METHODS FOR CALCULATING THE VISCOSITY INDEX HYDRAULIC OIL

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Abstract. In this paper viscosity index of hydraulic oil was determined using tree methods. Viscosity index was calculated from the measured viscosity at 40°C and 100°C using ASTM Method D 2270 and was graphically determined using ASTM D 341. Viscosity index calculation was performed with a computer program using kinematics viscosity at 40°C and 100°C. The viscosity-temperature coefficient was calculated from the measured viscosity at 40°C and 100°C.

Keywords: Viscosity index, viscosity-temperature coefficient, hydraulic oil.

1. INTRODUCTION

Viscosity index (VI) is a means of expressing the variation of viscosity with temperature. VI is also widely used as a rough measure of the paraffinic of naphthenic hydrocarbon character of oils. In this context, mid-VI or high-VI has connotations that suggest good or poor solvent power for additVIes or tendency to swell or shrink certain elastomers. Most recently, hydrocarbon type, along with manufacturing history, has been used to classify oils with respect to health hazards, particularity carcinogenicity.

Viscosity index is calculated from the measured viscosity at 40°C and 100°C using ASTM Method D 2270, by reference to two series of no longer existent oils. This method of VI calculation is one of the most awkward possible ways to express the type of information it conveys, and is one of the more obvious demonstrations of the conservatism of the petroleum and lubricant industries.

In the calculation of VI, for each viscosity at 100°C (called Y), the ASTM Method D 2270 gVIes the value of two parameters, called L and H. L is the 40°C viscosity of oil having the same 100°C viscosity as the test oil, but a VI of zero. H is the 40°C viscosity of second oil, also with the same 100°C viscosity, but with a VI of 100. Since a high VI indicates a lesser change in viscosity with temperature, L is always greater than H. The VI of the oil being considered is defined by the relationship of its 40°C viscosity (called U) to the parameters L and H. If U is between L and H, the VI is the percent of the way U is from L to H:

$$VI = 100 \text{ x } (L – U)/(L – H) \qquad (1)$$

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A completely different calculation is used for oils where U is smaller than H, which is true for oils with VI greater than 100. For these oils, the VI is defined by a new parameter N, calculated from H and Y rather than H and L [1]:

$$VI = 100 + 140((antilog\ N) - 1 \qquad (2)$$
$$N = (\log H - \log U)/\log Y \qquad (3)$$

All logarithms are to base 10. The tables given in ASTM D 2270 provide values for Y from 2 cSt to 70 cSt at 100°C. Values of L and H for higher viscosities are calculated from two equations:

$$L = 0.8385Y2 + 14.67Y - 216 \qquad (4)$$
$$H = 0.1684Y2 + 11.85Y - 97 \qquad (5)$$

where Y >70.

When VI is used to indicate hydrocarbon character, the solvent power, elastomer compatibility, the use of additVIes to improve VI can give very misleading results. The use of VI for non-petroleum hydrocarbons or for non-hydrocarbons materials seems completely bankrupt.

The viscosity at other temperatures may be conveniently determined graphically using ASTM D 341. Finding the viscosity at any gVIen temperatures is then reduced to finding the viscosity at two standard temperatures from the viscosity at one temperature and the VI.

To calculate the viscosity index we used a program viscosity index acc ISO 2909 / ASTM D2270 on http://www.tribology-abc.com/calculators/astm_d2270-226.htm using kinematics viscosity at 40°C and 100°C [3]. The importance of the VI can be shown by considering automotVIe lubricants: oil having high VI resists excessive thickening when the motor is cold, promoting rapid starting and prompt circulation, and resists excessive thinning when the engine is hot, providing full lubrication and preventing excessive oil consumption [2, 4].

The objective of the present paper is the determination of viscosity index of a hydraulic oil.

2. MATERIALS AND METHOD

Viscosity index of a hydraulic oil was determined using a set of Schott Ubbelohde-type viscometers selected according to the values of their constants, so that the margins of the uncertainty, inherent in the Hagebach-Couette correction, does not exceed the error allowed for the measurements. The measurements were carried out at 40 0.1 and 100 0.1°C, according to the recommandation of ASTM D2270 [5, 6].

3. RESULTS AND DISCUSSION

Viscosity is a measure of an oil thickness and ability to flow at certain temperatures, while viscosity index is a lubricating oil quality indicator, an arbitrary measure for the change of its kinematic viscosity with temperature and provides an insight into the oil's ability to perform at high and low temperatures [7].

The viscosity index of the hydraulic oil determined with equation (1) was 144. The kinematic viscosity of the hydraulic oil was 5.73 cSt at 100°C and 35.46 cSt at 40°C.

The viscosity index of hydraulic oil was determined using the ASTM D 341 diagram, shown in Fig. 1.

The value obtained for the viscosity index of hydraulic oil together with its kinematics viscosities at 40 and 100°C and viscosity-temperature are presented in table 1.
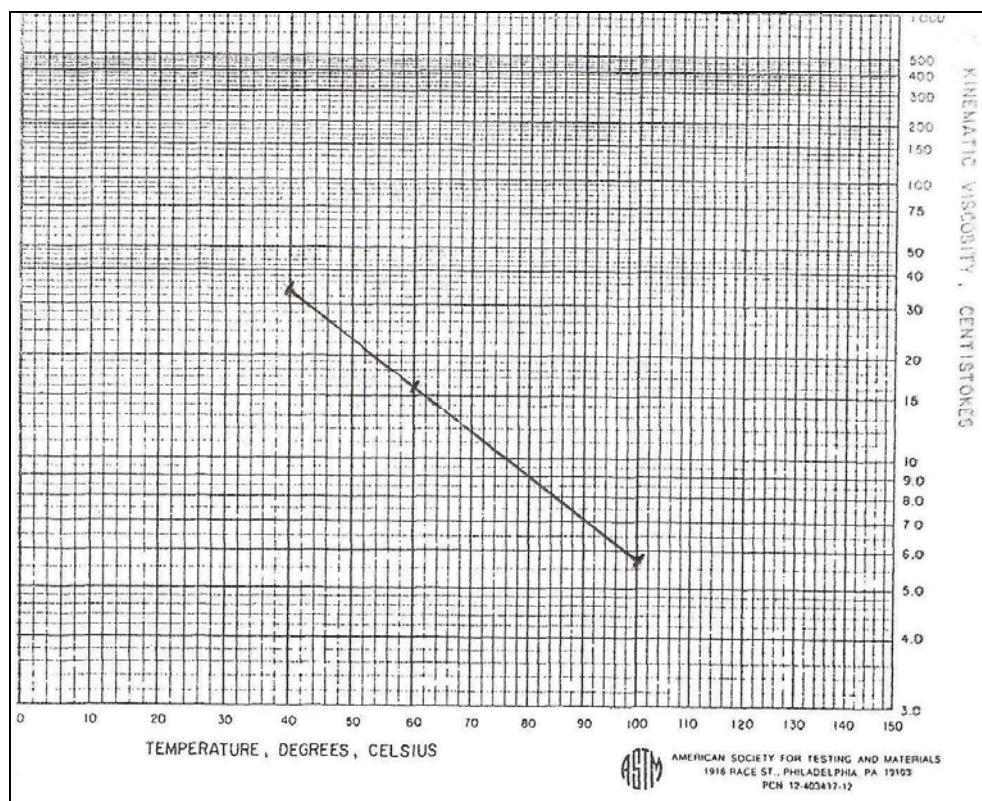

Fig. 1. Diagram ASTM D 341 for the determination of the VI viscosity index of hydraulic oil.

The value obtained for the viscosity index of hydraulic oil in Table 1, together with their kinematics viscosities at 40 and 100°C and viscosity-temperature coefficient.

Table 1. Values of kinematic viscosities at 40 and 1000C, viscosity index and viscosity-temperature coefficient for the hydraulic oil.

Oil	Density (g/cm^3)	Kinematic viscosity (mm^2/s)		Viscosity index relationship (1)	Viscosity index program VI	Viscosity-temperature coefficient
		40°C	100°C			
Hydraulic	0.8900	35.46	5.73	144	100.59	0.8380

Another indication of the change in kinematics viscosity with temperature, which is less arbitrary than the viscosity index, is the viscosity-temperature coefficient, VTC, defined by the relationship [8-12]:

$$VTC = (A - B)/A \qquad (6)$$

where A is the viscosity (cSt) at 40°C and B – viscosity at 100°C. The calculated values of VTC are also given in Table 1.

4. CONCLUSIONS

The viscosity of hydraulic oil was determined using tree methods: ASTM D 2270 and method graphically using ASTM D 341. Viscosity index calculation was performed with a computer program using kinematic viscosity at 40°C and 100°C.

Viscosity index obtained with the calculator program is 69% lower than that obtained by graphical method and the equation (1). The viscosity-temperature coefficient for hydraulic oil can vary by a factor of 10 depending on the temperature.

The viscosity of hydraulic oil is dependent upon temperature. Viscosity decreases as temperature increases because the molecules vibrate more, and interact less.

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