ORIGINAL PAPER

DETERMINATION VISCOSITY INDEX IMPROVERS FOR MULTI-GRADE OIL OF COPOLYMER POLYETHYLENE-PROPYLENE

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Abstract. *To establish the ability of copolymer polyethylene-propylene solutions in SAE 10W mineral oil as solvent to perform at low and high temperatures in a vehicle's engine that is their capacity to improve the oil viscosity index of their 3.0, 3.5, 4.0, 4.5 and 5.0 % solutions were determined two methods. The kinematic viscosities of the concentrated copolymer polyethylene-propylene solutions 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. Viscosity index is determined using the formula much higher than that determined by the software for all the solutions studied. Viscosity index of the solution copolymer polyethylene-propylene of 3.0 % concentration is 139.95 times lower than that, for of 3.5 % is 140.31 times higher than that, for of 4.0 % is 130.32 times higher than that, for of 4.5% is 140.33 times lower than and for of 5.0 % is 139.85 times lower than the one obtained with formula (1) according to ASTM D2270 standard.*

Keywords: *viscosity index, copolymer, multi-grade oil.*

1. INTRODUCTION

In general, mineral oil based fluids can not meet the demands of high performance lubricants without the use of an additive [1-3].

Additives are synthetic chemicals that added base oils can improve the characteristics of lubricants. Other additives may give new and useful properties of the lubricant; some can enhance properties already present, while some acts to reduce unwanted changes can occur in the product during service [4-7].

Improvement of viscosity is a function of increasing oil viscosity at higher temperatures. These results depend on the physical configuration of the polymer in solution with increasing temperature the mixture. The polymer molecule in solution is a random configuration which is filled with lubricating oil solvent. Thus, the volume increases viscosity lubricating oil molecule. At low temperatures the polymer molecules adopt a coiled shape so that their effect on viscosity is minimized [6-11]. At high temperatures, molecules tend to straighten and the interaction between these molecules long oil producing an effect that in turn lead to thickening which increases the viscosity index (VI) of oil. Viscosity Index is an indicator of temperature, viscosity modification. As VI is greater, the less the viscosity decreases with increasing temperature. Some of the polymers that are used commercially have certain advantages and disadvantages in performance [12-22].

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The purpose of this study was the determination of the viscosity of the solutions in two ways copolymer polyethylene- propylene concentrations 3.0, 3.5, 4.0, 4.5 and 5.0 g/dL.

2. MATERIALS AND METHODS

The copolymer polyethylene-propylene is Paratone 8900 commercialized by Exxon Chemical. The SAE 10W oil is used so predominantly paraffinic hydrocarbons containing 75 % saturated.

Dissolution of the copolymer polyethylene-propylene in the oil SAE 10W was conducted at room temperature with gentle stirring for several weeks. Solutions of concentration 6 g/dL brew was then diluted with mineral oil SAE 10W to achieve concentrations of 3.0, 3.5, 4.0, 4.5 and 5.0 g/dL.

The kinematic viscosities of concentrated copolymer polyethylene-propylene solutions 3.0, 3.5, 4.0, 4.5 and 5.0 g/ dL 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 ^{o}C and 100 ± 0.1^{o}C, according to the recommandation of ASTM D2270 [5]. They were possible only for 3.0, 3.5, 4.0, 4.5 and 5.0 g/dL solutions with the available set of viscometers.

3. RESULTS AND DISCUSSION

For the multi-grade oils, polyethylene-propylene copolymer, which have a viscosity index greater than 100 and viscosity index occur equation parameters U and H, and N where U is the viscosity of the multi-grade oil at a temperature of 40 ^{o}C. The IV is defined by a new parameter N, calculated from H and Y:

$$IV = 100 + 140((\text{antilog } N) - 1 \qquad (1)$$

$$N = (\log H - \log U)/\log Y \qquad (2)$$

All logarithms are to base 10. Y is the value of kinematic viscosity multi-grade oil at 100 ^{o}C.Values of H for higher viscosities are calculated from one equation:

$$H = 0.1684Y^2 + 11.85Y - 97 \qquad (3)$$

for Y >70.

The viscosity index for solutions copolymer polyethylene-propylene of 3.0, 3.5, 4.0, 4.5 and 5.0 % concentrations calculation was performed with a computer program developed by INCERP SA, created in Visual Basic using kinematics viscosity at 40 ^{o}C and 100 ^{o}C [9].

The kinematic viscosities of 3.0, 3.5, 4.0, 4.5 and 5.0 g/dL copolymer solutions Paratone 8900 in SAE 10W as solvent were measured at 40 and 100 ^{o}C, according to ASTM D2270 [15]. The viscosity indices were determined using the ASTM D-341 diagrams and are presented in Figs. 1-5.

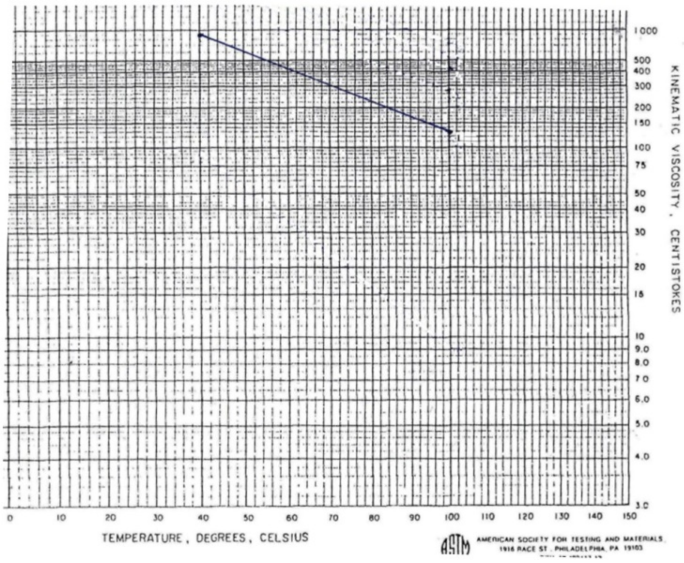

Figure 1. ASTM D-341diagram for determination of viscosity indices of SAE 10W oil and concentrated copolymer Paratone 8900 solution 3.0 %.

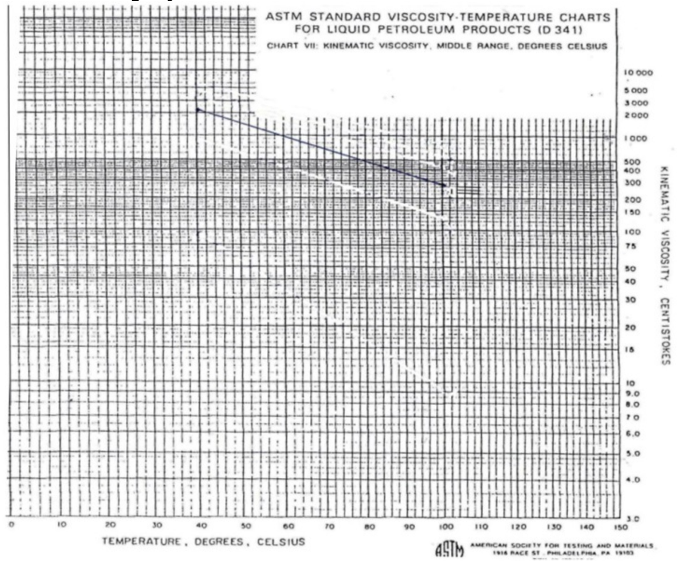

Figure 2. ASTM D-341diagram for determination of viscosity indices of SAE 10W oil and concentrated copolymer Paratone 8900 solution 3.5 %.

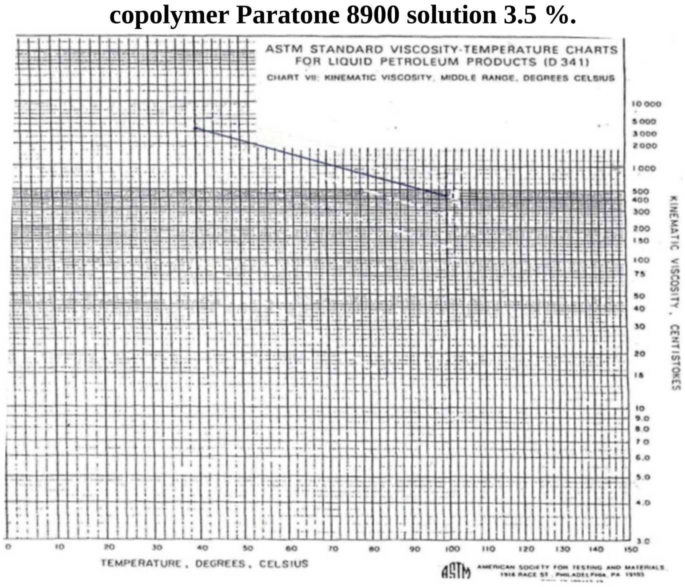

Figure 3. ASTM D-341diagram for determination of viscosity indices of SAE 10W oil and concentrated copolymer Paratone 8900 solution 4.0 %.

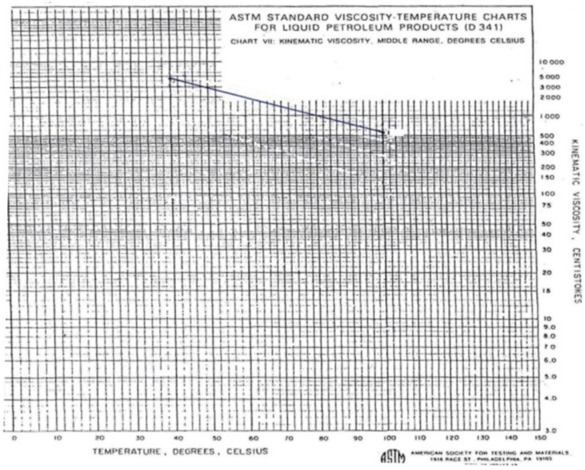

Figure 4. ASTM D-341 diagram for determination of viscosity indices of SAE 10W oil and concentrated copolymer Paratone 8900 solution 4.5 %.

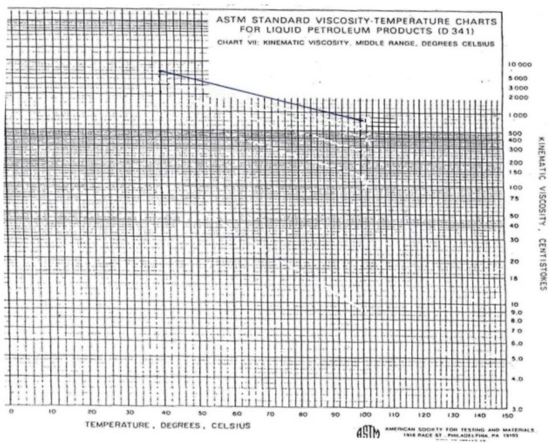

Figure 5. ASTM D-341diagram for determination of viscosity indices of SAE 10W oil and concentrated copolymer Paratone 8900 solution 5.0 **%.**

As can be seen in Figs. 1-5 the slopes of lines obtained decreases with increasing solution concentration. The slope has the largest concentration of the copolymer solution 3.0 % and lowest 5.0 % concentration solution. Table 1 shows the values of kinematic viscosity at 40 and 100 ^{o}C, viscosity indices calculated with equation (1) and determined viscosity indices using calculation software of solutions polyethylene-propylene copolymer in concentrations of 3.0, 3.5, 4.0, 4.5 and 5.0 %.

Table 1. Values of kinematic viscosities at 40 and 100 ^{o}C, viscosity index improvers for solution copolymer polyethylene-propylene.

Fluid	ν [cSt]		Viscosity index equation (1)	Viscosity index program VI
	40 ^{o}C	100 ^{o}C		
Paratone 8900				
3.0 % solution	900	131.3	394.95	255
3.5 % solution	2012	270.2	423.31	283
4.0 % solution	3100	411.9	437.32	307
4.5 % solution	4289	566.1	466.33	326
5.0 % solution	5421	710.7	479.85	340

The viscosity index of the copolymer polyethylene-propylene solution of 3.0 % concentration, obtained with equation (1), is 139.95 times lower than that obtained with the software but still respects the ASTM 2270 standard. For 3.5 % copolymer polyethylene-propylene solution, the viscosity index is 140.31 times higher than that obtained with formula (1). The 4.0 % concentration of copolymer polyethylene-propylene solution has viscosity index of 130.32 times higher than that obtained with the formula (1). For 4.5 % solution of copolymer polyethylene-propylene, the viscosity index is 140.33 times lower than the one obtained with formula (1) according to ASTM standard.

For 5.0 % concentration of copolymer polyethylene-propylene solution, the viscosity index is 139.85 times lower than the one obtained with formula (1) according to ASTM standard.

The chart shows that by introducing the additive copolymer polyethylene-propylene in oil SAE 10W the viscosity index is significantly increased, especially since the concentration is higher, but as the solution concentration increases (the amount of additive is higher), viscosity indices tend to a limit.

4. CONCLUSIONS

The viscosity indices of 3.0, 3.5, 4.0, 4.5 and 5.0 % solutions of copolymer polyethylene-propylene, recommended as viscosity index improvers, in SAE 10W mineral oil as solvent, were determined using the ASTM 2270-93 diagram and two methods according to the recommandation of ASTM D2270.

Viscosity index of the solution copolymer polyethylene-propylene of 3.0 % concentration is 139.95 times lower than that, for of 3.5 % is 140.31 times higher than that, for of 4.0 % is 130.32 times higher than that, for of 4.5 % is 140.33 times lower than and for of 5.0 % is 139.85 times lower than the one obtained with formula (1) according to ASTM D2270 standard.

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