Physical properties as indication for chemical composition of petroleum fraction of Hassira and Khurmala crude oil

Rawaz A. Ahmed, Abdulsalam R. Karim, Sadonya M. Jamel, Vian S. Hamma-Saeed, Bayan Q.S. Hussein

Abstract— **two types of crude oil from Hassira and Khurmala crude oil distilled into narrow fractions. The ranges of these narrow fractions are 10 °C, starting from IBP to 350 °C. Petroleum streams produced from distillation of crude oil such as gasoline, kerosene, diesel fuel, fuel oil, etc. are complex mixtures of large numbers of hydrocarbon components, such fractions are generally characterized in terms of small petroleum cuts, or pseudocomponents, which are identified primarily by their boiling point and specific gravity due to their true boiling point curve (TBP), based on these two properties empirical correlations were derived to predict other components physical properties required for the process calculations. TBP distillation data and density of whole crude oil are used to perform the basic characterization and to obtain the product distribution of the crudes (using Aspen HYSHYS software).**

Index Terms— **Characterization, Distillation, Hydrocarbons content, Petroleum fractions analysis and Physical properties**

I. Introduction

Petroleum contains an extreme range of organic functionality and molecular size. Particularly, crude oils and refined petroleum products consist largely of hydrocarbons, which are chemicals composed solely of hydrogen and carbon in various molecular arrangements. Crude oils contain hundreds of different hydrocarbons and other organic and inorganic substances including atoms of sulfur, nitrogen, and oxygen, as well as metals such as iron, vanadium, nickel, and chromium [1] , [2] .

The relationships between the physical and chemical properties of narrow fractions distilled from mixed Kirkuk and Sharki-Baghdad crude oils have been studied by Mohammed et al. [3]. They observed that, the total distillate from Kirkuk crude oil was higher than that from Sharki-Baghdad crude oil, and thus denoted that mixed Kirkuk crude oil lighter than Sharki-baghdad crude oil [3]. Nedelchev et al and his colleagues have applied Riazi's distribution model for converting ASTM D-86 to TBP for the whole range of the distillation curve for 33 crude oil samples [4]. The distribution model allowed the entire distillation curve of a crude oil to be built from incomplete distillation data, regardless of the method for measuring the distillation characterization [4]. However, they attempt to apply the Riazi-Daubert Conversion Method, the Daubert Conversion Method and the Edmister Conversion Method for converting ASTM D86 into TBP of the investigated crude oils was found to be unsuccessful. Therefore, a new method for conversion of ASTM D-86 distillation to TBP distillation applicable for crude oils should be developed [4]. The computational approach for studying physicochemical properties of heavy petroleum factions have been studied by Tovar, et al., [5] as their result suggested that the computational approach is a powerful and an efficient tool for predicting the properties of petroleum fractions. Their method required Boiling Temperature curve, and the specific gravity, as the input data information. This method focuses specifically on heavy fraction and selection of a right characterization method for petroleum fraction has an important effect on calculated properties. The computational procedure can be combined with or incorporated in petroleum process simulation [5].

Furthermore, the simulation of petroleum processes, Aspen Technologies provides the tool Aspen HYSYS. Aspen HYSYS is a comprehensive process modeling tool used by the world's leading oil and gas producers, refineries, and engineering companies for process simulation and process optimization in design and operations. However, Aspen HYSYS based Simulation and analysis of crude distillation unit has been revised by Shankar and his colleagues [6]. They concluded that the simulation software can be used for debottle necking, performance and process studies. The optimization can be done very easily, together with the advanced process control tools, make it profitable in the operation in real [6].

In the present study, two type's crude oils of Kurdistan/Iraq origins are evaluated using the fractional distillation in order to find their density (both of the whole crude and each distribution cut) and true boiling point distillation data. And the data are used to compute various properties of the crude oils by Aspen HYSHYS software. The outcomes are evaluated with regard to their potential for providing various straight-run products. The purpose of this work is to improve the refining quality and effectiveness of Kurdistan crude oil.

II. Experimental

A. Material and method

Two crude oil samples of Kurdistan/Iraqi origins were obtained from Hassira and Khurmala. The true boiling point distillation experiments along with density for each of the crude oils were conducted. The distillation of crude oils into

Rawaz A. Ahmed , Kurdistan Institution for Strategic Studies and Scientific Research, Qirga, Slemani, As Sulaymaniyah, Iraq, Tell: 009647510405929 .
Abdulsalm R. Karim, University of Sulamaniyah , School of Science & Chemistry department.
Sadonay M. Jamal, Vian Saeed, Bayan Hussein, Kurdistan Institution for Strategic Studies and Scientific Research, Qirga, Slemani, As Sulaymaniyah, Iraq.
University of Human Development, Qirga, Slemani, As Sulaymaniyah, Iraq.

narrow fractions (every 10°C) was operated using a fractional distillation unit following ASTM D-86. The distillation unit consists of a flask, heating mantle, distillation column, condenser, timer, thermometers, fraction collector, variac, gauge pressure, and vacuum pump. The size of distillation flask was 2 liters with two side arm: one for charging the crude oil and the other containing glass bulb for thermometer. The distillation flask was mounted with 2.4 KW heating kettle which connects to variac to control the heat input to the flask. The distillation column consisted of 7 trays, and has 40 mm inside diameter and 450 mm length. The column was isolated by high vacuum jacket to minimize the heat loss.

1700 ml of crude oil sample was distilled in specified glass apparatus under prescribed condition of heat and rate of distillation. The volume of distillate obtained at each multiple of 10 °C was recorded, up to a maximum of 340°C, or 350°C when the distillation was stopped. The experimental TBP and density data of crudes are shown in Table 1.

B. Characterization

The experimental data was used to develop the basic characterization of crudes by calculating their specific gravity, American Petroleum Institute (API), average boiling points, characterization factor, and correlation index. The details of the calculations are given in the next section.

III. RESULT AND DISSOCIATION

A. Characterization

Petroleum streams—from crude oil to products such as gasoline, kerosene, diesel fuel, fuel oil, etc.—are mixtures of large numbers of hydrocarbon components. It is impractical to analyze such mixtures and represent them compositionally based on their constituent components. Petroleum streams are generally characterized in terms of small petroleum cuts, or pseudocomponents, which are generated from their distillation curves. The pseudocomponents are identified primarily.

Fig. 1 shows the relation between the accumulative weight percent with boiling point temperature of the narrow fractions distilled from Hassira and Khurmala crude oils. The weight percent increased with increasing boiling temperature. This indicates with increase mass, the number of carbon increased.

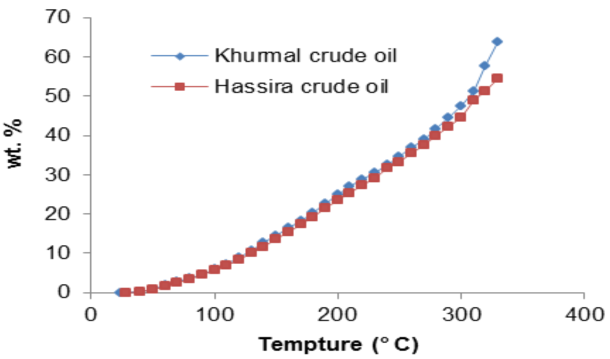

Fig. 1: Relation between boiling point of the narrow fraction with the weight percent.

Fig. 2 shows the relation between the specific gravity values with mid percent boiling point temperature of the narrow fractions distilled from Hassira and Khurmala crude oils. The specific gravity of the narrow fractions increases with the increase of mid percent boiling point of the fractions. This is due to the increase of the aromatic and decrease of paraffinic content, and this is in agreement with Nelson W. L. [7], usually the specific gravity of aromatic hydrocarbon is higher than those for alkyl hydrocarbon having the same number of carbon atoms. Noticed the specific gravity of Khurmala crude oil is higher as compared to Hassira crude oil. This indicates the aromatic compound is higher.

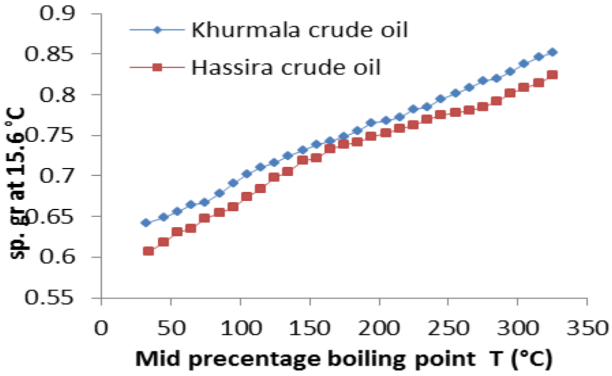

Fig. 2: Relation between mid-percent boiling point of the narrow fraction with the Specific gravity.

Fig. 3 shows the relation between the refractive index of the distilled narrow fractions with mid percent boiling temperature of Hassira and Khurmala crude oils. It was noted that the refractive index increases with the increase of mid percent boiling point temperature of the fractions because the refractive index of high molecular weight hydrocarbon is higher than that for low molecular weight fractions [8].

Table 1: Physical properties of Hassira and Khurmala crude oil.

No.	Hassira Crude oil				Khurmala Crude oil			
	T (°C)	Vol. %	Wt.%	SP. gr. at 15.6 °C	T (°C)	Vol.%	Wt.%	SP. gr. at 15.6 °C
0	28	0	0	0	24	0	0	0
1	40	0.47	0.33	0.6061	40	0.28	0.20	0.6423
2	50	1.15	0.82	0.6182	50	1.12	0.82	0.6491
3	60	2.09	1.51	0.6302	60	2.54	1.86	0.6565
4	70	3.35	2.44	0.6345	70	3.83	2.82	0.6636
5	80	4.47	3.28	0.6471	80	4.84	3.57	0.6676
6	90	6.00	4.45	0.6539	90	6.19	4.61	0.6780
7	100	7.53	5.62	0.6616	100	7.88	5.92	0.6906
8	110	9.23	6.96	0.6737	110	9.66	7.33	0.7021
9	120	11.00	8.37	0.6833	120	11.84	9.07	0.7109
10	130	13.00	9.99	0.6977	130	13.99	10.80	0.71669
11	140	14.94	11.58	0.7051	140	16.47	12.82	0.7245
12	150	17.26	13.53	0.7191	150	18.65	14.61	0.7316
13	160	19.35	15.28	0.7217	160	20.88	16.46	0.7383
14	170	21.70	17.29	0.7333	170	23	18.23	0.7432
15	180	23.94	19.21	0.7382	180	25.47	20.31	0.7486
16	190	26.47	21.39	0.7408	190	28.24	22.65	0.7557
17	200	28.76	23.39	0.7484	200	31.06	25.08	0.7649
18	210	30.94	25.29	0.7526	210	33.18	26.91	0.7679
19	220	33.06	27.16	0.7581	220	35.47	28.90	0.7726
20	230	35.06	28.93	0.7624	230	37.35	30.56	0.7818
21	240	38.00	31.57	0.7697	240	39.71	32.63	0.7842
22	250	39.76	33.16	0.7752	250	42.06	34.73	0.7947
23	260	42.23	35.39	0.7776	260	44.47	36.90	0.8012
24	270	44.35	37.32	0.7802	270	46.82	39.04	0.8079
25	280	47.09	39.81	0.7842	280	49.71	41.68	0.8163
26	290	49.68	42.20	0.7919	290	52.65	44.39	0.8194
27	300	52.20	44.56	0.8011	300	55.79	47.32	0.8287
28	310	56.61	48.71	0.8083	310	60.03	51.31	0.8378
29	320	59.06	51.02	0.8137	320	66.67	57.63	0.8471
30	330	62.46	54.28	0.8233	330	73.15	63.83	0.8519
31	340	67.49	59.18	0.8379	/	/	/	/
32	350	79.49	70.91	0.8402	/	/	/	/

The results are in consistence with the density measurement, showing that the narrow fractions have higher naphthenic hydrocarbon contents of Khurmala crude oil compared with those fractions distilled from Hassira crude oil.

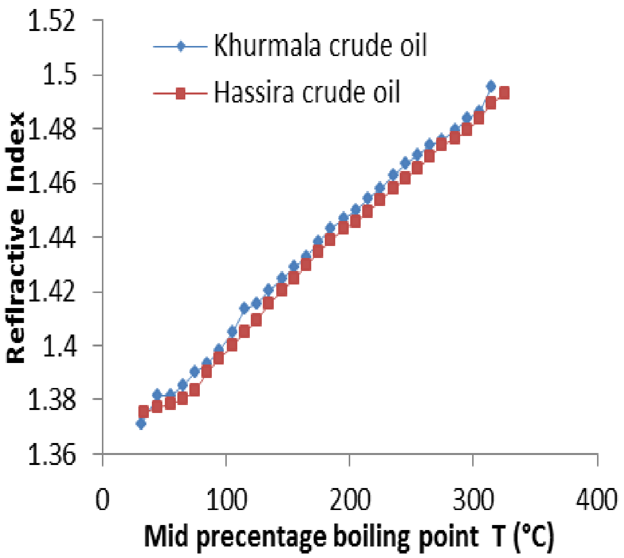

Fig. 3: Relation between mid-percent boiling point of the narrow fraction with the refractive index.

B. Aspen HYSHYS Characterization and cut distribution

Today, distillation of crude oil is an important process in almost all the refineries. Crude distillation is the process of separating the hydrocarbons in crude oil based on their boiling point. The crude oil fractioning is very intensive process. Aspen HYSHYS software One Engineering is a market leading suite of products focused on process engineering and optimization [6]. The experimental data of Table 1 was used in the Oil Manager (an environmental in Aspen HYSHYS for carrying out the characterization and determining the physical properties of crude oils and their products). As shown in Table 3 and 4 , the experimental data of crudes is not covering the full boiling range ad is short on both ends, i.e., it starts at values higher than 0 vol. % and ends at less than 100 vol. %. The TBP curve of crude oil was, therefore, first extrapolated on both ends using the probability method given in Aspen HYSHYS, as suggested by Behrenbruch and Dedigama [9], [10]. The full ranged (extrapolated) NTBP curves estimated by Aspen HYSHYS of both crude oil are shown in Fig. 4 and the cut plot distributions, obtained from Aspen HYSHYS, for defined temperature range are shown in Table 3, 4 and Fig. 5.

Although much progress has been made in identifying the chemical species present in petroleum, it is generally sufficient for purposes of design and analysis of plant operation of distillation to characterize petroleum and petroleum fractions by gravity, laboratory-distillation curves, component analysis of light ends, and hydrocarbon-type analysis of middle and heavy ends. From such data [11] five different average boiling points and an index of paraffinicity (Watson characterization factor) can be determined [2], [11], [12]; these are then used to predict the physical properties of complex mixtures by a number of well-accepted correlations. In each case, to find the average boiling points, hence, the other characterizing properties, the TBP curve was divided into 50 pseudo components. Using information such as mole fraction, normal boiling point (NBP), and molecular weight (MW) of each pseudo-component given by Aspen HYSHYS, the molal average boiling point (MABP), cubic average boiling point (CABP), and mean average boiling point (MeABP) were calculated by applying equation 1,2, 3,4,5,6,7 and 8, respectively . For the molecular weight of each pseudocomponent, the Twu correlation was selected in Aspen HYSYS.

$$\mathrm{ABP} = \sum_{i=1}^{n} X_i \; T_{bi} \ldots\ldots (1)$$

$$\mathrm{VABP} = \frac{T_{10} + T_{30} + T_{50} + T_{70} + T_{90}}{5} \ldots\ldots (2)$$

$$\mathrm{SL} = \frac{T_{90} - T_{10}}{80} \ldots\ldots (3)$$

$$\mathrm{ABP} = \mathrm{VABP} - \Delta\mathrm{T} \ldots\ldots (4)$$

$$\mathrm{Ln}(-\Delta T_W) = -3.64991 - 0.02706\,(VABP - 273.15)^{0.6667} + 5.163875\, SL^{0.25} \ldots.(5)$$

$$\mathrm{Ln}(\Delta T_M) = -1.15158 - 0.01181\,(VABP - 273.15)^{0.6667} + 3.70612\, SL^{0.333} \ldots\ldots(6)$$

$$\mathrm{Ln}(\Delta T_C) = -0.82368 - 0.08997(VABP - 273.15)^{0.45} + 2.45691\, SL^{0.45} \ldots\ldots\ldots(7)$$

$$\mathrm{Ln}(\Delta T_{Me}) = -1.53181 - 0.0128(VABP - 273.15)^{0.6667} + 3.64060644\, SL^{0.333} \ldots.(8)$$

However, the CI, K-factor, specific gravity and IPA characterization which are calculated (see Table 2) supported the above result. The characterization factor, correlation index (CI) are calculated by Equation 9 and 10. As the K factor values are approximately 10.86 and 11.25 for both Khurmala and Hassira crude oil, respectively. This result shows that the higher naphthenic hydrocarbons content of khurmala crude oil. CI values are 56.7 and 42 for Khurmala and Hassira crude oil, respectively. It is well known, that the CI value in between 15 to 50 indicates a predominance of either naphthenes or mixture of paraffins, naphthenes and aromatics. An index value more than 50 indicates a predominance of aromatic species [12]. The CI value obtained for Khurmala crude oil is higher than 50, indicates more aromatic species as compared with Hassira crude oil (see Table 2). This result agrees with increasing specific gravity for Khurmala crude oil as mentioned above (see Fig. 2 and 3).

$$K_w = \frac{T_B^{1/3}}{d} \ldots\ldots (9)$$

Where TB is average boiling point in degrees Rankine (F° + 460) and d is the specific gravity at 15.6°C/15.6°C.

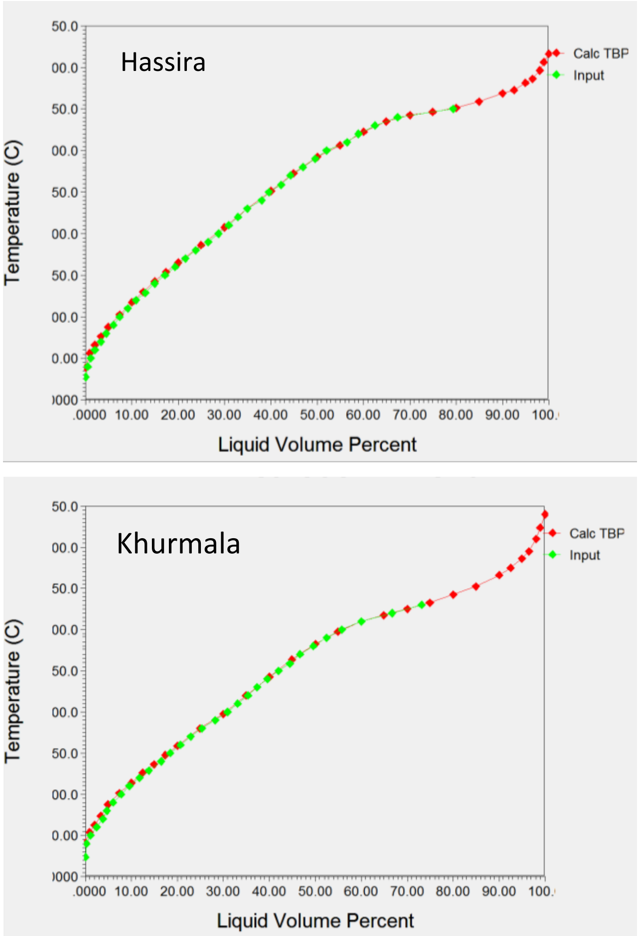

Fig. 4: Experimental and estimated (extrapolated) TBP distillation curves of both crude oils of Kurdistan.

$$CI = 473.7d - 456.8 + \frac{48640}{K} \ldots\ldots(10)$$

Where K for a petroleum fraction is the average boiling point determined by the Standard Bureau of mines distillation Method, in K and d is the specific gravity at 15.6°C/15.6°C

Another type of information necessary for refiners are operating and design data such as fractionating or true boiling distillation to produce various fractions like naphtha (I.B.P.-170°C), kerosene (171-240°C), gas oil (241-300 or 350 °C) and fuel oil (+300 or +350°C) [13]. Table 2 shows the percentage of hydrocarbons content such as; gasoline, kerosene, and gas oil fractions. We take only one break (breakup No. 1, rather breakup No.2). For Hassira crude oil, the gasoline, kerosene, gas oil fractions and crude residue are 28.76., 20.91, 29.81 and 20.52%v/v, respectively. While for Khurmala crude oil, the fractions are 25.47, 16.59, and 31.09 and 26.85%v/v. In conclusion, Table 2 shows such information that the maximum production of lightest fraction (naphtha) is from Hassira (28.76%) and the maximum production of heaviest fraction (fuel oil) is from khurmala field (26.85%) at temperature up to +350 °C. Tables (1 and 2) present important information for refiners, particularly the API or specific gravity for each fraction distilled this datum essential for constructing curves of temperature and gravity verses percent distilled.

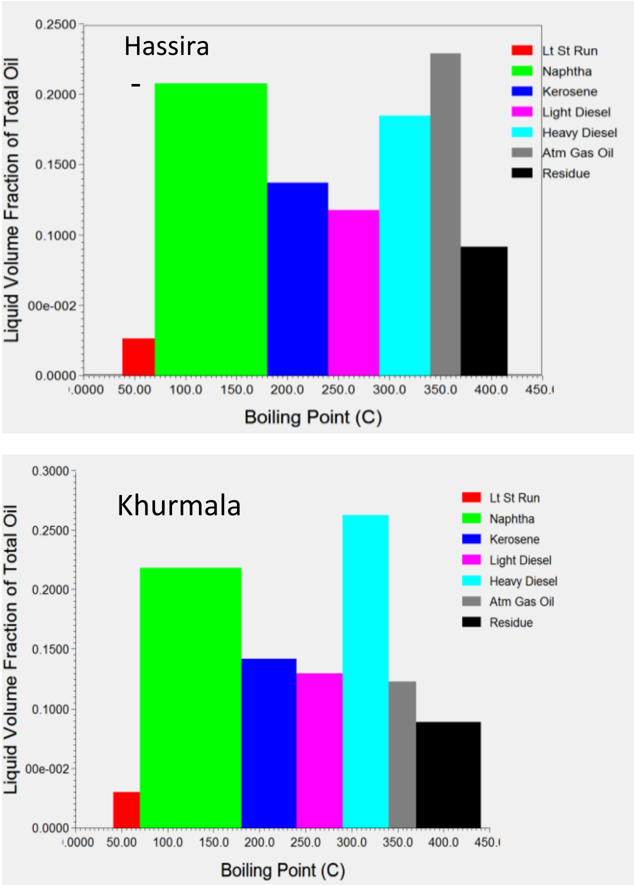

Fig.5: Estimated yields of various straight run products from both Hassira and Khurmala crude oils of Kurdistan.

Table 2 : Physiochemical properties of Hassira and Khurmala crude oil

Hassira crude oil			Khurmala crude oil		
T (°C)	T (°F)	Vol.%	T (°C)	T (°F)	Vol. %
82.4	28	0	24	75.2	0
239	115	10	110	230	10
320	160	20	155	311	20
392	200	30	195	383	30
455	235	40	245	473	40
536	280	50	285	545	50
599	315	60	310	590	60
644	340	70	325	617	70
662	350	80	345	653	80
689	365	90	365	689	90
779	415	100	440	824	100

Name	Break up No. 1 Hassira crude oil			
	Gasoline	Kerosene	Gas Oil	Gasoline
Temp range °C	IBP- 200	200-280	281-340	> 340
Actual Vol. RECD	489	355.5	506.8	
Vol.% RECD	28.76	20.91	29.81	
Sp. gr. at 15.6 °C	0.715	0.774	0.823	
Actual sp. gr at 15.6°C	0.73	0.78	0.83	
Note: Total volume -1700 ml, IBP-28 °C, R Temperature -24 °C				

Name	Break up No. 1 Khurmala crude oil			
	Gasoline	Kerosene	Gas Oil	Gasoline
Temp range °C	IBP-180	181-250	251-330	> 330
Actual Vol. RECD	433	282	528.5	
Vol.% RECD	25.47	16.59	31.09	
Sp. gr. at 15.6 °C	0.725	0.776	0.829	> 0.829
Actual sp. gr at 15.6°C	0.73	0.78	0.83	0.73
Note: Total volume -1700 ml, IBP-24 °C, R Temperature -24 °C				

Average boiling point	Haasira Crude oil	Khurmala crude oil
VABP	260	256
WABP	268	256
MABP	216	212
CABP	251	256
MeABP	234	230
Sp. Gr. At 15 °C	0.86	0.89
API	33	28
K	11.25	10.87
CI	42	56.8

Table 3: Aspen- HYSYS calculation of physical properties of Hassira crude oil.

No.	Moles	Ccum. moles	NBP(°C)	MWt.	d, Kg/m^3
0	0	0	36.05901489	70.88016711	629.6809762
1	1.00E-02	1.00E-02	50.85051918	76.37100614	726.9106822
2	1.00E-02	2.00E-02	61.28608415	79.92831744	734.3925726
3	1.00E-02	3.00E-02	69.36531984	83.60625341	740.2537356
4	1.00E-02	4.00E-02	77.66177383	87.2116153	746.1810825
5	1.00E-02	5.00E-02	85.01697001	90.34553823	751.3616545
6	1.00E-02	6.00E-02	91.42417342	93.46113327	755.8154626
7	1.00E-02	7.00E-02	97.80699645	96.6637314	760.1999447
8	1.00E-02	8.00E-02	103.9447809	99.73398164	764.3702148
9	1.00E-02	9.00E-02	109.7884875	102.5862788	768.2977504
10	1.00E-02	1.00E-01	114.5567767	104.6806613	771.4801613
11	2.50E-02	0.125	124.3737761	110.1842134	777.9271729
12	2.50E-02	0.15	137.0777995	116.7777635	786.1321658
13	2.50E-02	0.175	148.5392935	123.0415005	793.3861103
14	2.50E-02	0.2	159.6952517	129.4542536	800.3209271
15	2.50E-02	0.225	170.7627989	135.9836818	807.0854248
16	2.50E-02	0.25	181.2503261	142.4252389	813.392035
17	2.50E-02	0.275	191.5410352	149.0538462	819.4864083
18	2.50E-02	0.3	202.2614076	156.2882774	825.740121
19	2.50E-02	0.325	213.9156281	164.5234846	832.4315005
20	2.50E-02	0.35	225.7747596	172.8051662	839.1363102
21	2.50E-02	0.375	235.7592041	180.3078689	844.6959892
22	2.50E-02	0.4	246.5428538	188.8594602	850.6193597
23	2.50E-02	0.425	258.1606382	198.1026414	856.9125063
24	2.50E-02	0.45	268.6744974	206.8115272	862.5275902
25	2.50E-02	0.475	278.6191597	215.2271094	867.7731529
26	2.50E-02	0.5	287.9213484	223.54469	872.6212631
27	2.50E-02	0.525	297.4684709	231.9067143	877.5441359
28	2.50E-02	0.55	304.3561423	238.0255546	881.0611081
29	2.50E-02	0.575	310.6063339	244.1237895	884.22701
30	2.50E-02	0.6	319.4667776	252.5491267	888.6785
31	2.50E-02	0.625	327.6662775	260.1955434	892.7588586
32	2.50E-02	0.65	333.6442191	265.8423487	895.7097574
33	2.50E-02	0.675	338.4381572	270.3252026	898.0625074
34	2.50E-02	0.7	341.3939166	273.0689115	899.5069173
35	2.50E-02	0.725	343.3045165	274.9075003	900.4380792
36	2.50E-02	0.75	345.3679565	276.9057303	901.4416489
37	2.50E-02	0.775	347.3754016	278.8926572	902.4158706
38	2.50E-02	0.8	349.9153416	281.4208409	903.6453429
39	2.50E-02	0.825	354.4082799	285.7614713	905.8122399
40	2.50E-02	0.85	359.2164156	290.338881	908.1196961
41	1.50E-02	0.865	361.8859283	292.8299273	909.3958176
42	1.50E-02	0.88	363.7736101	294.6636778	910.2959995
43	1.50E-02	0.895	365.8227469	296.6380531	911.2711324
44	1.50E-02	0.91	368.7744154	299.4267682	912.6721748
45	1.50E-02	0.925	371.7964705	302.2479845	914.1021973
46	1.50E-02	0.94	375.2135558	305.4528962	915.7136482
47	1.50E-02	0.955	380.6760022	310.4253067	918.2781822
48	1.50E-02	0.97	386.1998599	315.3960011	920.8570122
49	1.50E-02	0.985	394.4629893	322.9119347	924.6873677
50	1.50E-02	1	409.3121014	341.7285867	931.4932004

Table 4: Aspen- HYSYS calculation of physical properties of Khurmala crude oil.

No.	Moles	ccum. moles	NBP(°C)	MWt.	d, Kg/m^3
0	0	0	36.05901489	70.8553541	629.5949829
1	1.00E-02	1.00E-02	52.45129146	75.67488574	731.0642118
2	1.00E-02	2.00E-02	59.19603482	78.170612	736.3055979
3	1.00E-02	3.00E-02	66.02592259	81.77467448	741.3103486
4	1.00E-02	4.00E-02	74.96927188	85.93266671	747.7674488
5	1.00E-02	5.00E-02	83.8536145	89.62426006	754.0761466
6	1.00E-02	6.00E-02	90.89039834	92.67493829	758.9997875
7	1.00E-02	7.00E-02	96.80291633	95.54182675	763.0864515
8	1.00E-02	8.00E-02	102.441125	98.4135128	766.9431918
9	1.00E-02	9.00E-02	107.9713953	101.0383408	770.6885868
10	1.00E-02	1.00E-01	112.2302176	102.9183804	773.5554278
11	2.50E-02	0.125	120.8121247	107.6709237	779.2463499
12	2.50E-02	0.15	131.820595	113.3137067	786.4411028
13	2.50E-02	0.175	142.4348003	119.0325347	793.2526193
14	2.50E-02	0.2	153.4821551	125.2781857	800.2188291
15	2.50E-02	0.225	164.9964437	131.9150258	807.3543477
16	2.50E-02	0.25	175.7704582	138.2502872	813.9193119
17	2.50E-02	0.275	185.1205565	143.9199443	819.5321433
18	2.50E-02	0.3	193.8226674	149.5946221	824.6861361
19	2.50E-02	0.325	203.6552024	156.2654055	830.433848
20	2.50E-02	0.35	214.8488792	164.131403	836.8813578
21	2.50E-02	0.375	226.924192	172.7886627	843.7283441
22	2.50E-02	0.4	238.3361853	181.1500905	850.0994743
23	2.50E-02	0.425	248.6362214	189.1282036	855.7670629
24	2.50E-02	0.45	259.113964	197.5232301	861.4569681
25	2.50E-02	0.475	269.296159	205.8326605	866.9159846
26	2.50E-02	0.5	278.3555149	213.4242002	871.7156248
27	2.50E-02	0.525	286.6775389	220.6681696	876.0779213
28	2.50E-02	0.55	294.9093455	227.9245964	880.3511634
29	2.50E-02	0.575	302.2060068	234.4083011	884.1046102
30	2.50E-02	0.6	308.1204425	239.7121211	887.1237273
31	2.50E-02	0.625	312.7490553	243.9056654	889.4721974
32	2.50E-02	0.65	316.4708936	247.3321368	891.3516152
33	2.50E-02	0.675	319.8788493	250.5323433	893.0655931
34	2.50E-02	0.7	323.4743436	253.9397069	894.8668103
35	2.50E-02	0.725	327.325564	257.5983764	896.7881543
36	2.50E-02	0.75	331.3603901	261.4480021	898.792293
37	2.50E-02	0.775	335.6796061	265.5863542	900.9278138
38	2.50E-02	0.8	340.3411904	270.0482109	903.2213484
39	2.50E-02	0.825	345.1074556	274.5971879	905.554537
40	2.50E-02	0.85	350.3270175	279.7152248	908.0954346
41	1.50E-02	0.865	354.8883688	283.994455	910.3048037
42	1.50E-02	0.88	358.7459069	287.6298428	912.164729
43	1.50E-02	0.895	363.0631151	291.7692393	914.237262
44	1.50E-02	0.91	368.2509243	296.598455	916.7156062
45	1.50E-02	0.925	372.8712073	300.8447622	918.911583
46	1.50E-02	0.94	377.9552692	305.5133818	921.3156116
47	1.50E-02	0.955	386.1012025	312.6796657	925.14213
48	1.50E-02	0.97	394.3410744	320.1927001	928.9807036
49	1.50E-02	0.985	406.6828458	335.5804169	934.670114
50	1.50E-02	1	428.807	362.7942324	944.7021779

From the cut plot distribution shown in Fig. 5, it is observed that both Hassira and Khurmala crude oils contain similar amounts of light products (light straight-run gasoline and naphtha). On the other hand, Khurmala crude oils contain the highest amounts of atm. gas oil and the lowest amounts of the light products as expected, since the Khurmala crude oil is medium crude oil as shown in Table 4. This is in agreement with above results.

IV. Conclusion

Both Hassira and Khurmala crude oils of Kurdistan/Iraq were characterized and various physical properties and product distributions of the crude oils were worked out based on the TBP distillation data and density of the whole crude oil.

Empirical correlations of pseudocomponents to TBP for these two crude oils are successfully derived using Aspen HYSHYS software, and the physiochemical properties of each pseudocomponent predicted by the derived correlations are in good agreement with the experimental data.

Both computational and experimental confirmed that Hassira crude oil gives highest yield of lightest fractions (28.76%v/v) and lowest yield of fuel oils at (+350°C) which is (20.52%v/v) while Khurmala crude oil gives the lowest yield of lightest fractions (25.5%v/v) and highest yield of fuel oil at (300°C+) which is (57.98%v/v) .

The higher pesdocompond, specific gravity, CI and lower API of Khurmala crude oil determined its higher level of hydrocarbons as proved by computational analysis and practical measurements.

Acknowledgment

The authors thank to University of Sulamaniyah for giving access to the petroleum lab, KISSR and University of Human development for their funding for this project. Also thanks for Dr Yongxin Pang for his reviewing paper.

.

References

[1] Chang, A.-F., Pashikanti, K. & Liu, Y. A., 2013. Characterization, Physical and Thermodynamic Properties of Oil Fraction. In: *Refinery Engineering: Integrated Process Modelling and Optimization.* Germany: Wiley-VCH Verlag GmbH & Co. KGaA, pp. 1-55.

[2] Speight, J. G., 2007. *The Chemistry and Technology of Petroleum.* 4 ed. U.S.A.: Taylor and Francis Group, LLC.

[3] Mohammed, H. K., Attiya, H. G. & Khudair, H. A. K., 2008. The relationships between the physical and chemical properties of narrow fraction distilled from mixed Kirkuk and Sharki-Baghdad crude oils. *Iraqi Journal of Chemical and Petroleum Engineering,* 9(2), pp. 1-8.

[4] Nedelchev, A., Stratiev, D., Ivanov, A. & Stoilov, G., 2011. Boiling point distribution of crude oils based on TBP and ASTM D-86 distillation data. *Petroleum & Coal,* 53(4), pp. 275-290.

[5] Tovar, L. P. et al., 2010. Computational Approach for Studying Physicochemical Properties of Heavy Petroleum Fractions. In: S. Pierucci & G. Buzzi Ferraris, eds. *Computer Aided Chemical Engineering.* Pierucci, S.;Buzzi Ferraris, G. ed. s.l.:20th European Symposium on Computer Aided Process Engnieering-ESCAPE20, pp. 1-1342.

[6] Shankar, N., Aneesh, V. & Sivasubramanian, V., 2015. Aspen Hysys based Simulation and Analysis of Crude Distillation Unit. International Journal of Current Engineering and Technology, 5(4), pp. 2833-2837.

[7] Nelson, W. L., 1958. Petroleum Refinery Engineering. 4 ed. New York: McGraw-Hill.
[8] John, M. H., 1979. Petroleum Geochemistry and Geology. 2 ed. s.l.: San Francisco.
[9] Behrenbruch, P. & Dedigama, T., 2007. Classification and characterization of crude oils based on distillation properties. Journal of Petroleum Science and Engineering, Volume 57, pp. 166-180.
[10] Chang, A. F., Pashikanti, K. & Liu, Y. A., 2012. Atmospheric distillation unit . In: Refinery engineering: Integrated process modelling and optimization. Weinheim: Wiley VCH, pp. 57-116.
[11] Al-Assady, Q. M. A., 2009. Characterization of petroleum fractions. The Iraqi Journal for Mechanical and Material Engineering,, 19(2), pp. 233-238.
[12] Rizi, M. R., 2005. Characterization of petroleum fraction. In: Characterization and properties petroleum fraction. U.S.A.: Philadelphia, PA,, pp. 87-151.
[13] Karim, A. R., Hamasalih, L. ,. T. D. I. & Salih, D. M., 2015. A comparative elemental analysis of the different kurdistan crude oil fields. American Journal of Science and Technology, 2(2), pp. 74-78.

Dr. Rawaz Ahmed: She worked at Teesside University, with valuable experience in heterogeneous catalysis and sustainable technology having won the top poster prize in catalysis by Royal Chemical Society at Johnson Matthey Conference, Biillingham in March, 2011, and The optimized preparation method and results obtained over the catalyst with optimal formulation are the subject of a patent application (P136962GB; New UK Patent Application; Supported Metal Catalyst; Teesside University). She worked as Research Associate: biomass carbonization at Teesside University after her Phd study. The major subject is focus on the biomass hydrothermal carbonization. Dr. Ahmed's is currently working on a number of research projects on heterogeneous catalysis and refinery processing at KISSR.