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Comparison of Commercial Parameters of Imported Crude Oils with Indigenous Crude Oils

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ABSTRACT

General features, based on the physical data (commercial parameters) of the important imported and Pakistani crude oils have been evaluated.Oil fields of Pakistan are located in Indus basin which is subdivided into Northern, Central and Southern parts. The laboratory analyses indicate a large variation in characteristics of crudes from one area to another. A total of 48 crudes (7 imported and 41 indigenous) is included in the discussions. The Northern crudes and condensates are of diversified quality, ranging from high to low gravity and sulfur, high to very low pour point, aromatic or naphthenic to paraffinic nature, indicating different sources of origin. As a contrast, Southern crudes are invariably of paraffinic (waxy) character with high pour point, indicating same type of source rocks and reservoirs. All the imported crudes show uniform characteristics in physical and chemical behaviour.

INTRODUCTION

Crude oil varies widely in both physical appearance and chemical composition. It may be a water white liquid and as light as gasoline of API 65. It may also be a thick semi-solid black asphaltic material having less than 10 API gravity.

For studying the general physical characteristics and chemical composition two types of testing procedures are carried out. One is routine testing sometime called as "Commercial parameters" of crude oil, and the other involves analytical methods. The analytical methods have advanced gradually in the last two decades and it is now possible to correlate the results of analytical methods along with routine testing data with the characteristics of the crude oil and the products derived from it. however, analytical methods are costly and also time consuming (Allinson, 1975). Routine testing has remained with the oil industry for the quality evaluation and pricing purposes of the crude oil.

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There are two main oil producing areas in Pakistan namely, Potwar in Northern Punjab (Northern Indus basin) and Badin in Southern Sindh (Southern Indus basin). The crude oil of each of these areas has different characteristics.

Quality of oil can be predicted on the basis of the nature of source rock. Thus calcareous rocks which often contain sulfur tend to produce sulfur-bearing oil with napthenic or asphaltic characteristics, whereas sandy rocks tend to produce crude oil of low sulfur with waxy paraffinic nature (Hobson and Phol, 1975). It is desired by the refiner that oil should be low in sulfur and wax content. This is a contradictory demand and is seldom achieved. It is illustrated by the differences between crudes found in north Potwar and south Badin areas.

With the development of modern refinery processes, it is theoretically possible to produce any type of refined or finished product from any crude, but usually it is not economically feasible to do so. In refinery, the refiner desires to produce best combination of the marketable products with minimum cost (Nelson, 1958). This report may help such refiner.

All experiments reported in this paper were carried out by ASTM standard test procedures. Imported crude oils include Arabian Light, Medium and Heavy, Lavan, Murban and Upper Zakum. Most of these crudes are regularly imported into Pakistan for processing, with the exception of Arabian Medium, Heavy and Lavan crude oils.

RESULTS AND DISCUSSION

Some of the important physical data of the indigenous and imported crude oils are given in Tables 1-3 and discussed briefly as under:

Gravity

Although gravity is not included in most of the specifications of crude oil products, but singly it is an important parameter that expresses the density or weight of a unit volume of material. The specific gravity

of the crude oil gives a rough measure of the amount of lighter hydrocarbons present. The lower the specific gravity or higher the API gravity, the greater is the yield of light fractions by distillation. Therefore, the price of the higher API gravity crude oil is higher. All the imported crudes have gravity around 34 API. Badin crude oils fit well in 38-50 API gravity crudes. Condensates have still higher API gravity. Northern crudes vary widely in gravity, ranging from 16 to 42 API gravity. Gravity is used for cargo assessment and freight rate determination.

Sulfur

It is one of the major concerns of refiners. It is argued that sulfur and salt are the major source of corrosion and plant rusting. Although other factors such as high temperature oxidation and low temperature rusting are also responsible for the deterioration of the refinery equipments. There are two important types of sulfur, one is organic sulfur and the other is dissolved (H_2S) sulfur. Organic sulfur is not so dangerous as volatile or dissolved sulfur. Certain crudes when distilled evolve hydrogen sulfide, low boiling sulfur compounds and also decomposition products of heavy sulfur compounds. However, most of the sulfur compounds concentrate in the distillation residue. The sulfur in the distillates is removed by alkali washing and hydro-treating. Most of the indigenous crudes are free from dissolved (H_2S) sulfur. Southern oil is termed as low sulfur crude as it contains less than 0.1 wt.% sulfur. The range of sulfur content of Northern crude oils is 0.05 - 2.10 wt. %. All the imported crudes have sulfur between 0.81-2.00 wt.%. On the average basis local crudes have lesser sulfur than the imported crude oils.

Salt Content

The salts of crude oils have adverse effects on refinery equipments. Therefore, desalting operation is carried out in the refinery. Salt removal in waxy crude is difficult. Prolonged heating, washing and settling is likely an answer to this problem in the oil field. There is a great variation in the salt content of local crude oils, depending upon the oil field and producing zone. Chak Naurang crude oil from North and South Mazari crude oil from Southern area have highest salt content. The salt content of imported crude oils ranges between 1-5 PTB.

BS & W

Base Sediment and Water (BS & W) are extraneous materials and they can be removed by unit operation. Water and sediment in crude oil lead to the corrosion of plant, flooding in the distillation column, blockage in heat exchangers and adverse effects on product quality. Sediment may come from drilling mud, sand, shale and salt brine. Water is present in the crude oil, either in emulsified form or in large droplets. Emulsified water in heavy asphaltic crude is difficult to separate. There is uniform content of BS & W (0.05 vol.%) in Southern crued oils, while there is variation from low to high BS & W in Northern crude oils. All the imported crudes have BS & W below 0.2.vol.%.

RVP

Reid Vapour Pressure (RVP) of an oil indicates the amount of light hydrocarbons present in the sample. The test is important for safety in storage and transportation. Excessive RVP causes vapour lock in fuel feed systems. The test is related to the methane to pentane content of the crude oil. In most of the local cases it is well below 5 lbs at 100 °F. In few crudes and condensates it is higher than 5 lbs. This shows that the crude oil has been well worked in GOSP. Upper Zakum, the imported crude oil, gave RVP as high as 11.7 psi.

Pour Point

It is used for the relative estimation of paraffinic or waxy content of the crude oil. High values of pour point (> +15 °C) indicate waxy nature of the Southern crudes, whereas Northern crudes show extremely low pour point (-30 °C) indicating intermediate or naphthenic nature. All the imported crude oils show extremely low pour point and can be termed as intermediate or naphthenic bases.

High wax content or high pour point materials present difficulties in handling and pumping. However, they are good feed stocks for hydrocracking plant.

Viscosity

The viscosity of crude oil is used in pumping and pipeline design calculations in consideration with composition and constituents of the crude. The viscosity data shown in the Tables (Kinematic viscosity at 40/50 °C, Tables 1-3) indicate that the Southern crude may be

Table 1. Commercial parameters of imported crude oil.

Sr. No.	Crude Oil	Sp.Gravity @ 60/60 °F	API Gravity @ 60/60 °F	Sulphur % Wt	R. V. P. @ 100 °F psi	Salt Cont. PTB	BS & W % Vol	Pour Point °C	Viscosity @ 40/50°C cSt	Con.Carbon Reside % Wt	Copper Strip Corrosion	Characterization Factor K
01.	Arabian Light	0.8509	34.7	1.80	4.6	4.0	0.10	-27	5.35/4.43	3.74	Ia	11.80
02.	Arabian Medium	0.8741	30.3	2.65	3.9	3.0	0.10	-15	9.7 @ 100°F	5.69	-	11.80
03.	Arabian Heavy	0.8867	28.0	2.85	8.2	4.0	0.05	-34	19.1@ 100°F	8.30	-	11.83
04.	Iranian Light	0.8500	34.9	1.30	7.8	5.0	0.20	-04	5.66/4.40	3.60	Ia	11.90
05.	Lavan	0.8536	34.3	2.00	2.7	1.0	0.05	-12	5.43/4.27	0.70	Ia	11.95
06.	Murban	0.8276	39.4	0.81	4.4	3.5	0.05	-12	3.10/2.42	1.45	Ia	11.99
07.	Upper Zakum	0.8509	34.86	1.96	11.7	5.0	0.10	-21	5.52/4.31	0.70	Ia	11.96

pumped through pipeline provided storage and pipeline is preheated. There is a lot of variation in the viscosity of Northern crudes. Crudes from Chak Naurang, Fimkassar and Joyamir have high viscosity and they may be a good feed stock for the production of asphalt. All the imported crude oils show a uniform pattern of viscosity (approx. 5 cSt at 40 °C).

Con. Carbon Residue

It gives an indication of the amount of high molecular or high boiling (cyclic) components in a crude. These high molecular hydrocarbons are concentrated in the residue after distillation. The test is performed by heating a sample under controlled conditions and estimating the residue. Generally, napthenic crudes have more con. carbon residue than the paraffinic crudes. Obviously some of asphaltic crudes from Northern areas have high con. carbon residue content than others. Con. carbon residues of all the imported crudes are below 3.7 wt.%.

Copper Strip Corrosion

Corrosive sulfur contained in the crude may be predicted with the help of this test. The effect of sulfur compounds is indicated by discoloration of a standard polished copper strip and comparing it with a standard color chart. Some of the Northern crude oils have as high as 3b value. Non-corrosive nature of the imported and Southern crude oils is evident from the results (Table 1) of this test.

Characterization Factor

Characterization factor (denoted by K) relates the gravity and distillation data of the crude oil and it also gives further information about the chemical nature of the oil (UOP, 1978). Most of the northerrn crudes have K values more than 12 and are termed as parraffinic base. The characterization factors of the Northern crudes, like other properties, are of varied nature and come under the classifications of paraffinic, intermediate and napthenic bases. Crudes from Joyamir, Chak Naurang and Fimkassar (Northern) have been found as naphthenic bases and may consequently be termed as having asphaltic character. All the imported crude oils are either of intermediate or paraffinic character. Other properties such as the molecular weight, hydrogen content, heating value and specific heat of crude oil, can also be computed with the help of characterization factor.

Table 2. Commercial parameters of southern crude oil.

Sr. No.	Crude Oil	Sp.Gravity @ 60/60 °F	API Gravity @ 60/60 °F	Sulphur % Wt	R. V. P. @ 100 °F psi	Salt Cont. PTB	BS & W % Vol	Pour Point °C	Viscosity @ 40/50°C cSt	Con.Carbon Residue % Wt	Copper Strip Corrosion	Characterization Factor K
08.	Akri North	0.7938	46.76	0.04	3.8	2.0	0.05	+ 15	1.63/1.40	0.45	Ia	12.21
09.	Bari	0.8123	42.70	0.05	4.1	1.5	0.05	+ 18	1.77/1.62	0.52	Ia	11.95
10.	Bhatti	0.8022	44.90	0.03	6.0	6.5	0.05	+ 21	2.56/2.14	0.60	Ia	12.30
11.	Bobi	0.7752	51.03	0.03	9.4	Traces	0.05	+ 15	1.03/0.99	0.10	Ia	11.83
12.	Buzdar North	0.8054	44.18	0.05	4.3	1.0	0.05	+ 24	2.00/1.64	0.24	Ia	12.02
13.	Dhabi	0.8333	38.31	0.05	2.2	4.0	0.05	+ 21	3.45/2.94	0.27	Ia	12.18
14.	Halipota	0.8051	44.25	0.05	3.4	26.0	0.05	+ 24	2.34/1.97	0.38	Ia	12.27
15.	Khaskheli	0.8333	38.31	0.05	2.6	9.0	0.10	+ 21	2.94/2.36	0.23	Ia	12.94
16.	Kunnar	0.7987	45.66	0.05	6.0	Traces	0.05	+ 21	1.65/1.42	0.40	Ia	11.88
17.	Lashari	0.8231	40.41	0.06	3.0	Traces	0.05	+ 21	2.39/1.95	1.95	Ia	12.01
18.	Laghari	0.8100	43.19	0.05	4.4	1.0	0.10	+ 27	2.26/1.95	0.52	Ia	12.19
19.	Liari	0.8102	43.15	0.08	5.7	4.0	0.05	+ 18	2.25/1.94	0.51	Ia	11.98
20.	Mazari	0.8058	44.10	0.05	5.4	1.5	0.05	+ 18	2.35/1.98	0.60	Ia	12.14
21.	Meyun Ismail	0.8111	42.95	0.02	4.7	2.0	0.15	+ 21	2.33/2.13	0.38	Ia	11.96
22.	Pasakhi	0.8189	41.29	0.05	4.2	Traces	1.05	+ 21	2.38/1.98	0.70	Ia	12.05
23.	Sono	0.8227	40.49	0.08	4.0	Traces	0.05	+ 24	2.65/2.15	1.23	Ia	12.02
24.	Sonro # 2	0.7917	47.22	0.05	13.6	< 1.0	0.05	+ 15	1.85/1.54	0.58	Ia	12.19
25.	South Mazari	0.8120	42.76	0.02	5.1	34	0.15	+ 27	2.82/2.26	0.49	Ia	12.31
26.	Tando Alam	0.8233	40.37	0.08	4.9	Traces	0.05	+ 21	2.95/2.47	1.01	Ia	12.01
27.	Thora	0.8212	40.81	0.09	3.8	Traces	0.05	+ 24	3.11/2.52	1.14	Ia	12.12
28.	Matli Condensate	0.7459	58.2	0.03	8.6	3.0	0.05	<- 18	0.89/0.82	0.03	Ia	11.87
29.	Nari Condensate	0.7827	49.28	0.05	3.6	2.0	0.05	<- 30	1.53/1.10	0.17	Ia	11.90
30.	Turk Condensate	0.7425	59.07	0.05	5.0	0.15	0.05	< -30	0.58/0.65	0.03	Ia	12.00

Table 3. Commercial parameters of northern crude oil.

Sr. No.	Crude Oil	Sp.Gravity @ 60/60 °F	API Gravity @ 60/60 °F	Sulphur % Wt	R. V. P. @ 100 °F psi	Salt Cont. PTB	BS & W % Vol	Pour Point °C	Viscosity @ 40/50°C cSt	Con.Carbon Reside % Wt	Copper Strip Corrosion	Characterization Factor K
31.	Balkassar	0.8801	29.27	0.60	1.9	9.2	0.80	-18	7.80/5.75	5.00	Ia	11.49
32.	Bhal Syedain	0.8184	41.37	0.25	7.2	1.0	0.05	-27	1.79/1.59	2.02	Ia	11.64
33.	Chak Naurang # 1	0.9360	19.67	1.62	4.1	180	0.40	-27	126.0/83.5	11.67	Ib	11.22
34.	Dhulian	0.8604	32.95	0.26	2.0	5.5	0.8	-3	5.24/4.06	1.30	Ib	11.81
35.	Dhurnal	0.8305	38.80	0.15	6.8	22.0	2.00	<-30	2.29/1.99	0.46	3b	11.77
36.	Fimkassar # 1	0.8769	29.86	0.76	3.9	4.0	0.05	< -30	6.28/4.73	3.01	Ia	11.22
37.	Joyamair	0.9559	16.67	2.10	-	1.5	0.8	+15	2557/953	6.76	Ia	10.98
38.	Khaur	0.8667	31.8	0.22	0.8	4.5	Traces	-24	6.36/4.75	0.98	Ia	11.73
39.	Meyal (Sweet)	0.8089	43.14	0.05	5.5	3.0	0.25	< -30	1.45/1.33	0.13	Ia	11.59
40.	Missakeswal # 2	0.8327	38.42	0.18	3.1	3.0	0.05	< -30	1.60/1.70	0.30	Ia	11.47
41.	Sadkal	0.8222	40.59	0.21	5.3	2.0	0.05	< -30	2.01/1.75	0.10	Ia	11.81
42.	Ratana # 2***	0.8115	42.86	0.12	7.8	<1.0	0.05	-15	1.46/1.25	0.01	Ia	11.60
43.	Toot	0.8388	37.20	0.30	2.7	1.0	0.05	< -30	2.68/1.98	0.90	Ia	11.75
44.	Turkwal # 1	0.8738	30.40	0.68	3.2	10.0	0.20	< -30	6.03/4.8	3.60	Ia	11.56
45.	Adhi Condensate	0.7700	52.27	0.09	9.0	Nil	0.05	< -30	0.83/0.72	0.09	Ia	11.88
46.	Dakhni Condensate	0.7866	48.39	0.10	4.5	0.1	0.05	< -30	1.20/1.11	0.08	Ia	11.63
47.	Dhamraki # 1 Condensate	0.7389	60.00	0.05	12.1	Nil	0.05	-12	0.90/80	0.01	Ia	12.01
48.	Dhodak Condensate	0.7456	58.28	0.05	4.3	0.25	Traces	< -30	0.80/0.74	0.02	Ia	12.09

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