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Pre-calculated API Gravity Tables as an Alternative to the Standard Equation

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Abstract

American Petroleum Institute (API) gravity is a key parameter for classifying crude oil and petroleum products by density. This study presents the development of tables of oil gravities ranging from 0.600 to 1.025, from which the American Petroleum Institute (API) gravity can be derived without resorting to the equation of state. This research also examined four densities across four oil products (gasoline, kerosene, gas oil, and lubricating oils), yielding a total of 16 models. Moreover, the results of the laboratory test showed that the gravity of the oils is close, take for instance (the gravity of gasoline ranges between 0.700 to 0.750, the density of kerosene ranges from 0.750 to 0.800, while the density of gas oil ranges from 0.800 to 0.850, and lastly the range of gravity of lubricating oils ranged from 0.850 to 0.900). In conclusion, the tables produced by this study will enable direct measurement of API gravity, saving testers time, improving accuracy, and reducing errors.

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1-Introduction

The American Petroleum Institute (API) gravity value is a key indicator of crude oil quality and its selling value. Accurate measurement of API gravity is essential for classifying crude oil and petroleum products. Existing crude oil API prediction methods are difficult and time-consuming because they rely on numerous parameters [1]. In the oil industry, the API gravity test is an important method for determining product type [2]. API gravity is a significant quantity in the crude oil sector; nitrogen compounds are not directly related to API gravity, which causes conceptual confusion [3]. The large quantities of oil originate from the upstream and downstream processes, which cause differences in specifications, specialists in specific gravity (Sp. gr) [4]. North refinery company NRC Baiji produced about 200,000 barrels/day. These quantities to be produced must be calculated in accordance with the specification [5]. The world has recently turned to solving problems through scientific research, including the oil industry, as this opportunity has justified reducing the

number of workers and the effort expended [6]. Fossil fuels are the largest source, accounting for more than 75% of global energy demand. Various fuels, including diesel fuel, gasoline, and kerosene, can be generated in petroleum refineries using several petrochemical processes [7]. Crude oil is a complex of hydrocarbon that contains organic and inorganic materials.

2. Materials and methods

2.1. Oil samples and equipment

Four types of petroleum products were used in this study, which are gasoline, kerosene, gas oil, and lubricating oils. In this work were used 16 samples, 4 samples of gasoline, 4 samples of kerosene, 4 samples of gasoil, and 4 samples of lubrication oil, these samples were different and Sp.gr to find different API gravity depending on it. These samples were brought from North Refineries Company (NRC) in Baiji. The testes of these samples were evaluated for specific gravity, temperature, and American Petroleum Institute (API) gravity. Four different samples were tested for each model, bringing the total number of samples examined to sixteen. Samples were taken from the loading arms of petroleum products from the dispatch warehouse (Baiji), concentrated in the laboratories of the Petroleum Products Distribution Company (OPDC), Salahuldeen branch, and cooled at room temperature (15 °C). The equipment employed in this work (cylinder 100 ml, thermometer range from 0 to 100 °C, and hydrometers range 0.600 to 0.650, 0.650 to 0.700, 0.700 to 0.750, 0.750 to 0.800, 0.800 to 0.850, 0.850 to 0.900, 0.900 to 0.950, 0.950 to 1.000).

Testing methods

The Sp.gr according to the ASTM D1298 [12], while the API gravity was determined depending on ASTM D 5002 [

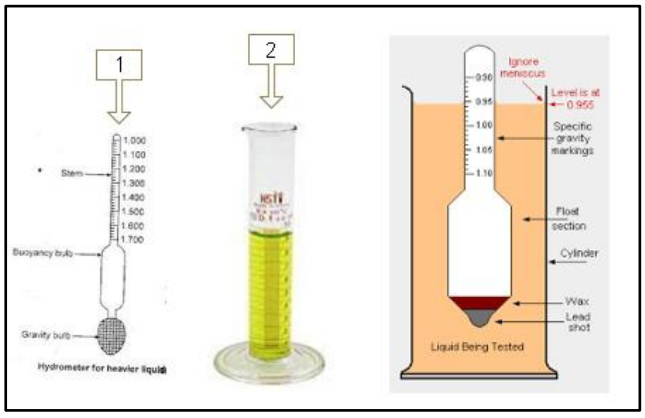

Figure 1: The Sp.gr apparatus

3Results and discussions

3.1.Gasoline test

Table 1 presents the data on specific gravity, temperature, and API gravity for gasoline samples. As a result, the range of specific gravity was from 0.700 to 0.750 while the range of API gravity was from 75.6 to 57.2. The results also showed that the temperatures of the gasoline samples were lowest, at approximately 20 °C, compared with kerosene and gasoil, which reached 20-21 °C. These results are attributed to the presence of light volatile aromatic compounds in gasoline. Therefore, these results will contribute to strengthening the findings that constitute the final Table of this research [15].

Table 1: Sp.gr, temperature, and API results of gasoline samples

Sample name	Sp. gr	Temperature °C	API
Gasoline-1	0.710	20	75.6
Gasoline-2	0.725	20	63.7
Gasoline-3	0.735	20	61.0
Gasoline-4	0.745	20	58.4

3.2. Kerosene test

Table 2 presents the data on specific gravity, temperature, and API gravity for kerosene samples. As a result, the range of the specific gravity was from 0.750 to 0.800, while the range of API gravity was from 57.2 to 45.4. The results also showed that the temperatures of the kerosene product were average compared to gasoline and gasoil, ranging between 22 and 23 °C. This is attributed to the mixture that makes up the kerosene. These results are attributed to the presence of light volatile aromatic compounds that contribute to the composition of gasoline products. Therefore, these results will contribute to strengthening the results that are the basic components of the final Table of this research [16].

Table 2: Sp.gr, temperature, and API results of kerosene samples

Sample name	Sp. gr	Temperature °C	API
Kerosene-1	0.755	22	55.9
Kerosene-2	0.765	22	53.6
Kerosene-3	0.770	22	52.3
Kerosene-4	0.785	22	48.

3.3. Gasoil test

Table 3 presents specific gravity, temperature, and API gravity for gasoil samples. As a result, the range of specific gravity was from 0.800 to 0.850, while the range of API gravity was from 45.4 to 35.0. The results also showed that the temperatures of the gas oil product were reasonable compared to other products, as they ranged between 23 and 25 °C. This is attributed to the mixture that makes up the gas oil, which is a mixture of linear organic hydrocarbon compounds that extend up to C30. These results are attributed to the presence of light volatile aromatic compounds that contributed to the composition of the

gasoline product. Therefore, these results will contribute to strengthening the results that are the basic components of the final Table of this research [17].

Table 3: Sp.gr, temperature, and API results of gasoil samples

Sample name	Sp. gr	Temperature °C	Sample name
Gasoil-1	0.815	23	Gasoil-1
Gasoil-2	0.830	23	Gasoil-2
Gasoil-3	0.840	23	Gasoil-3
Gasoil-4	0.845	23	Gasoil-4

3.4. Lubrication oil

Table 4 presents the specific gravity, temperature, and API gravity for lubrication samples. As a result, the range of specific gravity was from 0.850 to 0.900 while the range of API gravity was from 25.4 to 25.7. The results also showed that the temperatures of the lubrication product were low compared to other products, ranging between 20 and 25 °C. These results are attributed to the presence of lubricating oils are heavy hydrocarbons compounds that contribute to the composition of the lubricant product. Therefore, these results will contribute to strengthening the results that are the basic components of the final Table of this research [18].

Table 4: Sp.gr, temperature, and API results of lubrication oil samples

Sample name	Sp. gr	Temperature °C	Sample name
Lubrication-1	0.850	24	Lubrication-1
Lubrication-2	0.860	24	Lubrication-2
Lubrication-3	0.870	24	Lubrication-3
Lubrication-4	0.880	24	Lubrication-4

3.5.API gravity tables

Table 5 presents the ranges of Sp. gr. and API gravity for oil products. Tables 6, 7, and 8 present the API gravity data, which range from 0.600 to 0.795, corresponding to API gravities of 104.3 to 46.5. In addition, the API gravity ranges from 0.800 to 0.995, corresponding to API gravities of 45.4 to 35.0. Furthermore, API gravity was initially set at a specific gravity (Sp.gr) of 1.000 to 1.025, corresponding to API gravities of 10 to 7.0, respectively [19].

Table 5: Range of Sp.gr and API gravity ranges of oil samples

Sample	Sp.gr		ApI Gravity	
	Min	Max	Nin	Max
Gasoline	0.700	0.750	70.6	70.6
Kerosene	0.750	0.800	57.2	57.2
Gasoil	0.800	0.85	45.4	45.4
Lubrication oil	0.850	0.900	35.0	35.0

Table 6: API gravity started of Sp.gr from 0.600 to 0.795

SP. gr	API	≤ API	SP. gr	API	≤ API
0.600	104.33	104.3	0.700	70.64	70.6
0.605	102.38	102.4	0.705	69.20	69.2
0.610	100.46	100.5	0.710	67.79	67.8
0.615	98.58	98.6	0.715	66.40	66.4
0.620	96.72	96.7	0.720	65.02	65
0.625	94.90	94.9	0.725	63.67	63.7
0.630	94.15	94.2	0.730	62.44	62.4
0.635	91.33	91.3	0.735	61.01	61
0.640	89.59	89.6	0.740	59.71	59.7
0.645	87.87	87.9	0.745	58.43	58.4
0.650	86.19	86.2	0.750	57.16	57.2
0.655	84.53	84.5	0.755	55.91	55.9
0.660	82.89	82.9	0.760	54.68	54.7
0.665	81.28	81.3	0.765	53.64	53.6
0.670	79.69	79.7	0.770	52.26	52.3
0.675	78.12	78.1	0.775	51.08	51.1
0.680	76.58	76.6	0.780	49.91	49.9
0.685	75.06	75.1	0.785	48.75	48.8
0.690	73.57	73.6	0.790	47.61	47.6
0.695	72.09	72.1	0.795	46.48	46.5

Table 7: API gravity started of Sp.gr from 0.800 to 0.995

SP. gr	**API**	**≤API**	**SP. gr**	**API**	**≤API**
0.800	45.37	45.4	0.900	25.72	25.7
0.805	44.27	44.3	0.905	24.85	24.9
0.8 10	43.19	43.2	0.910	23.99	24
0.8 15	42.11	42.1	0.915	23.14	23.1
0.8 20	41.06	41.1	0.920	22.35	22.4
0.8 25	44.01	44	0.925	21.47	21.5
0.8 30	38.98	39	0.930	25.65	25.7
0.8 35	37.96	38	0.935	19.83	19.8
0.8 40	36.95	37	0.940	19.54	19.5
0.8 45	35.95	36	0.945	18.23	18.2

0.8 50	34.97	35	0.950	17.44	17.4
0.8 55	33.99	34	0.955	16.66	16.7
0.8 60	33.53	33.5	0.960	15.89	15.9
0.8 65	32.08	32.1	0.965	15.13	15.1
0.8 70	31.14	31.1	0.970	14.37	14.4
0.875	30.21	30.2	0.975	13.62	13.6
0.8 80	29.29	29.3	0.980	12.42	12.4
0.8 85	28.38	28.4	0.958	12.15	12.2
0.8 90	27.48	27.5	0.990	11.42	11.4
0.895	26.60	26.6	0.995	10.71	10.7

Table 8: API gravity started of Sp.gr from 1.000 to 1.025

SP. gr	API	≤API	SP. gr	API	≤API
1.000	10	10	1.015	7.9	7.9
1.005	9.29	9.3	1.020	7.22	7.0
1.010	8.59	8.6	1.025	6.54	7.0

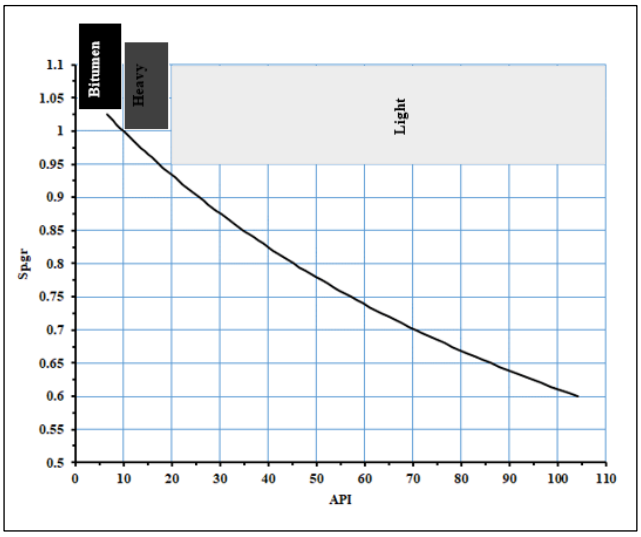

Figure 2: API gravity curve, relationship with sp. gr of oils

4.Conclusions

The Tables of all API gravity values by their relationship with specific gravity has successfully in this work. Extracting the weight value through the equation may take about five minutes, while extracting it from the table does not take half a minute, which saves time in the oil sector. Therefore, these Tables will be of great importance in all aspects of oil extraction, production, refining and distribution, as the API gravity values will be taken directly from the specific gravity via these Tables. As well as there is no need to calculate the equation or the possibility of being exposed to error after these Tables. While statistical analysis, which included standard deviation, error bars, or confidence intervals, was not found because the current work was done according to the API gravity equation.

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جداول الكثافة النوعية وفق معيار API المحسوبة مسبقًا كبديل عن المعادلة القياسية

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يعَدّ كثافة معهد البترول الأمريكي (API) معيارًا أساسيًا لتصنيف النفط الخام والمنتجات النفطية اعتمادًا على الكثافة. يقدّم هذا البحث تطوير جداول لكثافات الزيوت تتراوح بين 0.600 إلى 1.025، يمكن من خلالها اشتقاق كثافة API مباشرةً دون الحاجة إلى استخدام معادلة الحالة. كما تناولت الدراسة فحص أربع كثافات لأربعة منتجات نفطية (البنزين، الكيروسين، زيت الغاز، وزيوت التزييت)، مما أسفر عن 16 نموذجًا إجمالًا. وأظهرت نتائج الاختبارات المختبرية تقارب كثافات الزيوت؛ فعلى سبيل المثال، تتراوح كثافة البنزين بين 0.700–0.750، وتتراوح كثافة الكيروسين بين 0.750–0.800، بينما تتراوح كثافة زيت الغاز بين 0.800–0.850، وأخيرًا تتراوح كثافة زيوت التزييت بين 0.850–0.900. وخلاصة القول، فإن الجداول التي أُنتجت في هذه الدراسة تُمكّن من القياس المباشر لكثافة API، مما يوفر وقت الفاحصين، ويُحسّن الدقة، ويُقلّل الأخطاء.