Improving the Intrinsic Viscosity for Base Lubricating Oils mixed with OCP by using Some Polymeric Additives

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Abstract
The relative viscosity, specific viscosity and reduced viscosity were enumerated to evaluate the intrinsic viscosity for three types of base lubricating oils 40, 60 and 150 stock that were mixed with olefin copolymer of type Polyvinyl chloride-100XA at four temperature degrees of 40, 60, 80 and 100 ºC and using of three different kinds of polymeric additives formulations named as Lubrizol 21001, HiTEC 8722B and HiTEC 340. Mixtures of base lubricating oils with proportions of 2, 4, 6, 8 and 10 wt% from the Polyvinyl chloride-100XA were blended with 4 and 8 wt% of the three additives. The results were remarkable and showed that the intrinsic viscosity for the base lubricating oils increase by increasing both temperature degrees and the proportions of Polyvinyl chloride-100XA and the additives.

Keywords: Intrinsic Viscosity, Lubricating oil, Polymeric Additives, Polyvinyl Chloride.

1. Introduction

Iraqi oil which is refined from crude oil is paraffinic. It is featured by long chains of hydrocarbons, high flash points, high pour points, low specific gravities and excellent stability [1].
Lubricants are domain of physical features. They can vary from lubricating oils to graphite considered as inserted materials between two contacted surfaces that are in relative motion. Lubricants contain materials that have large [2] lubricant according to the specific implementations that they used for[3].

Different kinds of additives are added to improve the properties of lubricants, which can be considered as auxiliary materials [4]. Those additives are generally added in low concentrations from one to five percent or may be more. The importance of the additions may be to improve viscosity-temperature relationship, eliminate rusting, reduce bearing corrosion, eliminate foaming, etc.[5].

to gas the relation between the intrinsic viscosity and temperature due to the intrinsic viscosity shows the ability of additives to improve the viscosity of the lubricants.

considered as inserted materials between two contacted surfaces that are in relative motion. Lubricants contain materials that have large lubricant according to the specific implementations that they used for [3].
The behavior of viscosity of large molecular materials is one of the most repeatedly used

ways for characterization. And the intrinsic viscosity number is known as the limit amount.

2. Material

a. Base Lubricating Oil

Three different kinds of base lubricating oil were gained from the research and quality control laboratory at Al-Daura Refinery. These

kinds of base oils were named as 40, 60 and 150 stock; each has a specific °API gravity value which was estimated by the aforementioned laboratory. These °API gravity values were 34.976, 29.24 and 23.90 respectively.

b. Olefin Copolymer

Olefin Copolymers have so many types, because their composition are ranging from two to enormous different monomers and and each type has different propeties and used for certain applications. In this study an olefin copolymers of type PVC-100XA is used.

This specific type of olefin copolymers is considering as a good viscosity index improver for base lubricating oil[7].

PVC-100XA is prepared to equip a low-temperature liquidity, shear stability and high-temperature viscosity[8].

c. Polymeric Additives

Three kinds of polymeric additives named Lubrizol 21001, HiTEC 8722B and HiTEC 340 were gained from the research and quality control laboratory at Al-Daura Refinery. Each type is used for a specific purpose such as Lubrizol 21001 is a multipurpose additive used for gasoline engines by a recommended dosage of 10.8% by weight.

The second kind of polymeric additives is HiTEC 8722B is also a multipurpose additive but it is used for diesel engines. This polymeric additive is designed to provide a number of advantages and also offer cost optimized formulations. It's recommended dosage is 7.8% by weight.

The third kind of polymeric additives is HiTEC 340 which is an economic automotive gear oil additive. It is used for transmissions and axles. It offers a powerful performance in automotive applications, cost savings and it is very suitable for safe drain. It's recommended dosage is 4% by.

1. Experimental work

Mixtures were prepared as weigh percentage for accuracy as presented in Figure (1). Mixing process was made by stirring thoroughly and heating to a temperature range of 50-60 °C at the same time.

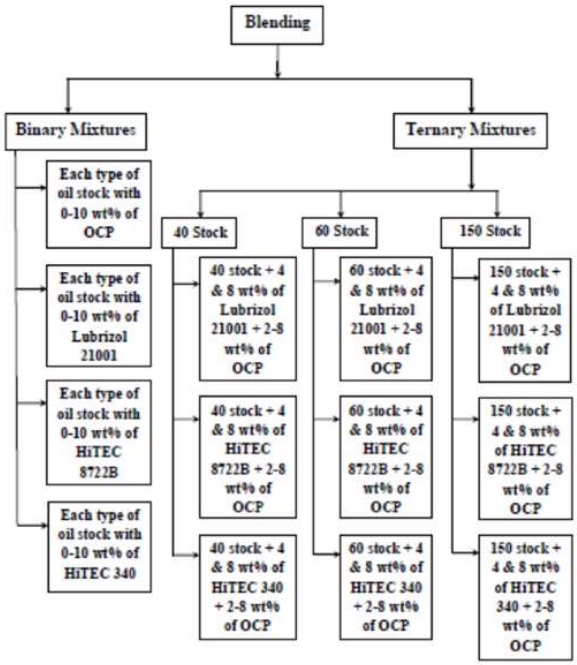

Fig 1. Flow-Chart for the experiment mixtures

To calculate the intrinsic viscosity an Ubbelohde Viscometers, a glass capillary type, were used according to the Standard test method for determining inherent viscosity of petroleum measurement tables (ASTM D4603). Those viscometers were of different sizes depending on the base oil type[9].

The time of the base lubricating oils as solvent (t_o) and time of mixtures (t) are used to calculate the relative viscosities by using the following equation:

$$\eta_{rel.} = t/t_o \quad (1)$$

Then determine specific viscosities by using the following equation:

$$\eta_{sp.} = \frac{t-t_o}{t_o} = \eta_{rel.} - 1 \quad (2)$$

After that reduced viscosities is calculated as follows using the concentration value of the solute (C) according to the following equation:

$$\eta_{red.} = \eta_{sp.}/C \quad (3)$$

The $\eta_{red.}$ Values were sketched versus concentrations to get the intrinsic viscosity **[η]** [10].

2. Results and Discussion

In this study three kinds of polymeric additives were used to show their effect on the intrinsic viscosity for three types of base lubricating oil. The three types of additives as mentioned before are Lubrizol 21001, HiTEC 8722B, and HiTEC 340 were mixed with the three base oil types in the presence of PVC-100XA. And the results were as follow.

a. Effect of OCP

The viscosities, relative, specific and reduced were measured to estimate the intrinsic viscosity for base stocks at a range of weight percentages 0-10 wt% of the olefin copolymer of kind PVC-100XA and at four different temperatures of (40, 60, 80 and 100 ºC). Figure (2) shows the effect of PVC-100XA on the intrinsic viscosity for the three base oils.

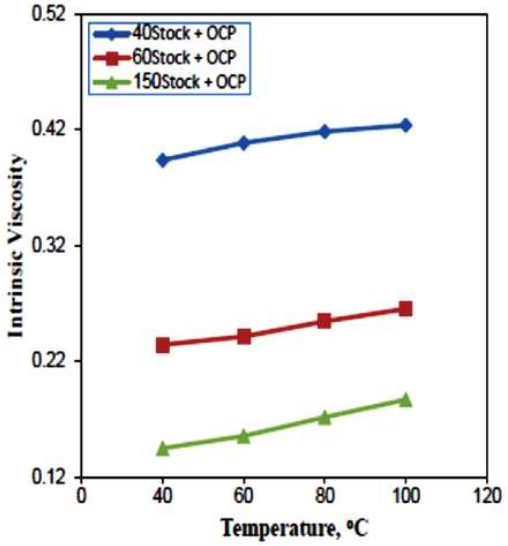

Fig 2. Intrinsic Viscosities of 40, 60 and 150 stock with PVC-100XA at Different Temperatures

From Figure (2) it can be noticed that by increasing the temperature and the concentration of PVC-100XA the intrinsic viscosity increase.

In general olefin copolymers behaves with an uncertain manner because the anonymous polymeric structure of them. But if considering the three base oil types were bad solvents so the intrinsic viscosity will increase by increasing the temperature as a result of increasing the [11].

b. Effect of Lubrizol 21001

This type of polymeric additive is as mentioned earlier is designed for Otto engines and the recommended dosage is 10.8% by weight. A ccompany called Afton produces this type of polymeric additive with an unknown polymer series structure as a multipurpose additive.

Different concentrations of Lubrizol 21001 with a range of 0-10 wt% were blended with the three types of base oils. These mixtures gave a remarkable increase in the intrinsic viscosity accompanying the increasing in weight percent of Lubrizol 21001.

Then relative viscosity, specific viscosity and reduced viscosity were obtained to determine the intrinsic viscosity for base oils at different weight percentages of Lubrizol 21001 and at the temperature range of 40, 60, 80 and 100ºC. Figure (3) represents the effect of this type of polymeric additive on the intrinsic viscosity for the three types of base stocks.

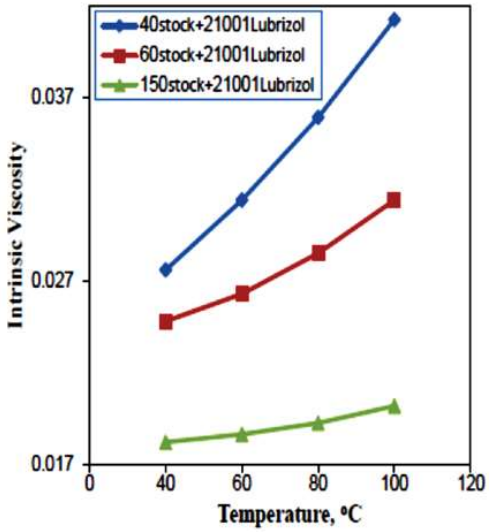

Fig 3. Intrinsic Viscosity of 40, 60 and 150 stock with Lubrizol 21001 at a range of Temperatures

Figure (3) shows that with the increasing of temperature and Lubrizol 21001 concentration, the intrinsic viscosity increased of all the base oil types. This presents that polymeric additive acts as a neutral polymer in the lubricating oil. Neutral polymers have a feature of increasing the intrinsic viscosity with the concentration increasing of the polymer [12].

c. Effect of H-8722B

HiTEC 8722B is also a multipurpose additive as mentioned before and it is used for diesel engines. It's recommended dosage is 7.8% by weight. Its effect on The relative, specific and reduced viscosities were determined to evaluate the intrinsic viscosity for base oils at different weight percentages of H-8722B and at the range of temperatures of 40, 60, 80 and 100ºC. Figure (4) shows the effect of H-8722B on the intrinsic viscosity for the three types base lubricating oils.

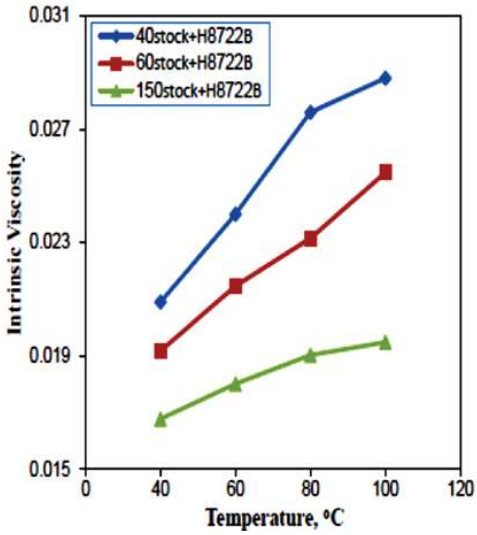

Fig 4. Intrinsic Viscosity of 40, 60 and 150 stock with H-8722B at a Range of Temperatures

Figure (4) explains the slightly increasing in the intrinsic viscosity for all base stocks with increasing of the temperature and the concentration of H-8722B because of the inconsequential effect of this additive on base stocks.

a. Effect of H-340

This polymeric additive is a package additive used for economic automotive gear oil and its recommended dosage is 4% by weight.

Then relative viscosity, specific viscosity and reduced viscosity were measured to get the intrinsic viscosity for 40 stock only at different weight percentages of H-340 and at a range of temperatures of 40, 60, 80 and 100ºC. Figure (5) shows the effect of H-340 on the intrinsic viscosity for only 40 stock because of the inability to obtaine the reduced viscosity values for both 60 stock and 150 stock due to the negative values of their specific viscosities.

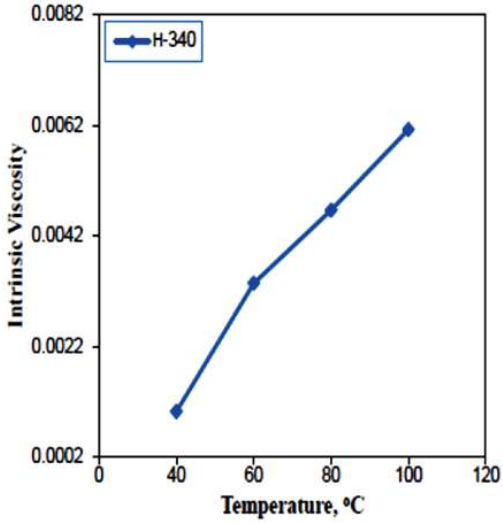

Fig 5. Intrinsic Viscosity of 40 stock with H-340 at a Range of Temperatures

It is Obvious that as the temperature increases, the polymer chains in the mixture and become fully extended, and this lead to an increase in the hydrodynamic polymer coil size, therfore increases the resistance of the fluid flow and lead to increasing the intrinsic viscosity [13].

b. Effect of Lubrizol 21001 on the Mixtures of OCP with Base Lubricating Oils

Two groups of mixtures were prepared using Lubrizol 21001 with two concentrations, one of 4 wt% and the other of 8 wt% with the three types of base oils in the presence of PVC-100XA with a concentration range of 2-8 wt%.

Then relative viscosity, specific viscosity and reduced viscosity were obtained to evaluate the intrinsic viscosity. Figures (6), (7) and (8) show the effect of this polymeric additive on the intrinsic viscosity for the three base stocks.

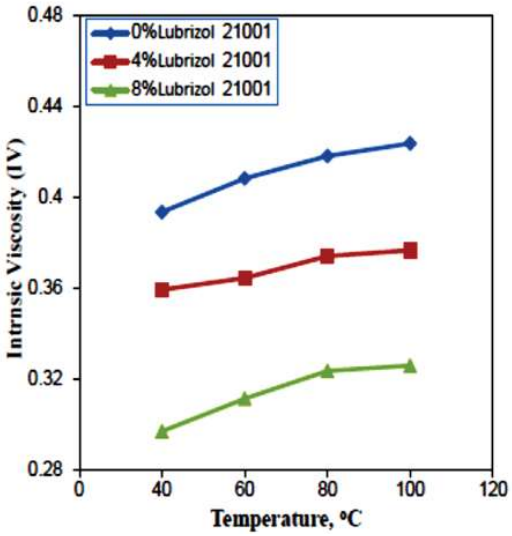

Fig 6. Intrinsic Viscosity of 40 stock mixed with PVC-100XA and with 4 and 8 wt% of Lubrizol 21001 at a Range of Temperatures

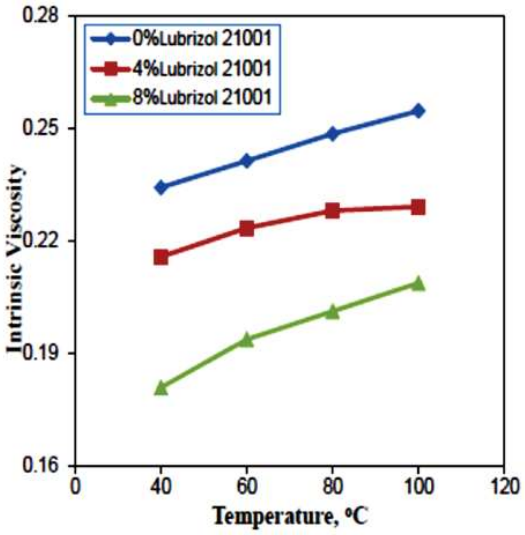

Fig 7. Intrinsic Viscosity of 60 stock mixed with PVC-100XA and with 4 and 8 wt% of Lubrizol 21001 at a Range of Temperatures

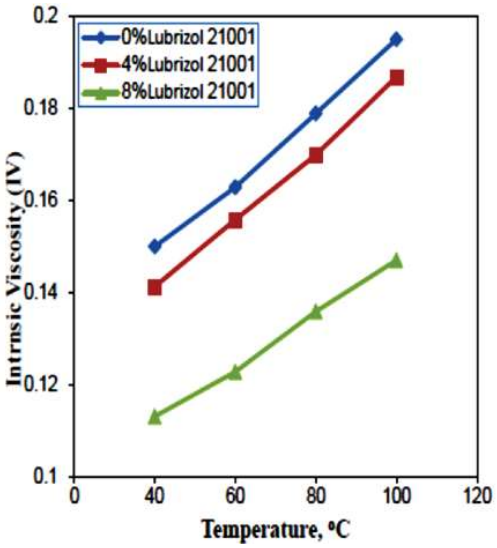

Fig 8. Intrinsic Viscosity of 150 stock mixed with PVC-100XA and with 4 and 8 wt% of Lubrizol 21001 at a Range of Temperatures

From Figures (6), (7) and (8) it is plainly that at a particular concentration of Lubrizol 21001, with the increase of both the concentration of PVC-100XA and temperatures, the intrinsic viscosity will increase due to the structure of this polymeric additive which may not contain a carboxyl group [12].

a. Effect of H-8722B on the Mixtures of OCP with Base Lubricating Oils

Two sets of blends were prepared using the second polymeric additive type named H-8722B in two concentrations of 4 wt% and 8 wt% with the three base stocks and PVC-100XA which is exists in a concentration range of 2-8 wt%.

Then relative viscosity, specific viscosity and reduced viscosity were measured to determine the intrinsic viscosity for the mixtures. Figures (9), (10) and (11) show the effect of H-8722B on the intrinsic viscosity for all the base stocks.

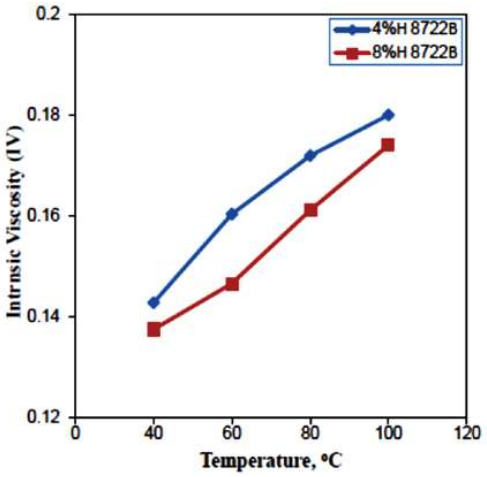

Fig 9. ntrinsic Viscosity of 40 stock mixed with PVC-100XA and with 4 and 8 wt% of H-8722B at a Range of Temperatures

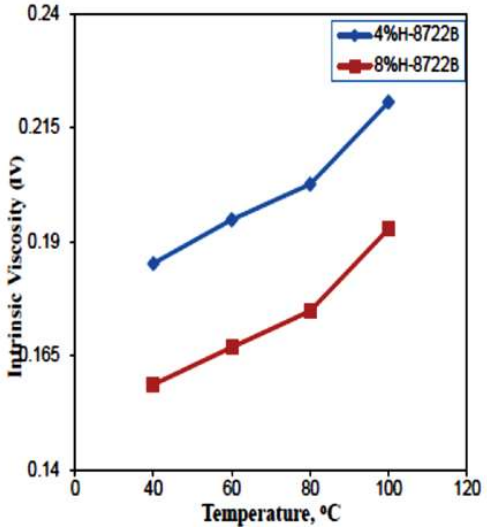

Fig 10. Intrinsic Viscosity of 60 stock mixed with PVC-100XA and with 4 and 8 wt% of H-8722B at a Range of Temperatures

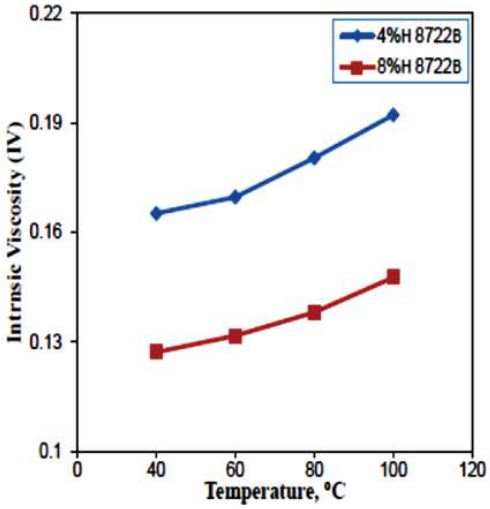

Fig 11. Intrinsic Viscosity of 150 stock mixed with PVC-100XA and with 4 and 8 wt% of H-8722B at a Range of Temperatures

It can be shown from Figures (9), (10) and (11) that the increasing of temperature of the mixtures as well as the increasing of the concentration of H-8722B will increase the intrinsic viscosity for all the three types of base lubricating oil. This is because of the associated interaction of this polymeric additive molecules and PVC-100XA molecules in base oils will overlapping with each other resulting the increase in the intrinsic viscosity.

b. Effect of H-340 on the Mixtures of OCP with Base Lubricating Oils

Two sets of blends were made using the third kind of polymeric additives used in this study which is H-340 with two concentrations, one of 4 wt% and second of 8 wt% mixed with the three types of base stocks and PVC-100XA in a concentration range of 2-8 wt%.

Then relative viscosity, specific viscosity and reduced viscosity were obtained to evaluate the intrinsic viscosity.

Figures (12), (13) and (14) show the effect of H-340 on the intrinsic viscosity for all the three base oil types.

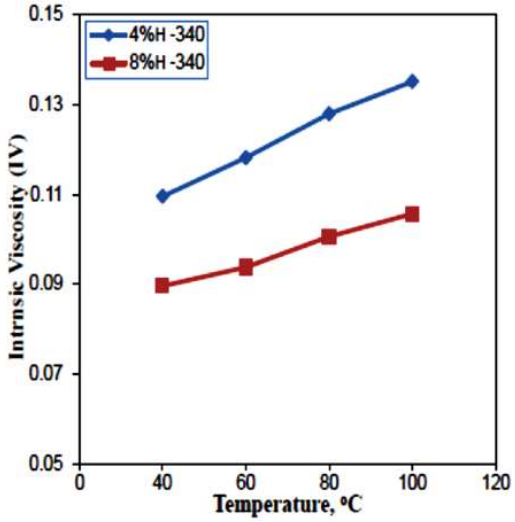

Fig 12. Intrinsic Viscosity of 40 stock mixed with PVC-100XA and with 4 and 8 wt% of H-340 at a Range of Temperatures

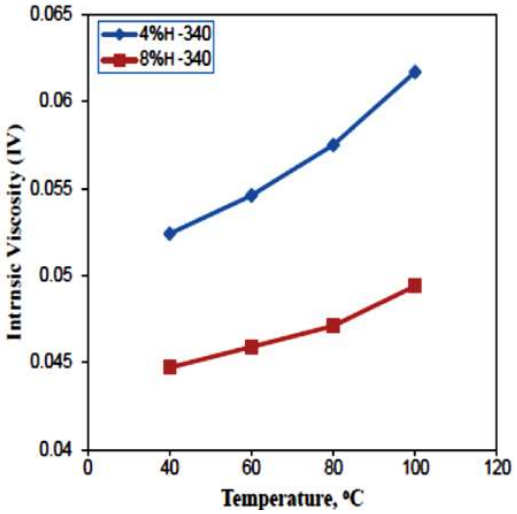

Fig 13. Intrinsic Viscosity of 60 stock mixed with PVC-100XA and with 4 and 8 wt% of H-340 at a Range of Temperatures

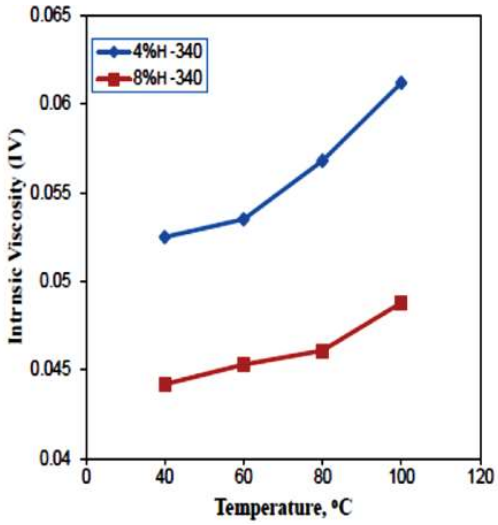

Fig 14. Intrinsic Viscosity of 150 stock mixed with PVC-100XA and with 4 and 8 wt% of H-340 at a Range of Temperatures

Figures (12), (13) and (14) show that the increasing in the values of the intrinsic viscosity for all the three base oil types the 40 stock is higher than that of 60 stock and 150 stock.

In general, by increasing the temperature of the blend, the polymer will change its physical configuration. It is supposed that the polymer molecules in any solution exist as random coils, which is then swollen by the base oil solvents. The volume of these molecules will lead to the increase in viscosity and the penetration of the solvent will get better, especially with increasing the temperature, then the intrinsic viscosity will increase [14].

4. Conclusions

The following conclusions may be drawn from this study:

a. For all binary mixture prepared the intrinsic viscosity value for 40 stock were higher than that for 60 stock and 150 stock at the same temperature degree.

b. The intrinsic viscosity values of all three base oil types will increase with increasing the concentration of PVC-100XA as well as the concentration of the two polymeric additives, Lubrizol 21001 and H-8722B.

c. The negative values of specific viscosities for 60 stock and 150 stock mixed with H-340

lead to the inability to obtain the intrinsic viscosity.

d. In general for all the ternary mixtures it was found that the optimum percentage of polymeric additives was 4% as it gives the higher intrinsic viscosity value for all base oil types and at all temperature degrees.

e. It is found that the enhancement of the intrinsic viscosity is more pronounced with 4 wt% of the polymeric additives.

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