ORIGINAL PAPER

VISCOSITY IMPROVERS FOR SOLUTIONS COPOLYMER ETHYLENE PROPYLENE IN OIL SAE 10W-40

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Abstract. *In this article we presented viscosity improvers for ethylene propylene copolymer solution in SAE 10W-40 oil using tree method. Viscosity indices are calculated from the measured viscosity at 40 and 100 ºC using ASTM D 2270 and method graphically was using ASTM D 341. Viscosity improvers for solution oil were calculated using computer program created in Visual Basic. The viscosity-temperature coefficients for SAE 10W-40 oil were calculated from the measured viscosity at 40 and 100 ºC.*

Keywords: *viscosity index, SAE 10W-40 oil, solutions.*

1. INTRODUCTION

The temperature range oil is exposed to in vehicles' engine is usually pretty wide: from cold ambient temperatures in the winter before starting up to the hot operating temperatures when it is fully warmed up in hot summer weather. As the viscosity of oils decreases with increasing temperature, such a difference is too large to be covered by any single-grade mineral oil.

High temperature lubrication can be improved with the advent of oil viscosity index improvers or modifiers. These are polymers that, added to low viscosity oils, effectively thicken them as temperature increases, improving the viscosity/temperature characteristics [1]. Thus the lubricating effect of mineral oils is extended across a wider temperature range and such lubricants are called multi-grade oils.

The decrease in viscosity with temperature in commercial lubricant products is described by the so called viscosity index, VI. This is an empirical number indicating the rate of change in viscosity of oil within a given temperature range [2]: high numbers indicate a low change, while low numbers a relatively large change. These numbers can only be compared within a viscosity range. VI is not an indication of how well the oil resists thermal breakdown.

Ideal oil for most purposes is one that maintains a constant viscosity throughout the temperature changes [3].

The importance of the VI can be shown by considering automotive 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.

The object of the present paper is the determination of viscosity improvers for ethylene propylene copolymer solutions – recommended as viscosity improvers for multi-grade mineral oils.

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Copolymer ethylene propylene is a multifunctional engine oil additive combining the functions of viscosity index improver and pour point depressant. Polymer is a unique low-viscosity emulsion based on ethylene and propylene copolymer in a carrier fluid. Its physical properties are: color – brown, viscosity at 40 °C – 7.5cSt, density – 0.90g/cm^3, flash point – 150.

2. MATERIALS AND METHOD

Viscosity improvers were determined for solution of ethylene propylene copolymer, recommended as viscosity improvers for mineral oils, in SAE 10W-40 mineral oil.

Dissolution of polymer in SAE 10W-40 oil was realized at room temperature with gentle shaking now and then.

The kinematic viscosities of copolymer solution were determined using a set of Schott Ubbelohde-type viscometers selected according to the values of their constants and viscosities of solutions, 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 recommendation of ASTM D2270 [4]. They were possible only for 3g/dL solution with the available set of viscometers.

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 [3].

In the calculation of IV, for each viscosity at 100 °C (called Y), the ASTM Method D 2270 gives 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 IV of zero. H is the 40 °C viscosity of second oil, also with the same 100 ° C viscosity, but with a IV of 100. Since high IV indicates a lesser change is viscosity with temperature, L is always greater than H. The IV 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 IV is the percent of the way U is from L to H:

$$IV = 100 \times (L - U)/(L - H) \quad (1)$$

The viscosity index of copolymer solution in SAE 10W-40 oil were determined equation (1) is 158. The copolymer solution in SAE 10W-40 oil was 14.80cSt viscosity at 100 ° C and 97.9cSt viscosity at 40 ° C. Viscosity index of copolymer solution in SAE 10W-40 oil calculation was performed with a computer program developed by INCERP SA, created in Visual Basic called IV. Such programs can be found on the Internet, such as Calculator for copolymer solution in SAE 10W-40 oil Surveyor Version 2.0 developed by Saylbot Computers, Moscow, in 2002, using OrbForm version 1.2.

The kinematics viscosity of 1g/dl, 1.5g/dl, 2g/dl, 2.5g/dl and 3g/dL copolymer solutions in SAE 10W-40 oil as solvent were measured at 40 and 100 ° C, according to ASTM D2270 [6], and the viscosity index were determined using the ASTM 2270-93 diagrams, shown in Figs. 1-3.

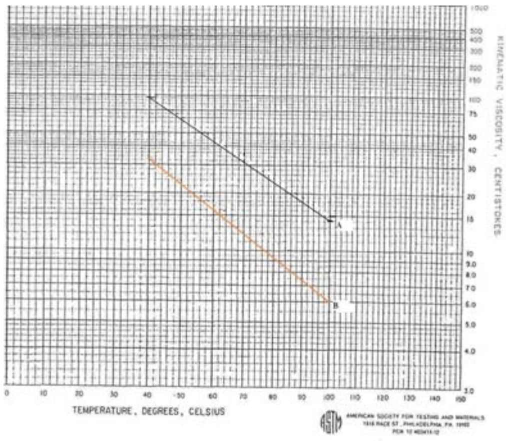

Fig. 1. ASTM D 341 diagram for determination of viscosity indices: A – oil SAE 10W-40; B – oil SAE 10W-40 and poly(ethylene-co-propylene) 1%.

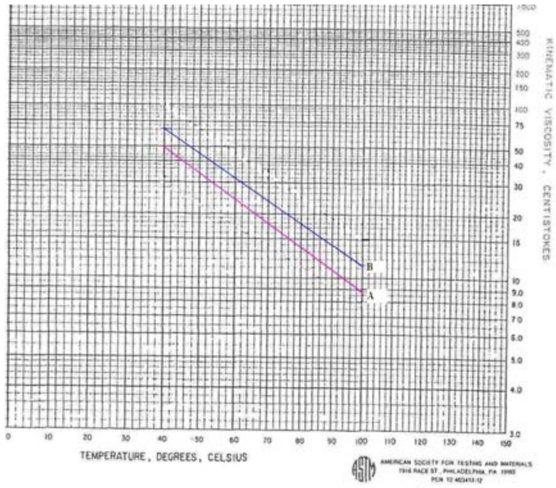

Fig. 2. ASTM D 341 diagram for determination of viscosity indices: A - oil SAE 10W-40 and poly(ethylene-co-propylene) 2%, B- oil SAE 10W-40 and poly(ethylene-co-propylene) 1.5%.

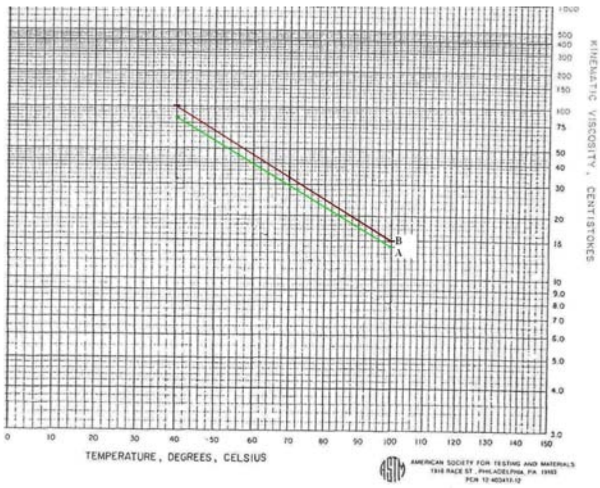

Fig. 3. ASTM D 341 diagram for determination of viscosity indices: A - oil SAE 10W-40 and poly(ethylene-co-propylene) 2.5%, B- oil SAE 10W-40 and poly(ethylene-co-propylene) 3%.

The values obtained for the viscosity improvers 1g/dl, 1.5g/dl, 2g/dl, 2.5g/dl and 3g/dl copolymer ethylene propylene solution are given in Table 1, together with their kinematics viscosities at 40 and 100 ºC and viscosity-temperature coefficient.

Table 1. Values of kinematics viscosities at 40 and 100 ºC, viscosity improvers and viscosity-temperature coefficients.

Fluid	ν, cSt		Viscosity index relationship (1)	Viscosity index program	Viscosity-temperature coefficient
	40 ºC	100 ºC			
SAE 10W-40	94.0	14.3	134	157.11	0.8478
1 g/dl solution	32.6	5.9	124	126.29	0.8910
1.5 g/dl solution	49.2	8.7	138	156.37	0.8231
2 g/dl solution	65.7	11.6	142	173.14	0.8234
2.5 g/dl solution	81.5	14.5	144	186.37	0.8221
3 g/dl solution	98.1	15.2	158	163.43	0.8488

Appropriate viscosity index 1g/dl solution concentration obtained in equation 1 is 0.8 times lower than that obtained with the software. If 1.5g/dl solution viscosity index calculated concentration is 0.9 times lower than that obtained with the program. 2g/dl concentration solution is obtained by calculating viscosity index of 0.8 times lower than that obtained with the program. Viscosity index corresponding solution obtained by calculation 2.5g/dl concentration is 0.7 times lower than that obtained with the software. 3g/dl concentrated solution viscosity index is obtained with formula 1 0.9 times lower than that obtained with the program.

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 [5]:

$$VTC = (A - B)/A \qquad (2)$$

where A is the viscosity (cSt) at 40^{o}C and B – viscosity at 100^{o}C. The calculated values of VTC are given also in Table 1. They are in accordance with the values of VI and the previously published results on the efficiency of the copolymer as viscosity improvers obtained using the dynamic viscosities [6, 7].

The table shows that viscosity-temperature coefficient values are much higher viscosity indices are both higher.

CONCLUSIONS

The viscosity index of copolymer solution in SAE 10W-40 oil was determined using tree methods: ASTM D 2270 and method graphically using ASTM D 341. Viscosity index obtained using a computer program is 5.43 higher than that obtained by method graphics and relation (1).The viscosity-temperature coefficient for hydraulic oil can vary by a factor of 10 depending on the temperature.

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

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