PRJ Vol 1, (January 1989); P. 37–39, 5 TABLES.

Short Note

A VISCOSITY BLENDING MODEL FOR LUBRICATING OILS

A. Alem *

نمط خلط لتحديد لزوجة زيوت التشحيم

د . عبد العاطى العالم

تستعمل زيوت التشحيم فى الحياة العملية لاغراض متعددة ، وبالتالى فان مواصفاتها تختلف باختلاف تلك الاغراض ، واختيار الخلطة المناسبة من قطفات نواتج تكرير خام معين لتحضير زيت الاساس الذى هو العنصر الرئيسى للمنتوج النهائى يعتبر من أهم العوامل فى تحديد تلك المواصفات ..

ومن ناحية أخرى فان خاصية اللزوجة تلعب دورا أساسيا فى تحديد نوعية الزيت المنتج ، ويتم مراقبة لزوجة المواد المنتجة بالتحكم فى نسب خلط قطفات نواتج التقطير المستعملة فى تحضير زيت الأساس .

وتهدف هذه الدراسة لاستنباط نمط دقيق لتحديد نسبة خلطة قطفات خام البريقة الليبى لانتاج أنواع متعددة من زيت التشحيم وذلك قبل استعمال أى نوع من الاضافات أو استخلاص أى كمية من الشمع كما تهدف أيضا لحساب كمية الانتاج المتوقعة من تلك الانواع من الزيوت .

ويتوقع لهذه الدراسة أن تساهم فى تمكين مصافى التكرير التى تتعامل مع خام البريقة الليبى فى تحديد الكمية القصوى من كل نوع من أنواع زيوت التشحيم مع المحافظة على جودة هذه الزيوت من حيث مواصفاتها ودرجة خاصية اللزوجة بها ..

INTRODUCTION

Any suitable lubricating oil performance can be modified by controlling the amounts of different cuts and using additives so as to give lubricating oils a broad range of uses. Blending of different cuts of lubricating oil ranges of Brega crude had been investigated to obtain an optimum base oil before adding any additives.

Lubricating oils are best made from wax free crude oils. However, applications of solvent extraction and solvent dewaxing make it possible to use a wide range of crude oils in the manufacture of lubricating oils. The type and concentration of additives to lubricating oils vary depending on the applications, types of operations and the ranges of the cuts used in the blending program.

Lubricating oils are classified according to their viscosity. A useful system of Lubricating oil classification was developed by the Society of Automotive Engineers (1974) where maximum and minimum viscosities are specified at 110°F and 210°F, respectively.

The objective of the present study is to enable the users to determine the volume and ranges of the cuts to be used in order to obtain an optimum blend of lubricating oils. The blend must satisfy the requirements of viscosity which is essential for a given specific lubricating oil.

Cuts of Brega crude oil in lubricating oil ranges have been blended and the results are compared with the experimental work of this study. All possible combinations of the blended cuts were measured experimentally.

* Petroleum Research Centre, Tripoli, G.S.P.L.A.J.

EXPERIMENTAL WORK

According to the U.S. Bureau of Mines method of classification (IP Standards, 1972) the Brega crude oil is a paraffin-intermediate base crude. The characteristics of Brega crude oil are listed in Table 1.

Table 1. Brega crude oil characteristics

Property	Test method	Result
Sp.gr.15.7°C/15.7°C	IP 160	0.824
API	IP 146	40.1
Sulphur content wt%	IP 63	0.197
Viscosity at 100°C cst	IP 71	4.39
Pour point °C	IP 15	3.
R.V.P. at 37.6°C Kg/cm^2	IP 69	0.457
Flash point, °C		-5
Asphalthene content wt%	IP 143	0.072
Con-carbon (wt%)	IP 13	1.63
Ash content (wt%)	IP 4	0.014
Wax content (wt%)	UOP	4.235
Salt content	IP 77	0.024
H_2S(ppm)	Shell	102.
Characterization factor		12.30

ASTM distillation was performed using the ASTM 86/1P24 procedure (IP Standards, 1972). The crude was distilled using a batch fractionation unit made according to the ASTM D-2842 method. The unit consists of a 2.5 cm inside diameter column with a packed hight of 1.5 m. The fractionation efficiency corresponds to 15-17 theoretical trays as determined under a total reflux condition. The operating range is up to 400°c and the absolute pressure ranges from 2 to 760 mm Hg. In order to extend the fractionation beyond 400°C the residue was distilled according to the UOP 109-59 method (IP Standards, 1972). The TBP curve on the volume basis was extended beyond 400°C using probability charts. The TBP curve on the weight basis was extended beyond 400°C, using the specific gravity data collection from the fractions obtained from the UOP 109-59 procedure. It was possible to obtain 90-95 V.I. motor oils having low pour points from this crude. The 450-500°C cut is 4.1 volume per cent of crude after dewaxing. The 500-550°C fraction is 3.1 volume per cent of the crude after dewaxing. Characteristics of the lubricating oil distillates are presented in tables 2 and 3.

COMPUTING THE BLEND

Viscosity charts for viscosity blending have been developed by ASTM. The method consists of two steps; first viscosity-temperature lines of oil are plotted, then blended at constant viscosity by linear proportioning.

The above method is time consuming and is not accurate enough since it does not blend at a constant temperature, which is the usual approach. Viscosity of different cuts in the lubricating oil range connot be linearly blended. As a result, a function that is linearly dependent on temperature is proposed. A modified form of Wathler's equation (Hobson and Pohl, 1975) was used to express the viscosity as a function of temperature :

$$\ln \ln (v + 0.7) = m \, \mathrm{Ln}\, T + b$$

Where v is the kinematic viscosity in cst and T is the temperature in °F, m and b are constans.

The procedure to compute the blend of any number of cuts is based on treating the two adjacent cuts as two oils, one being light while the other is heavy. Two equations are to be solved for m and b. Blending will be conducted at constant viscosity. Light oil parameters are used to calculate the light oil temperature T_L that will have the same viscosity as the heavier oil for the next cut. A blend of the weight of light oil m_L with the weight of heavy oil m_H of the two cuts at the same viscosity v_H would be at a temperature Tx which can be calculated from the equation :

$$m_L \,\mathrm{Ln}\, T_L + m_H \,\mathrm{Ln}\, T_H = (m_L + m_H)\,\mathrm{Ln}\, T_x$$

Where T_H denotes the heavy oil temperature.

T_x can be calculated for both the light and heavy cuts. This will lead to two viscosities for the binary blend at T_x based on light and heavy cuts.

In these calculations the basic temperatures are taken to be 100 °F and 210 °F for each cut. The blend is extended by considering the first and second cut as the light component and the third cut as the heavy component. A computer program was used to include several combinations of seven cuts of the crude oil in lubricating oil ranges.

The cuts and some of the blended results are shown in Table 4. Results show that Brega crude oil is an excellent feed stock for different lubricating oil productions (Table 5). The derived model will enable the refinery to determine the maximum amount of lubricating oil that can be produced from this or any other given crude oil. Specifications on the viscosity ranges will be the only constraint. Futher work should be conducted to cover crude oils from other terminals in Libya.

Table 2. Characteristics of lube oil distillates before phenol extraction

	Light crude oil 360-400°C	Med. lube oil 400-450°C	Vis. lube oil 450-500°C	Heavy lube oil 500-550°C
Range on crude				
Vol.%	65.5-71.3	71.3-78	78 -83.8	83.8 -88
Wt%	61-67.2	67.2-74.5	74.5-80.8	80.8 -86
Yield on crude				
Vol.%	5.7	6.7	5.8	4.3
Wt.%	6.2	7.3	6.3	5.2
Mid vol.%	68.5	74.7	80.9	86
API	31.2	27.7	23.4	20.3
Total sulphur (Wt%)	0.4	0.441	0.46	0.48
Con. carbon (Wt%)	0.017	0.035	0.066	0.123
Wax content (Wt%)	23	23	19	17
Asphaltene content (Wt%)	0.05	0.061	0.12	0.132
Pour point °C	15	32	38	-
Characterization factor	11.5	11.5	11.8	11.7

Table 3. Characterization of lube distillates after phenol extraction at 400-450°C

	Before phenol extraction	After phenol extraction (1:1)	After phenol P/O (1:2)
Viscosity index	78.7	91.6	80.7
Kinematic viscosity			
cut at 37.8 °C	30.98	34.57	36.24
at 98.9 °C	4.84	5.3 1/4	5.33
Yield on crude	6.7	5.4	5.4
Pour point °C	32	-18	-
Characterization factor	11.5	11.4	11.45

Table 4. Viscosities of different cuts of lubricating oil at 100 and 210 °C

T, °C	V at 100 °C	V at 210 °C
Cut 1.280-300	3.42	1.31
Cut 2.300-320	4.65	1.54
Cut 3.320-340	6.2	1.85
Cut 4.340-360	8.0	2.2
Cut 5.360-380	11.2	2.63
Cut 6.380-400	11.73	2.77
Cut 7.400-450	26.43	4.4
Blend, all cuts	7.8	2.14

Table 5. Samples of blends and deviation from experimental results

Blend	Deviation from experimental results (%)	
	at 100 °F	at 210 °F
All cuts	-0.25	-.19
Cuts : 1+2+3+4+7	0.18	-.02
Cuts : 1+2+3+4+6+7	0.21	-.18
Cuts : 3+4+6+7	0.03	-0.21
Cuts : 1+7	0.36	0.28

REFERENCES

American Petroleum Institute, 1974, Technical Data Book, Petroleum Refining, 1 and 2.

Hobson, G.D. and Pohl, W., 1975, Modern Petroleum Technology. Applied Science Publisher, England, 968 p.

United States Institute of Petroleum, 1972, IP Standards for Petroleum and its Application Products, 35th ed.