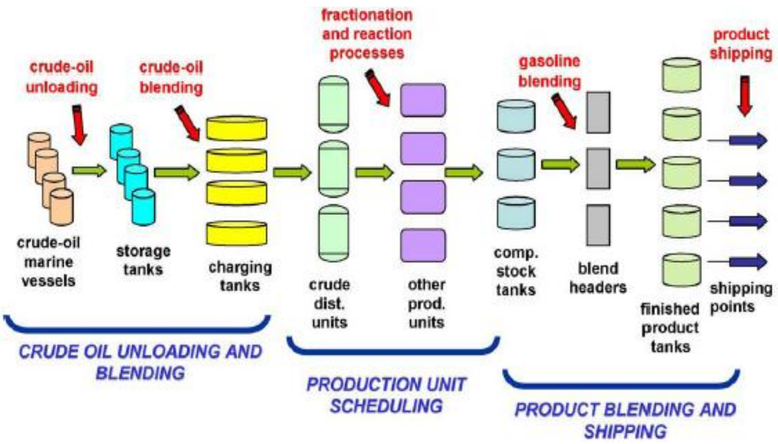

Figure 3. Illustration of a standard refinery system

Table (1) depicts the main characteristics of crude oil and their classification on the basis of some parameters.

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Table 1. Main characteristics of crude oil and their classification on the basis of some parameters (Habson, 1984)

Petroleum type	API Gravity [1]	Viscosity (μ) (centipoise) [2]	Volume Factor (β) [3]	Gas-oil ratio* [4]	Benchmark crude	% sulfur [5]
Bitumen [6]	4 - 10	5000 - 10^6	1	0		
Tar / Heavy Oil [7]	10 - 20	100 - 5000	1.0 - 1.1	< 50		
Low-shrinkage oils ("Black Oils")	20 - ~33	2 - 100	1.1 - 1.5	5 - 500		
	31				Dubai	2
	39.6				West Texas Intermediate	0.24
	38.1				Brent	0.37
High-shrinkage oils ("Volatile Oils")	~33 - ~53	0.25 - 3	1.5 - 3.5	500 - 6000		
(Retrograde) Condensate gas	~54 - 70	~0.25	–	2000 - 15,000		
Wet Gas	> 60	~ 0.25	–	2000 - 15,000		
Dry Gas	–	–	–	–		

More economically desirable petroleum

[1] API Gravity= (141.5/Specific gravity) – 131.5. Thus water (SG = 1.0) is 10 °API; petroleum lighter than water °API > 10.
[2] For comparison, the viscosity of water at 20°C is 1 cP.
[3] Volume factor is the ratio of volume in surface storage tanks to volume in the producing formation.
[4] GOR= cubic feet of gas per barrel of stock - tank oil. The ratios shown conflate R and R_S.
[5] Sweet crudes have S < 0.5%; sour crudes have S > 0.5%. Sweeter crudes have greater economic value.
[6] "Bitumen" is used in its narrower sense here; sometimes "bitumen" is used to denote all petroleum.
[7] Langenkamp (1984, 1985) puts the boundary between heavy and light oils at 20 °API; Miles (1989) puts it at 25 °API.

Numerous important feed and product characterization properties in refinery engineering include:

2.1. API gravity

API gravity of petroleum fractions is a measure of density of the stream. Usually measured at 60 °F the API gravity is expressed as;

$$API = \frac{141.5}{specific\ gravity} - 131 \qquad \ldots.. \quad (1)$$

where specific gravity is measured at 60 °F.

According to the above expression, 10 °API gravity indicates a specific gravity of 1 (equivalent to water specific gravity). In other words, higher values of °API gravity indicate lower specific gravity and therefore lighter crude oils or refinery products and vice-versa (Kite *et al.*, 1993). As far as crude oil is concerned, lighter API gravity value is desired as more amount of gas fraction, naphtha and gas oils can be produced from the lighter crude oil than with the heavier crude oil (Yeung, 2006). Therefore, crude oil with high values of API gravity are expensive to procure due to their quality. API gravity or density or relative

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density: can be determined using hydrometer method (ASTM D-287) (Kramer, 2004; and Lambert, 2007).

2.2. Watson Characterization Factor

The Watson characterization factor is usually expressed as;

$$K=\frac{(T_B)^{\frac{1}{3}}}{specific\ gravity} \quad \text{….. (2)}$$

where T_B is the average boiling point in ^oR taken from five temperatures corresponding to 10, 30, 50, 70, and 90 vol.% vaporized. Typically, Watson characterization factor varies between 10.5 and 13 for various crude streams (Speight, 1999). A highly paraffinic crude typically possesses a K factor of 13. On the other hand, a highly naphthenic crude possesses a K factor of 10.5. Therefore, Watson characterization factor can be used to judge upon the quality of the crude oil in terms of the dominance of the paraffinic or naphthenic components. It is determined by the standard distillation method (ASTM D-86, ASTM D-1160) (Speight, 2001).

2.3. Sulfur Content

Since crude oil is obtained from petroleum reservoirs, sulphur is present in the crude oil. Usually, crude oil has both organic and inorganic sulphur in which the inorganic sulphur dominates the composition. Typically, crude oils with high sulphur content are termed as sour crude. On the other hand, crude oils with low sulphur content are termed as sweet crude. Typically, crude oil sulphur content consists of 0.5–5 wt.% of sulphur. Crudes with sulphur content lower than 0.5 wt.% are termed as sweet crudes. It is estimated that about 80% of world crude oil reserves are sour. Doctor test measures the amount of sulfur (ASTM D-129) (Speight, 2001).

2.4. Viscosity Index

It is a measure of the flow properties of the refinery stream. Typically, in the refining industry, viscosity is measured in terms of centistokes (termed as cSt) or saybolt seconds or redwood seconds. Usually, the viscosity measurements are carried out at 100 °F and 210 °F. Viscosity is a very important property for the heavy products obtained from the crude oil. The viscosity acts as an important characterization property in the blending units associated to heavy products such as bunker fuel (Riazi and Al-Sahhaf, 2006). Typically, viscosity of these products is specified to be within a specified range and this is achieved by adjusting the viscosities of the streams entering the blending unit. It is estimated using (ASTM D-445) method (Speight and Ozum, 2002).

2.5. Flash and Fire Point

Flash and fire point are important properties that are relevant to the safety and transmission of refinery products. Flash point is the temperature above which the product flashes forming a mixture capable of inducing ignition with air. Fire point is the temperature well above the flash point where the product could catch fire. These two important properties are always

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taken care in the day to day operation of a refinery. The method used to determine the flash point and fire point are (ASTM D-56, ASTM D-93, and ASTM D-3828) (ASTM, 2000).

2.6. Pour Point

When a petroleum product is cooled, first a cloudy appearance of the product occurs at a certain temperature. This temperature is termed as the cloud point. Upon further cooling, the product will ceases to flow at a temperature. This temperature is termed as the pour point. Both pour and cloud points are important properties of the product streams as far as heavier products are concerned. For heavier products, they are specified in a desired range and this is achieved by blending appropriate amounts of lighter intermediate products. The test used to determine the pour point is (ASTM D-97, IP 15) (ASTM, 2000).

2.7. Octane Number

Though irrelevant to the crude oil stream, the octane number is an important property for many intermediate streams that undergo blending later on to produce automotive gasoline, Diesel … etc. (Stratier *et al.*, 2010). Typically, gasoline tends to knock the engines. The knocking tendency of the gasoline is defined in terms of the maximum compression ratio of the engine at which the knock occurs. Therefore, high quality gasoline will tend to knock at higher compression ratios and vice versa. However, for comparative purpose, still one needs to have a pure component whose compression ratio is known for knocking. Iso-octane is eventually considered as the barometer for octane number comparison. While iso-octane was given an octane number of 100, n-heptane is given a scale of 0. Therefore, the octane number of a fuel is equivalent to a mixture of an iso-octane and n-heptane that provides the same compression ratio in a fuel engine. Thus an octane number of 80 indicates that the fuel is equivalent to the performance characteristics in a fuel engine fed with 80 vol.% of isooctane and 20% of n-heptane.

2.8. TBP/ASTM Distillation Curves

The most important characterization properties of the crude/intermediate/product streams are the TBP/ASTM distillation curves. Both these distillation curves are measured at 1 atm. pressure. In both these cases, the boiling points of various volume fractions are being measured. However, the basic difference between TBP curve and ASTM distillation curve is that while TBP curve is measured using batch distillation apparatus consisting of no less than 100 trays and very high reflux ratio, the ASTM distillation is measured in a single stage apparatus without any reflux. Therefore, the ASTM does not indicate a good separation of various components and indicates the operation of the laboratory setup far away from the equilibrium (McCann, 1998).

3. World Crude Oil Quality

Figure (4) presents the general trend of World crude oil quality through the period between 1980 and 2013. It is clear that API gravity decreases while the sulphur and metal contents increase.

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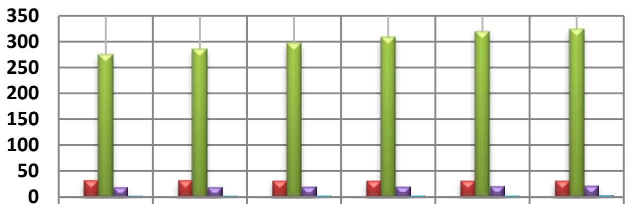

	1985	1990	1995	2001	2010	2013
S in crude oil (wt%)	1.14	1.12	1.31	1.41	1.51	1.59
API of crude oil	32.7	32.6	32.4	32.2	31.8	31.7
Metal in crude oil residue (ppm)	275	286	297	309	320	325
Residue in crude (vol.%)	19	19.4	19.8	20.2	21.3	22.1
S incrude oil residue (wt.%)	3.07	3.26	3.61	3.91	4	4.2

Figure 4. World crude oil quality (Stratier *et al.*, 2010)

4. Material and Methods

The physiochemical properties of crude oil and petroleum products were determined through the data of tests and chemical analysis that have been carried out on the Messla and Sarir crude oils samples and petroleum products of Tobruk refinery using different analytical techniques in central laboratory of the refinery.

5. Results and Discussion

Refinery processing is designed to process a number of different crude oils including Messla, Sarir mix and Nafora crude oils. The more important properties of these crude oils are listed in Table (2).

The characterization properties of these crude oils are summarized in Table (2) and compared with other crude oils in the world. The data in Table (2) show that the API gravity of light crude is above 30°, such as Messla and Sarir mix as well as Nafora, MAD, BR, AL and Kuw crudes, while that of heavy crude is less than 30° such as AM and AH crudes. These API gravity values agree with publish data. Furthermore, as expressed the pour point of light crude oil is higher than that of heavy crude oil.

Table 2. Properties of Messla Sarir mix and Nafora crude oils (AGOCO, 2014)

No.	Property	Crude oil	
		Messla and Sarir mix	Nafora
1	API gravity @ 60 °F	38.9	33.2
2	Distillation test: IP 123/D86		
3	IBP, °C 670 mms	52.5	50.3
4	Final Boiling Point	365.0	366.0
5	Sulfur content, wt.%	0.16	0.27
6	Kinematics viscosity @ 100 °F, cSt	10.70	11.25
7	Salt content as NaCl, Ib/1000 bbl	3.20	4.12
8	Acidity, mg KOH/g	0.080	0.052
9	Hydrogen sulphide, ppm	< 1.0	< 1.0
10	Reid vapour pressure, kPa (psi)	6 (0.85)	6.7
11	Pour point, °F	-13	-20

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The data in Table (3) is expressed graphically in Figures. (5-7), that give a comparing between the characterization properties of Messla-Sarir mix, Nafora and the other crude oils. The figures reveal that Messla-Sarir mix has an API gravity similar with that of Brent blend crude oil and less than Murban crude oil as well as higher than Arab medium, Arab heavy and Kuwait crude oils.

Table 3. Comprehensive assay of crude oil under study (Stratier *et al*., 2010)

Parameters / Crude oils	Messla-Sarir	Nafora	MAD	BR	AL	AM	Kuw	AH
API gravity @ 60/60 °F	38.9	33.2	40.5	38.3	33.4	28.5	31.4	27.4
Specific gravity (g/cm^3)	0.830	0.86	0.82	0.833	0.858	0.884	0.869	0.890
Kinematics viscosity(cSt) @ 100°F	10.70	11.25	2.70	3.90	8.40	17.50	9.80	27.60
Sulfur content (wt./wt. %)	0.16	0.27	0.78	0.40	1.77	2.85	2.52	2.80
Pour point (°F)	-13	-20	-32	-42	-25	-41	-26	-43
Acid number (mg, KOH/g)	0.080	0.052	0.20	0.10	0.00	0.06	0.15	0.10
Aniline point (°C)	140	130	140	139	142	141	143	145
Smoke point (mm)	21	24	22	20	23	22	26	24
Cetane index	45	43	49	44	50	49	51	50
Freezing point (°C)	-50	-47	-43	-64	-46	-43	-41	-47

Note: Names of the investigated crude oils are as follow:
MAD= MURBAN (origin: Abu Dhabi, UAE) BR= BRENT BLEND (origin: Nord sea)
AL= ARAB LIGHT (origin: Saudi Arabia) AM= ARAB MEDIUM (origin: Saudi Arabia)
KUW= KUWAIT EXPORT (origin: Kuwait) AH= ARAB HEAVY (origin: Saudi Arabia)

The Kinematics viscosity shows variable values for the different crude oils where the highest value of Arab heavy crude oil and the lowest value of Murban crude oil. On the other hand, Nafora crude oil is similar with that of Arab light. The other parameters such as specific gravity, cetane index, smoke point, acid number and aniline point show no wide variation between them. The sulfur content in Messla-Sarir and Nafora crude oils is lowest value (0.16 & 0.27) while the highest value was recorded in Arab medium crude oil (2.85). The pour point of Messla-Sarir mix and Nafora show the lowest value (-13 and -20°F) and the highest value of Arab heavy crude oil.

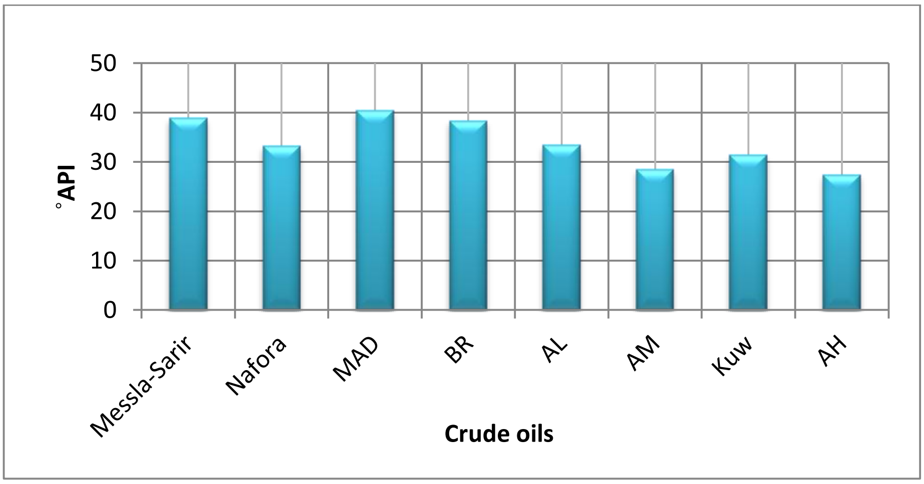

Figure 5. °API gravity of Messla-Sarir mix, Nafora and other crude oils

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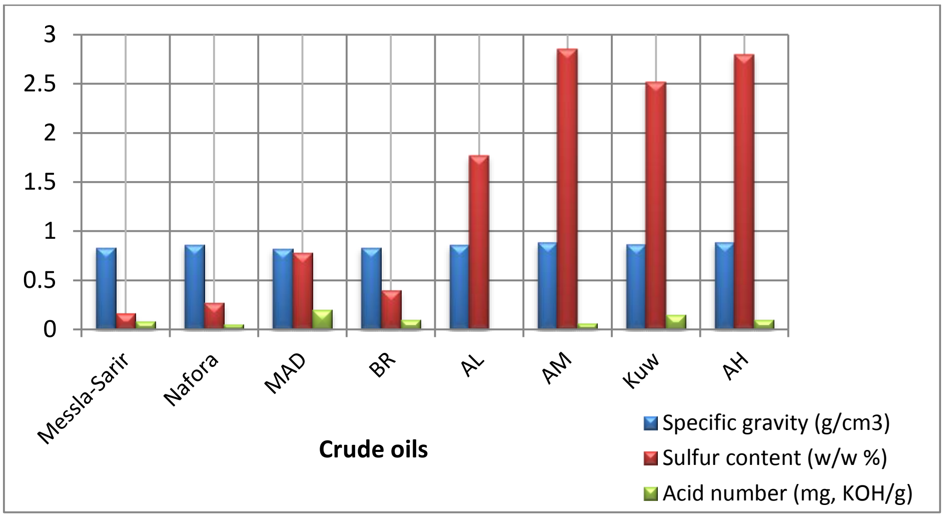

Figure 6. Messla-Sarir mix, Nafora and other crude oils properties

The data in Table (4) of petroleum products of refinery represented Kerosene, Naphtha and Diesel that have different characterization properties, this may attributed to the differences in their chemical characteristics. The API gravity of Kerosene is higher than Diesel (42.5 and 35.95 respectively), this is the vice versa of flash point (35.0 and 90.0 respectively). The sulfur content in Kerosene (0.005) is very low if compared with Diesel (0.07). On the other hand, they have a similar content of acid (0.008). Figures (8 & 9) illustrate the different characterization properties of petroleum products.

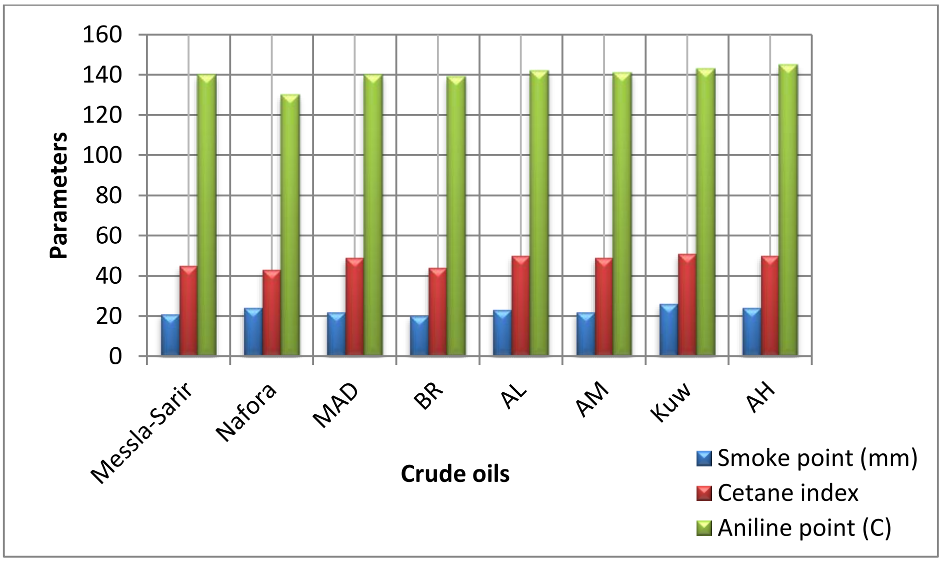

Figure 7. Messla-Sarir mix, Nafora and other crude oils properties

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Table 4. Physiochemical properties of petroleum products (AGOCO, 2014)

Test \ Products	Kerosene	Diesel	Naphtha
API gravity @ 60/60 °F	42.5	35.95	60.8
Specific gravity (g/cm^3)	0.815	0.850	0.781
Pour point (°C)	12	20	18
Flash point (°C)	35.0	90.0	82.0
Smoke point (mm)	22.0	-	-
Kinematics viscosity (cSt) @ 100 °F	3.02	3.14	2.98
Diesel index	-	51.5	-
Acid content (mg, KOH/g)	0.008	0.008	0.006
Sulfur content (wt%)	0.005	0.07	0.02
Water content (v/v%)	Trace	Trace	Trace

The data in Table (5) are expressed graphically in Figure (10) which gives a plot of the true boiling points (TBP) of the distillate fractions versus the percentage cumulative volume of the crude oil.

Table 5. Products of distillation of crude oil

Products	Light Naphtha	Heavy Naphtha	Kerosene	Diesel	Residue	Total	Loss
True boiling points (TBP) (°C)	95	160	255	325	402	-	-
Fraction percent	15.4	31.5	22.9	18.8	11.02	99.62	0.38

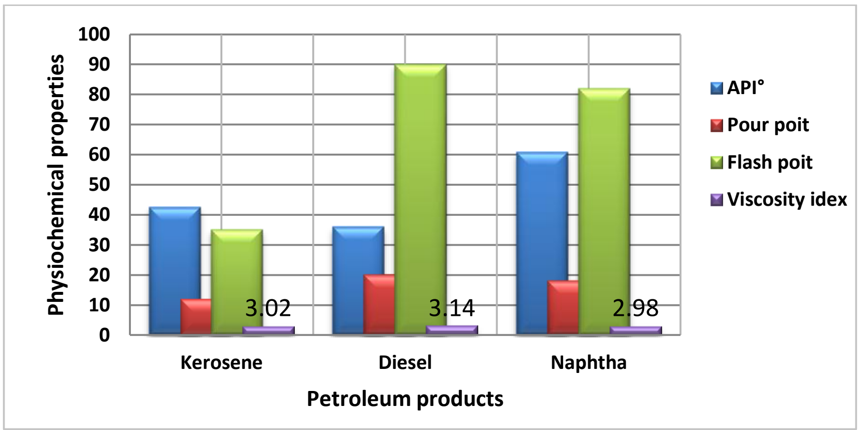

Figure 8. Characterization properties of petroleum products

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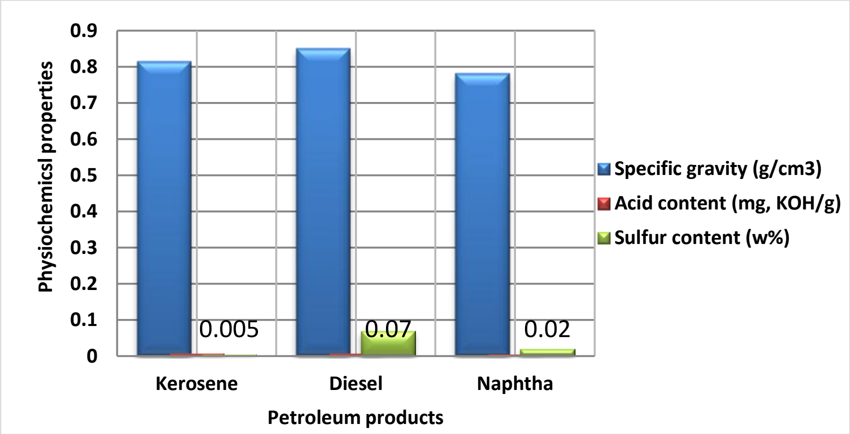

Figure 9. Physiochemical properties of petroleum fractions

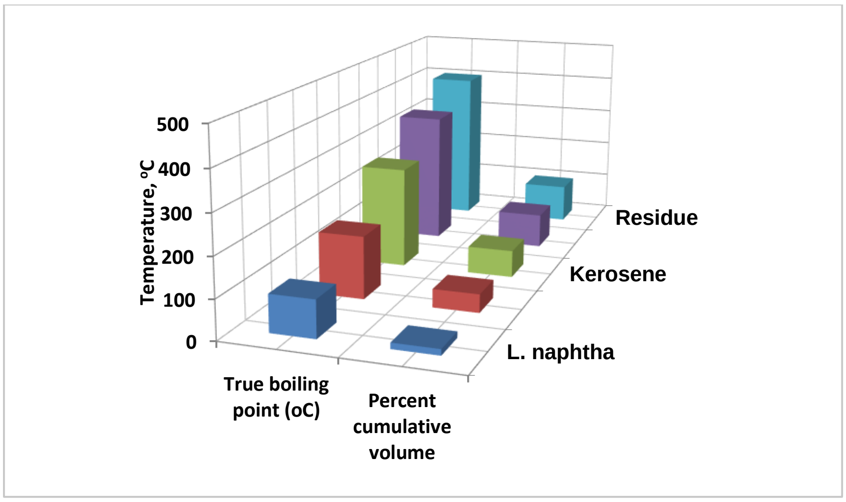

Figure 10. True boiling point versus percentage cumulative volume fractions

Figure (11) presents the plots of the volume fractions as a function of the true boiling points. From the results obtained, it is found that the distillation of products of atmospheric distillation are coinciding with the publish data for the similar characteristic features of the investigate crude oils.

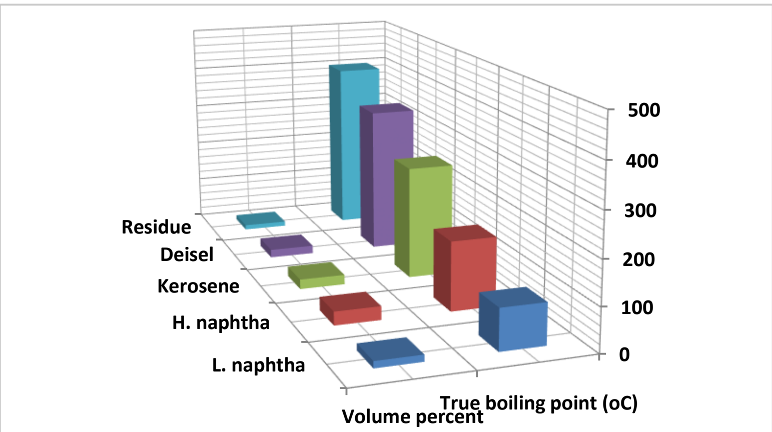

Figure 11. Volume percent of crude oil fractions versus true boiling point

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In the petroleum refinery the physical and chemical operations are integrated, where atmospheric distillation process involved. Thus the products are expected to show a wider range in their characteristics. However, our present results show that the product distribution of atmospheric fractional distillation of Messla-Sarir mix is a function of the nature of the crude oils.

The distillation profiles (Figure 12) of the investigated petroleum products also show the same trend. The boiling point of the distillate fractions increases as the volume percent of the fraction increases. Moreover, as expected Diesel has a higher boiling point than kerosene which has a higher boiling point than naphtha for all the fractions collected.

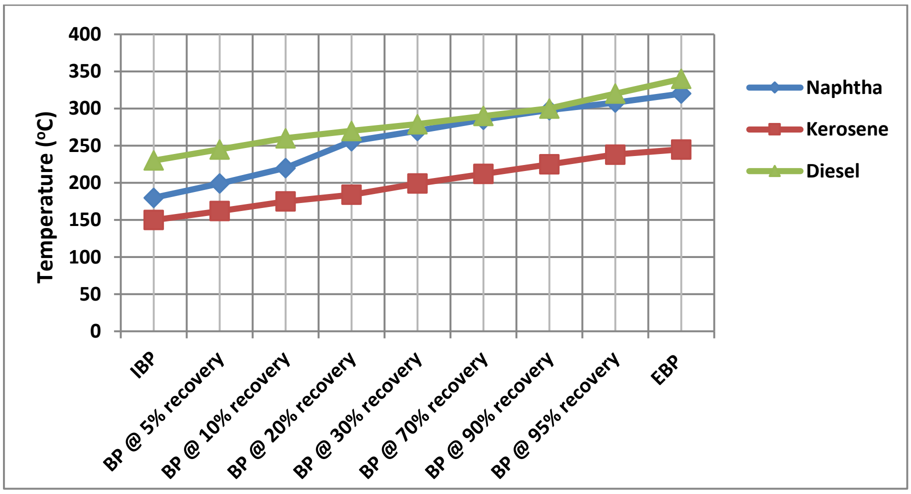

Figure 12. Distillation profiles of petroleum products

On the other hand, the petroleum products of the mix crude oils have been compared with the other petroleum products as shown in Figure (13), which shows more or less similarity with that of Brent blend and Arab light.

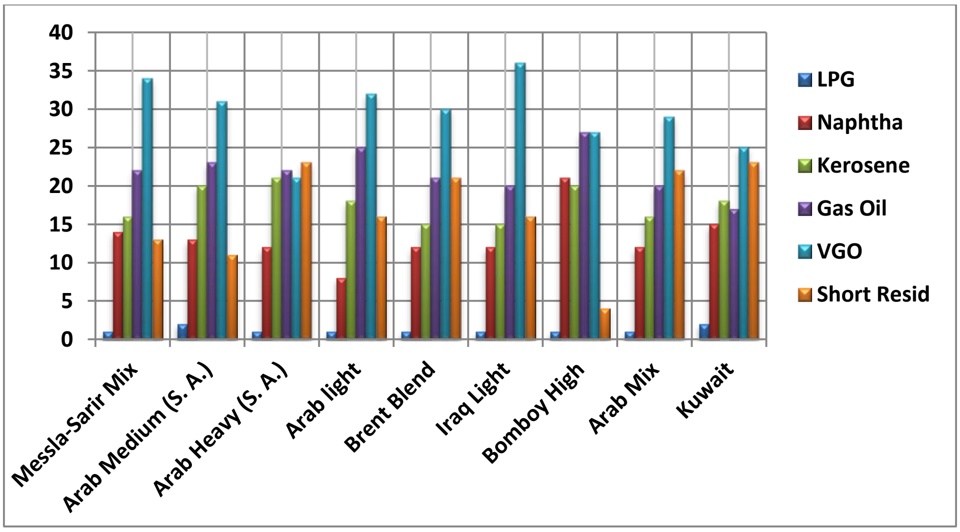

Figure 13. Petroleum products of different crude oils

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6. Evaluation Parameters of Crude Oil

There are different parameters can have been applied to evaluate the quality of the crude oils. The most important of them including °API, the factor governing the quality of crude oils. The results from the investigated Sarir crude oils reveal an average value of °API is 38.9. According to this value crude oil can be classified as light crude oil.

The content of sulfur plays an important role for the quality of the crude oil. Generally, it ranges from 0.1% to 5% by weight percent. Crude oil is classified as sweet when sulfur content less than 0.5% and sour if the percent exceeds this value. The concentration of sulfur in the studied crude oils of Messla-Sarir and Nafora are 0.16 and 0.27 respectively, thus it can be classified as sweet crude oil (Table 2).

The pour point of petroleum is an index of the lowest temperature at which the crude oil will flow under specified conditions. The pour point of the examined crude oils shows that both paraffinic and aromatic more or less are similar content, where the average of the pour point is -13°F and -20 °F.

The Characterization Factor was originally devised to show the thermal cracking characteristics of heavy oil. Thus, highly paraffinic oils have K= 12.5–13.0 and cyclic (naphthenic) oils have K= 10.5–12.5. The average value of characterization factor for the investigated crude oil is 10.90 and 11.2, these means that the crude oils is naphthenic.

The crude oil of naphthenic base exhibit a wide variation of viscosity index (-60-+40), while the paraffinic base has high viscosity index (79-151), and not affected so much by temperature degree. The intermediate crude oils show viscosity index ranging from 20-98. The viscosity index of Messla-Sarir and Nafora crude oils show low values (24 & 25.2) and this may be attributed to naphthenic base.

7. Conclusion

The following conclusions may be drawn up as a result of the carried out investigation:

The characterization properties of Messla-Sarir mix crude oils are compared with other crude oils in the world. The results reveal that the °API gravity of light crude is above 30°, such as Messla-Sarir mix, Nafora, MAD, BR, AL and Kuw crudes, while that of heavy crude is less than 30° such as AM and AH crudes. The pour point of light crude oil is higher than that of heavy crude oil.

Messla-Sarir mix has a gravity °API similar with that of Brent blend crude oil and less than Murban crude oil as well as higher than Arab medium, Arab heavy and Kuwait crude oils. The Kinematics viscosity shows variable values for the different crude oils.

The studied crude oils can be classified as light sweet crude oil because of the low content of sulfur. It has been established that light crude oil characterized by light fraction high content, Diesel fraction low and low K-factor. The Salt content shows low contents in crude oils compared with other types and the water content found as traces

The other parameters such as specific gravity, Cetane index, smoke point, acid number and aniline point show no wide variation between them. The sulphur content in Sarir and

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Nafora crude oils are lowest values comparing with the other crude oils, while the pour point of Sarir and Nafora crude oils show the highest value.

The petroleum products of Kerosene and Diesel have different characterization properties; this may have attributed to the differences in their chemical characteristics. The ˚API gravity of Kerosene is higher than Diesel, this is the vice versa of flash point. The sulfur content in Kerosene is very low if compared with Diesel. Also it is found that the distillation of products of atmospheric distillation are coinciding with the publish data.

The distillation profiles of the petroleum products also show that the trend of the boiling point of the distillate fractions increases as the volume percent of the fraction increases. Moreover, as expected Diesel has a higher boiling point than Kerosene which has a higher boiling point than Naphtha for all the fractions collected.

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