ORIGINAL PAPER

VISCOSITY INDEX IMPROVER FOR POLY (ALKYL METHACRYLATE) CONCENTRATED SOLUTIONS

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Abstract. *To establish the ability of copolymer poly (alkyl methacrylate) solutions in rapeseed oil as solvent to perform at low and high temperatures in a vehicle's engine, that is their capacity to improve the oil's viscosity index, the viscosity/temperature characteristics of their 5, 8, 12 and 18% solutions were determined. It was obtained polymer increase very much the viscosity index, as much as it concentration is higher. The introduction of copolymer poly (alkyl methacrylate) in rapeseed oil viscosity index increases by 73 units at the 5%, 85 units for solution of 8%, 99 units for a 12% solution and 109 units for 18% solution.*

Keywords: *viscosity index, rapeseed oil, solutions, poly (alkyl methacrylate)*

1. INTRODUCTION

The development of modern engine and transmission technologies would be impossible without lubricant additive. From its conception in the early 1900s, the lubricant additive industry has worked in partnership with the oil and the automotive industries to enhance durability and performance of engine and drive line systems through lubricant design [1, 3]. Additives are synthetic chemicals that can improve or add performances of lubricants. Some additives impart new and useful properties to the lubricant; some enhance properties already present, while some act to reduce the rate at which undesirable changes take place in the product during its service life. One of the important types of additive is Viscosity Index improver (VI) commonly known as viscosity modifier [2, 3].

The viscosity index is an indicator of the change in viscosity as the temperature is changed. The higher the viscosity index (VI), the less the viscosity of an oil changes for a given temperature change [3, 4]. Viscosity index improvers are used to limit the rate of change of viscosity with temperature. These improvers have little effect on oil viscosity at low temperatures. However, when heated the improvers enable the oil viscosity to increase within the limited range permitted by the type and concentration of the additive. This quality is most apparent in the application of multi grade motor oils.

Viscosity Index improver function by increasing the relative viscosity of oil more at high temperatures than at low temperatures [3, 5, 6]. Generally this results from the polymer changing its physical configuration with increasing temperature of the mixture. Molecules of polymers in solutions assume a shape of statistical coil [7]. The hydrodynamic volume of a coil is influenced by the interactions between polymeric and molecules of the solvent, as well as between the same kind of molecules and diverse molecules of polymers in solutions, apart from the basic structure of polymeric molecules (chain length, branching). Type and intensity

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of interactions depend on the temperature, polymer concentration and, again, structure of polymeric macromolecules [8, 9]. An adequate choice of polymeric additive, its macromolecular dimensions and structure allow control of rheological properties such as solution viscosity and viscosity dependence on temperature. Among numerous examples it is worth to underline application of amorphous poly (ethylene-co-propylene), poly (alkyl methacrylates), or hydrogenated block and star poly (styrene-co-butadiene) and poly(styrene-co isoprene) as mineral lubricating oil additives, where they act as viscosity index improvers [1, 2, 10].

Alkyl methacrylate copolymer (PAMA) of specific composition and structure are well known and widely used improvers of rheological properties of mineral lubricating oils especially viscosity index and pour point of the engine and transmition oils where they are added in relatively high concentrations. Recently, development of the PAMA additives is oriented towards copolymers that display detergent-dispersive properties apart from improving shear and oxidation stability [3, 11].

The present article presents characterizations and their evaluations as a viscosity index improver in rapeseed oil with copolymer poly (alkyl methacrylate).

2. MATERIALS AND METHOD

The rapeseed oil used in this work is provided by a company in Bucharest, Romania. The following copolymer was used as viscosity improvers is poly (alkyl methacrylate).

Solutions having the concentration of 18 g/dL were prepared and than diluted at 12, 8 and 5 g/dL.

The kinematic viscosity of the concentrated solutions is determined with calibrated Schott Ubbelohde-type viscometers at temperatures 40 and 100 °C. The viscometer is placed in a temperature controlled vessel equipped with a thermostat which maintained the temperature with an accuracy of ± 0.1. The temperature erorr in viscosity determination is less than 0.5%. Density and temperature is measured using a 25 °C pycnometer immersed in a temperature – controlled circulating water bath. The kinematic viscosity values at each temperature are determined by multiplying the measured flow time on the oil through the viscometer capillary with a callibration constant [12].

3. RESULTS AND DISCUSSION

Fig. 1 shows the diagram to determine the ASTM D 341 viscosity index applies to both rapeseed oil and for concentrated solutions of alkyl methacrylate copolymer.

The viscosities of concentrated solutions of poly (alkyl methacrylate) with concentrations of 5, 8, 12 and 18 g/dL as a first-order exponential decrease with rising temperature. In the case of solutions of poly (alkyl methacrylate) slopes of lines increases slightly as the concentration increases in the concentration range 5-12 g /dL. The low slope, which is the lower variation of viscosity with temperature, was obtained by concentration of the solution 5 g /dL followed by 8 g/dL, and the higher the concentration of 18 g/dL.

Introducing polymer rapessed oil significantly increases the viscosity index value, the more that its concentration is higher. Indices of viscosity solutions of poly (alkyl methachrylate) are higher than rapeseed oil as you can see both in Table 1 and the graph in Fig. 2, where it represented the concentration dependence of the solution viscosity indices. The difference between the viscosity index of rapeseed oil and the solution concentration of 5 g /dL is 73 to 85 to 8 g /dL. For solutions of concentration 12 g /dL difference is 99 and 109 for 18g/dL.

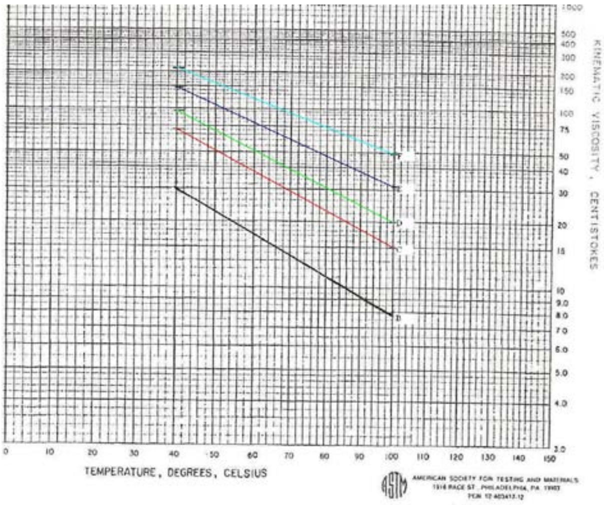

Fig. 1. ASTM D 341 diagram for determination of viscosity indices: B - rapeseed oil; C – rapeseed oil and poly (alkyl methacrylate) 5%, D - rapeseed oil and poly (alkyl methacrylate) 8%, E- rapeseed oil and poly (alkyl methacrylate) 12%, F - rapeseed oil and poly (alkyl methacrylate) 18% solutions.

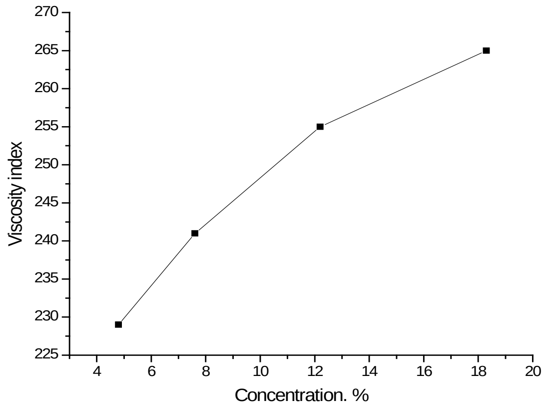

Fig. 2. Dependence of viscosity indices on copolymer concentration.

Table 1 shows the values of kinematic viscosity at temperatures of 40 °C and 100 °C for rapeseed oil and concentrated solutions of poly (alkyl methacrylate), Viscosity Index values for the solutions studied and viscosity-temperature coefficients.

Table 1. Values of kinematics viscosities at 40 and 100 °C, viscosity indices and viscosity-temperature coefficients.

Fluid	**ν, cSt**		**Viscosity Index**	**Viscosity-temperature coefficient**
	40 °C	**100 °C**		
rapeseed oil	34.26	7.51	156	0.7807
Poly (alkyl methacrylate)				
5% solution	70.2	15.1	229	0.7843
8% solution	95.2	20.5	241	0.7845
12% solution	147.6	30.2	255	0.7874
18% solution	230.2	50.4	265	0.7932

Fig. 2 shows the concentration dependence of solution viscosity index. From the graph it is observed that as the concentration of polymer increases the Viscosity Index tends to a limit value.

The table 1 shows that viscosity-temperature coefficient values are even higher as viscosity indices are higher. The lowest value of viscosity-temperature coefficient was obtained for rapessed oil and the largest solution poly (alkyl methacrylate) with concentration of 18 g /dL.

4. CONCLUSIONS

The viscosities of concentrated solutions of poly (alkyl methacrylate) with concentrations of 5, 8, 12 and 18 g/dL have a first-order exponential decrease with rising temperature. Introducing polymer rapeseed oil significantly increases the viscosity index value, the more that its concentration is higher. Viscosity index solution concentration of 18 g /dL is significantly higher than the viscosity index of the solution concentration 5 g /dL.

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