Influence of Some Additives on the Efficiency of Viscosity Index Improver for Base Lubricating Oils

Prof. Dr. Talib Bahjat Kashmoula
Tiba Naif Jasim
E-mail: taiba208@yahoo.com
Chemical Engineering Department, Collage of Engineering, Alnahrain University, Baghdad, Iraq

ABSTRACT

The effects of three different additives formulations namely Lubrizol 21001, HiTEC 8722B and HiTEC 340 on the efficiency of VII namely OCP of three base lubricating oils namely 40 stock and 60 stock and 150 stock at four temperatures 40, 60, 80 and 100°C were investigated. The efficiency of OCP is decreased when blended with 4 and 8 wt% of Lubrizol 21001 for all the three base oil types. But it is increased when adding 4 wt% and 8 wt% of H-8722B in 40 stock. While for 60 stock and 150 stock the OCP efficiency decreased by adding 4 and 8 wt% of H-8722B. In the other hand, it is decreased with a high percentage by adding 4 and 8 wt% of H-340 for 60 stock and 150 stock and for 40 stock it is increased by adding 4 wt% of H-340 and decreased with insignificant percentage when adding 8 wt%. Finally, a number of VI correlations have been obtained depending on the results predicted in this study. These correlations represent the functional relationships between the VI and the concentration of OCP for three types of base lubricating oil and for each type of additives.

Keywords: Lubricating oil, Kinematic Viscosity, Viscosity Index, Viscosity Index Improver, Additives, Temperatures.

تأثير بعض المضافات على كفاءة مؤشر محسن اللزوجة لزيوت التزييت الأساس

أ.د. طالب بهجت كشمولة
طيبة نايف جاسم
قسم الهندسة الكيمياوية، كلية الهندسة، جامعة النهرين، بغداد، العراق

الخلاصة

في هذا البحث تمت دراسة تأثير ثلاثة أنواع من المضافات المستحصلة من مصفى الدورة في بغداد والتي هي Lubrizol 21001 و HiTEC 8722B و HiTEC 340 على كفاءة محسن مؤشر اللزوجة من نوع Olefin Copolymer والذي يستخدم لزيوت التزييت الأساس الثلاثة المستحصلة أيضا من مصفى الدورة والتي هي 40 stock و 60 stock و 150 stock . وتمت الدراسة عند أربع درجات حرارة هي 40 و 60 و 80 و100 °م. وجد إن كفاءة محسن مؤشر اللزوجة (OCP) تقل بمعدل تصاعدي عند خلط 4 و8 wt% من المضاف Lubrizol 21001 لأنواع زيوت التزييت الثلاث. ولكن هذه الكفاءة تتحسن بإضافة 4 wt% و 8 wt% من المضاف HiTEC 8722B عند خلطه مع الزيت 40 stock. بينما للنوعين 60 و 150 stock فإن كفاءة OCP تقل عند كلا التركيزين 4 و8 wt%. لوحظ إنه عند خلط المضاف HiTEC 340 وبكلا التركيزين 4 و8 wt% فإن كفاءة محسن مؤشر اللزوجة تنخفض بمقدار كبير للنوعين 60 و 150 stock. بينما عند خلطه مع الزيت 40 stock وبتركيز 4 wt% فإن الكفاءة تزداد بينما تقل عند خلطه بتركيز 8 wt%. أيضا تم إيجاد عدة معادلات تربط بين مؤشر اللزوجة وتركيز محسن مؤشر اللزوجة لكل نوع من زيوت التزييت الثلاث ولكل نوع من المضافات الثلاثة المستخدمة.

كلمات رئيسية: زيوت التزييت، اللزوجة الكينماتيكية، مؤشر اللزوجة، محسن مؤشر اللزوجة، مضافات، درجات حرارة.

1. INTRODUCTION:

Lubricant may serve many purposes such as conducting the heat of friction away from the bearings, serving as a seal to exclude undesirable substances from the area being lubricated, acting as a carrier for rust preventive, anti-friction agents, extreme pressure additives and other properties. However, their primary purpose is in general to lubricate, i.e., to reduce friction (Zuidema, 1959). Lubricating oil additives are normally used in low concentrations from a fraction of a one percent to five percent or may be more. Their purposes may be to impart extreme pressure characteristics, reduce pour point, improve the viscosity index, reduce bearing corrosion, reduce or eliminate foaming and so on (Hobson, 1984). The selection of right additive or of the most suitable combination of additives depends on the specific use of the oil (Brouwer, 1966).

The most important property of lubricating oil is its kinematic viscosity, which is a measure of its internal friction or ability to flow and largely determines its suitability for any particular application (Brouwer, 1966).

The kinematic viscosity of an oil decreases with rising in temperature but to varying degree depending on the type of crude oil from which it is derived and the refining treatment to which it has been subjected. The relationship between viscosity and temperature is the significance for lubricating oils since most oils have to operate over a range of temperatures. There are many ways of expressing this relationship but the one firmly established in the petroleum industry is viscosity index (VI) system, even though it is an arbitrary system and more fundamental methods have been suggested (Bill Hires, 1993).

2. MATERIALS:

In this study, the experimental work will be carried out on Iraqi paraffinic oils which have three types of base-stocks that were obtained from Al-Daura Refinery, namely 40, 60 and 150 stock. These types of base stocks were processed as base lubricating oil without additives. The lightest one is 40 stock with ^{o}API gravity of 34.976, the middle type is 60 stock which have ^{o}API gravity of 29.24 and 150 stock is the heaviest type with ^{o}API gravity of 23.90 (measured in the Research and Quality Control Laboratory, 2012).

Olefin Copolymer (OCP) of type PVC-100 XA is a VII (solute) for base lubricating oil (solvent). OCP is a polymer composed of two or more different monomer. The OCPs have unknown structure, different companies are producing them.

This type of VII is designed to provide a careful balance of thickening power, low-temperature fluidity, shear stability and high-temperature viscosity (McCrum, 1997).

Three types of additives (Lubrizol 21001, HiTEC 8722B and HiTEC 340) were obtained from Al-Daura Refinery. Lubrizol 21001 is a multipurpose additive for otto engine. The recommended dosage is 10.8% by weight. This additive when formulated with the appropriate base stocks and VII will meet the requirements of ACEA A3/B4-04(2004), API SL, API CF, and Volkswagen VW50101 (2005) (Research and Quality Control Laboratory, 2012).

HiTEC 8722B is a multipurpose additive for diesel engine**.** It provides efficient additive solutions according to API, ACEA and OEMs heavy-duty diesel requirements. This additive has been designed to offer cost optimized formulations and delivers a number of customer benefits. Its package approval is supported by complete engine test data. The recommended dosage is 7.8% by weight. And it allows the use of a wide range of base oils and VIIs (Afton Company, HiTEC-8722B).

HiTEC 340 is an economic automotive gear oil additive. It is used for axles and transmissions. It provides robust performance in automotive applications, cost savings at all treat-rates, extensive history of trouble-free performance and suitable for unharmed drain. The recommended dosage is 4% by weight and its treat-rates may vary depending on base oil type (Afton Company, HiTEC-340).

3. EXPERIMENTAL WORK:

The composition of each mixture was prepared as weight percentage for more accuracy than mole percentage. Mixing process was made by stirring and heating to about 50-60^{o}C at the same time to ensure thorough mixing.

Viscosity measurements were taken immediately, after preparing the mixture to avoid deposit formation or vaporizing the light ends. All these measurements were taken at the atmospheric pressure.

The following mixtures were prepared in this study:

1) Binary Mixtures:
There were four types of binary mixtures, as follows:
- **a)** Binary mixtures of each type of oil-stock (40, 60 and 150 stock) with 0-10 wt% of OCP.
- **b)** Binary mixtures of each type of oil-stock (40, 60 and 150 stock) with 0-10 wt% of Lubrizol 21001.
- **c)** Binary mixtures of each type of oil-stock (40, 60 and 150 stock) with 0-10 wt% of H-8722B.
- **d)** Binary mixtures of each type of oil-stock (40, 60 and 150 stock) with 0-10 wt% of H-340.

2) Ternary Mixtures:
These ternary mixtures were prepared as follows:
- **a)** 40 stock:
  1. 40 stock with 4 and 8 wt% of Lubrizol 21001 with 2-8 wt% of OCP.
  2. 40 stock with 4 and 8 wt% of H-8722B with 2-8 wt% of OCP.
  3. 40 stock with 4 and 8 wt% of H-340 with 2-8 wt% of OCP.
- **b)** 60 stock:
  1. 60 stock with 4 and 8 wt% of Lubrizol 21001 with 2-8 wt% of OCP.
  2. 60 stock with 4 and 8 wt% of H-8722B with 2-8 wt% of OCP.
  3. 60 stock with 4 and 8 wt% of H-340 with 2-8 wt% of OCP.
- **c)** 150 stock:
  1. 150 stock with 4 and 8 wt% of Lubrizol 21001 with 2-8 wt% of OCP.
  2. 150 stock with 4 and 8 wt% of H-8722B with 2-8 wt% of OCP.
  3. 150 stock with 4 and 8 wt% of H-340 with 2-8 wt% of OCP.

Cannon Fenske Routine Viscometers (the glass capillary type) with different sizes were used for measuring the time of the solvent (base oil) (t_o) and time of mixtures (t) which are used in calculating the kinematic viscosity of transparent Newtonian liquids according to the Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (ASTM D 445–03).

Times measured are used to calculate the kinematic viscosity using the following equation:

$$\nu = t \times f \qquad (1)$$

Where: ν is the kinematic viscosity (mm^2/s), t is the measured time (s) and f is the viscometer factor.

The VI as mentioned before is an arbitrary scale for comparing the rates of viscosity changes of lubricating oil with temperature. The VI scale was set up by the SAE. The temperatures chosen arbitrarily for reference are 40 and 100°C.

4. RESULTS AND DISCUSSION:

The effect of temperature on the VI of the three types of base lubricating oil was measured. Table 1 shows the values of VI which are obtained from the kinematic viscosities and the SAE VI scale at the two reference temperatures 40 and 100°C.

Blends from the three types of base stocks with different concentrations of OCP with a range of 0-10 wt% were prepared. Those blends give a significance increase in the kinematic viscosity and VI as the weight percent of OCP increase. This is because OCP composed of long and flexible polymer molecules that interact with the base stocks and this interaction leads to increase the resistance to flow (Canter, 2011).

The concentration of OCP must be limited, because the additional effects may then arise from intermolecular forces and entanglements between chains. Therefore, OCP is excellent in economical efficiency, because it exhibits the effect even if it is added in a small amount (Kaneshige, 2009).

It is noticed that the increase in OCP concentration, which blended with the base oils, will improve the VI as shown in Figure 1. It affects 40 stock by 154%, 60 stock by 90% and 150 stock by 57%, by adding 10 wt% of OCP.

Also, the improving in VI will be with a decreasing rate as the concentration of OCP increased.

In the other hand, the three types of additives (Lubrizol 21001, HiTEC 8722B, and HiTEC 340) will blend with the three types of base oil in a concentration range of 0-10 wt% and temperature range of 40-100^{o}C. And their effects on the kinematic viscosity and VI were different as shown in Figures 2, 3 and 4.

For Lubrizol 21001, it has been found that the enhancement in the VI for 40 stock is more pronounced than for 60 and 150 stock as sketched in Figure 2. The increasing in VI is about 35%, 10% and 8% for 40, 60 and 150 stock, respectively when adding 10 wt% of Lubrizol 21001. Also it has been noticed that the rate of improvement in the VI for 40 stock is in a range of 7.5-10%, while it is 2% for 60 stock and 1.1-2.2% for 150 stock with every 2 wt% added of Lubrizol 21001.

For the second type of additives which is H-8722B, it has been found that the improving in the VI for 40 stock is very noticeable more than for 60 and 150 stock as shown in Figure 3. The increasing in VI is about 22%, 5% and 2% for 40, 60 and 150 stock, respectively when adding 10 wt% of H-8722B. So it recommended using such additive with light oil types like 40 stock because of its insignificance effect on both 60 and 150 stock.

While for the third type of additives which is H-340, it can be seen from Figure 4 that the maximum VI is obtained at different concentrations of H-340. These concentrations are 2 wt% for 40 stock and 150 stock whereas 2, 4 and 6 wt% for 60 stock.

These concentrations are very helpful in selecting the base oil type and the recommended dosage of H-340 for producing effective and economic automotive gear oil. Such behavior of additive on the VI was also obtained by using the PIB and PBR with the base oil types (Tanveer, 2006).

But in order to study the influence of the three additives on the efficiency of OCP, two sets of mixtures from a base stock, OCP and an additive were prepared with an additive concentration of 4 wt% in the first set and 8 wt% in the second with the three types of base stocks (40, 60 and 150 stock) and OCP concentration range of 2-8 wt%.

The effect of Lubrizol 21001 on the VI is sketched in Figures 5, 6 and 7. It can be shown that at a specific concentration of Lubrizol 21001, when blended with the three types of base oil, the VI will be improved with the increasing of OCP concentration.

Also it can be noticed that at all OCP concentrations the VI will be decreased as the concentration of Lubrizol 21001 increased.

The efficiency of OCP is performed by measuring the VI of blends before and after adding Lubrizol 21001. For 40 and 150 stock, the decreasing rate of OCP efficiency is calculated to be about 7% and 10% by adding 4 and 8 wt% of Lubrizol 21001, respectively. While the decreasing rate of the efficiency is obtained to be about 10% and 16% when 60 stock is blended with 4 and 8 wt% of Lubrizol 21001, respectively. So it is not preferred to use Lubrizol 21001as lubricating oil additive in the presence of OCP because it lowers the VI as well as the efficiency of the VII.

For H-8722B its effect is drawn in Figures 8, 9 and 10. It can be indicated that the VI is improved with increasing OCP concentration at the two concentrations of H-8722B because this additive is composed of long and flexible polymer molecules that interact with the base oil and OCP. This interaction will cause greater volume and the base oil produces a proportionally greater thickening effect which in turn raises the VI of the oil (Shawn, 2002). In the other hand at all OCP concentrations the VI will be decreased as the concentration of H-8722B increased.

With respect to the efficiency of OCP, the 60 stock showed the same behavior as in adding Lubrizol 21001 by having the highest decreasing rate for the OCP efficiency which was about 7% and 14% by adding 4 and 8 wt% of H-8722B, respectively. While for 150 stock the decreasing rate is obtained to be about 2% by adding 4 wt% and being 4% by adding 8 wt% of H-8722B.

It is interesting to know that for 40 stock the efficiency is increased by 5% when adding 4 wt% and it increased by insignificant value when adding 8 wt% of H-8722B so it is better to use H-8722B as lubricating oil additive in the presence of OCP by adding 4 wt% or less.

Finally, the VI Figures from 11, 12 and 13 showed the effect of H-340 on the three base oil types and OCP.

It can be noticed that the VI is improved with increasing OCP concentration at the two concentrations of H-340. And at all OCP concentrations the VI will be decreased as the concentration of H-340 increased.

As for the efficiency of OCP, this additive would strongly decrease the OCP efficiency of the 60 stock, the decreasing rate for the OCP which was about 37% and 28% by adding 4 and 8 wt% of H-340, respectively. While for 150 stock the decreasing rate is obtained to be about 10% by adding 4 wt% and being about 14% by adding 8 wt% of H-340.

It is a coincidence that for 40 stock the efficiency at 4 wt% of H-340 is increased just like in H-8722B which it was by about 5% and it also decreased when adding 8 wt% of H-340. So it is better to use H-340 as lubricating oil additive in the presence of OCP by adding 4 wt% or less.

5. CORRELATIONS FOR VI

A number of VI correlations have been obtained in this section using the regression analysis and depending on the results which presented in the previous section of this study.

The functional relationships are between the VI and the concentration of OCP for three types of base lubricating oil and for each type of additives.

From Table 2 three correlations between VI and the OCP concentration where obtained as shown below:

For 40 stock:

$$VI = -1.9821C_{OCP}^2 + 35.493C_{OCP} + 109.71 \quad (2)$$

For 60 stock:

$$VI = 9C_{OCP} + 102 \quad (3)$$

For 150 stock:

$$VI = 4.7571C_{OCP} + 94.381 \quad (4)$$

For Lubrizol 21001 it has been noticed that the correlations at 4 wt% of this additive is different from the correlations of 8 wt%. From Tables 3 and 4 the functional relationships were obtained as follows:

a. At 4 wt% of Lubrizol 21001:

For 40 stock:

$$VI = -2.0625C_{OCP}^2 + 31.875C_{OCP} + 121.25 \quad (5)$$

For 60 stock:

$$VI = 6.4C_{OCP} + 102 \quad (6)$$

For 150 stock:

$$VI = 3.151C_{OCP} + 97 \quad (7)$$

b. At 8 wt% of Lubrizol 21001:

For 40 stock:

$$VI = -0.875C_{OCP}^2 + 17.65C_{OCP} + 142.5 \quad (8)$$

For 60 stock:

$$VI = 4.5C_{OCP} + 96.5 \quad (9)$$

For 150 stock:

$$VI = 2.65C_{OCP} + 96.5 \quad (10)$$

Also for H-8722B the functional relationships were obtained using the regression analysis depending on Tables 5 and 6. The correlations are given bellow:

a. At 4 wt% of H-8722B:

For 40 stock:

$$VI = -0.5625C_{OCP}^2 + 18.275C_{OCP} + 107.75 \quad (11)$$

For 60 stock:

$$VI = 6.85C_{OCP} + 92.5 \quad (12)$$

For 150 stock:

$$VI = 4.1C_{OCP} + 87.5 \quad (13)$$

b. At 8 wt% of H-8722B:

For 40 stock:

$$VI = 10.95C_{OCP} + 117.5 \quad (14)$$

For 60 stock:

$$VI = 4.5C_{OCP} + 93 \qquad (15)$$

For 150 stock:

$$VI = 3.6C_{OCP} + 86.5 \qquad (16)$$

For H-340 the correlations at 4 wt% of this additive is different from the correlations of 8 wt%. These functional relationships were obtained depending on Tables 7 and 8 as follows:

a. At 4 wt% of H-340:
For 40 stock:

$$VI = 11.8C_{OCP} + 111 \qquad (17)$$

For 60 stock:

$$VI = 1.35C_{OCP} + 95.5 \qquad (18)$$

For 150 stock:

$$VI = 1.9C_{OCP} + 92 \qquad (19)$$

b. At 8 wt% of H-340:
For 40 stock:

$$VI = 9.9C_{OCP} + 109.5 \qquad (20)$$

For 60 stock:

$$VI = C_{OCP} + 95.5 \qquad (21)$$

For 150 stock:

$$VI = 1.5C_{OCP} + 91.5 \qquad (22)$$

For the correlations above the error percentage is in the range of 2-3%. These functional relationships are applicable only for this set of blends and it can be applied usefully for determining the VI values at any OCP concentration or vise versa.

6. CONCLUSIONS:

From the proposed study, the following conclusions have been extracted:

1. The kinematic viscosity and viscosity index of the light oil (40 stock) is affected more than the medium oil (60 stock) and the heavy oil (150 stock) and this can be attributed to the fact that the rate of change with temperature depends largely on the type of base oil.
2. The kinematic viscosity of the mixtures prepared from base oil, viscosity index improver and additives will decrease with increasing temperature as their resistance to flow will decrease.
3. The used additives (Lubrizol 21001, H-8722B and H-340) are packages contain a polymeric chain behaves as a viscosity index improver. So when those additives are blended with only the base oil the viscosity index will increase slightly and this is recommended in monograde oils. While when those additives are blended with the base oil and with a viscosity index improver like OCP, the obtained oil will be a multigrade oil.
4. The viscosity index for both 40 and 150 stock when blended with 2 wt% of H-340 additive will increase by about 4% and at higher concentrations it will decrease. While for 60 stock at 2, 4 and 6 wt% of H-340 the viscosity index will increase negligibly and then decrease at higher concentrations.
5. The efficiency of OCP (VII) is decreased with an increasing rate when blended with 4 and 8 wt% of Lubrizol 21001 for all the three base oil types.
6. The efficiency of OCP is increased by 5% when adding 4 wt% of H-8722B in 40 stock and increase by insignificant value when adding 8 wt%. For 60 stock the OCP efficiency decreased by a rate of about 7% and 14% by adding 4 and 8 wt% of H-8722B, respectively. While for 150 stock the efficiency of OCP decreased the decreasing rate is obtained to be about 2% by adding 4 wt% and being 4% by adding 8 wt% of H-8722B. So it is better to use this additive with lubricating oil in the presence of OCP by adding 4 wt% or less.
7. H-340 would strongly decrease the efficiency of OCP for 60 stock, the decreasing rate was about 37% and 28% by adding 4 and 8 wt% of H-340, respectively. For 150 stock the decreasing rate is obtained to be about 10% by adding 4 wt% and being about 14% by adding 8 wt% of H-340. While for 40 stock the efficiency at 4 wt% of H-340 is increased by about 5% and decreased insignificantly when adding 8 wt% of H-340. It is recommended to use H-340 as lubricating oil

additive in the presence of OCP by adding 4 wt% or less.

8. Many correlations were obtained for the VI with respect to the concentration of OCP. And it has been found that there is no unified correlation can represent this system as whole.

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8. Tables and Figures:

Table 1 VI of Base Lubricating Oil

Base Lubricating oil type	VI
40 stock	106
60 stock	97
150 stock	90

Table 2 VI Values of Base Oil Blended with OCP

OCP wt%	VI of 40 stock	VI of 60 stock	VI of 150 stock
0	106	97	90
2	178	119	105
4	223	143	117
6	248	162	126
8	262	176	133
10	270	185	138

Table 3 VI Values of Base Oil and 4 wt% of Lubrizol 21001 with Different Concentrations of OCP at Different Temperatures

OCP wt%	VI of 40 stock	VI of 60 stock	VI of 150 stock
2	176	114	103
4	218	128	110
6	236	142	116
8	245	152	122

Table 4. VI Values of Base Oil and 8 wt% of Lubrizol 21001 with Different Concentrations of OCP at Different Temperatures

OCP wt%	VI of 40 stock	VI of 60 stock	VI of 150 stock
2	174	106	101
4	200	113	108
6	216	125	113
8	228	132	117

Table 5. VI Values of Base Oil and 4 wt% of H-8722B with Different Concentrations of OCP at Different Temperatures

OCP wt%	VI of 40 stock	VI of 60 stock	VI of 150 stock
2	141	108	97
4	175	118	102
6	194	132	112
8	219	149	121

Table 6. VI Values of Base Oil and 8 wt% of H-8722B with Different Concentrations of OCP at Different Temperatures

OCP wt%	VI of 40 stock	VI of 60 stock	VI of 150 stock
2	139	100	95
4	163	114	99
6	181	120	108
8	206	128	116

Table 7. VI Values of Base Oil and 4 wt% of H-340 with Different Concentrations of OCP at Different Temperatures

OCP wt%	VI of 40 stock	VI of 60 stock	VI of 150 stock
2	134	99	96
4	161	100	99
6	178	103	103
8	207	107	107

Table 8. VI Values of Base Oil and 8 wt% of H-340 with Different Concentrations of OCP at Different Temperatures

OCP wt%	VI of 40 stock	VI of 60 stock	VI of 150 stock
2	131	98	95
4	147	99	97
6	168	101	100
8	190	104	104

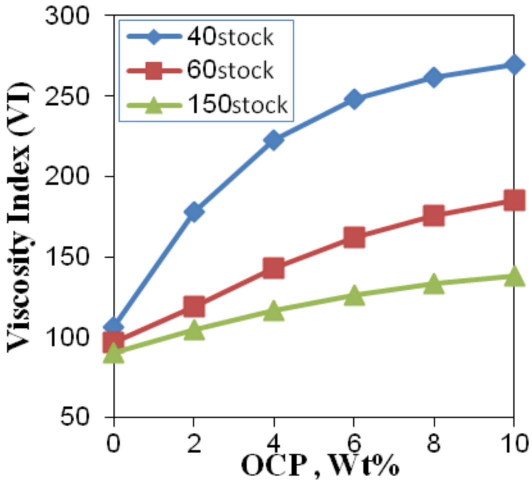

Fig. 1 Effect of OCP on VI of the Three Types of Base Lubricating Oil

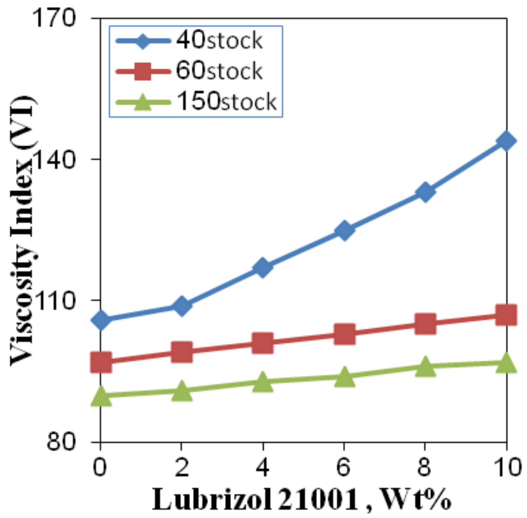

Fig. 2 Effect of Lubrizol 21001 on VI of the Three Types of Base Lubricating Oil

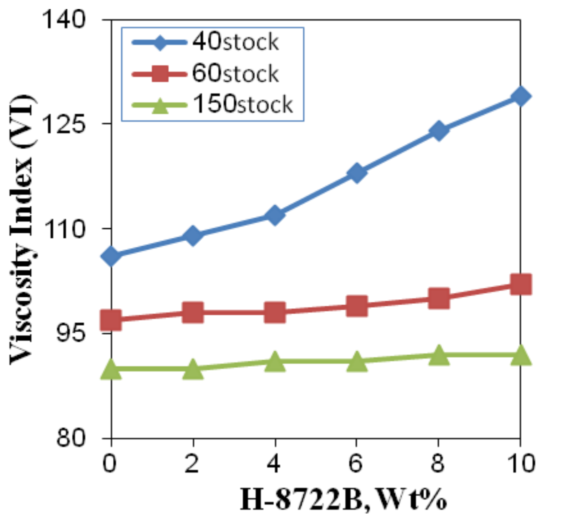

Fig. 3 Effect of H-8722B on VI of the Three Types of Base Lubricating Oil

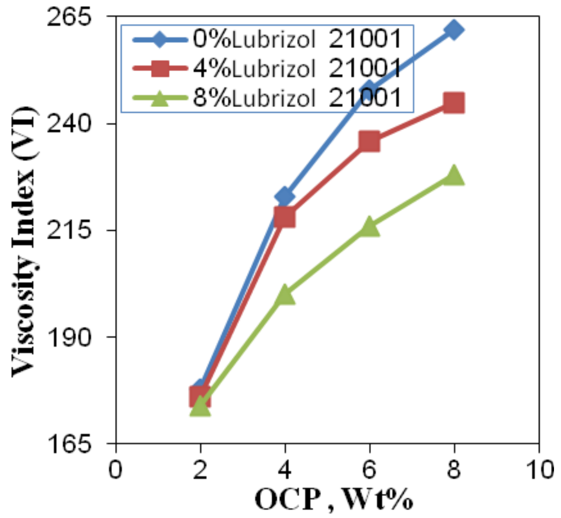

Fig. 5 Effect of OCP on VI of 40 stock + 0, 4 and 8 wt% of Lubrizol 21001

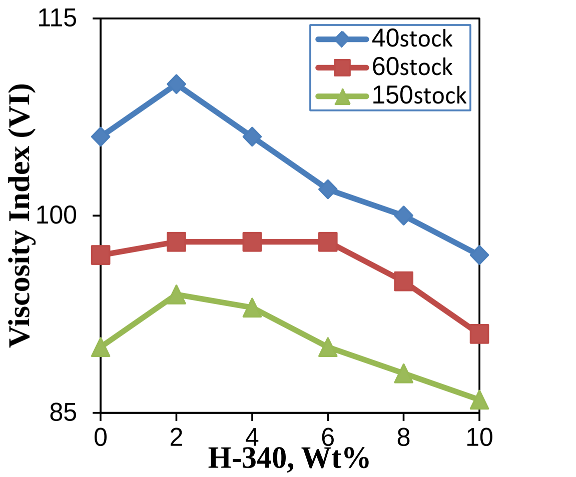

Fig. 4 Effect of H-340 on VI of the Three Types of Base Lubricating Oil

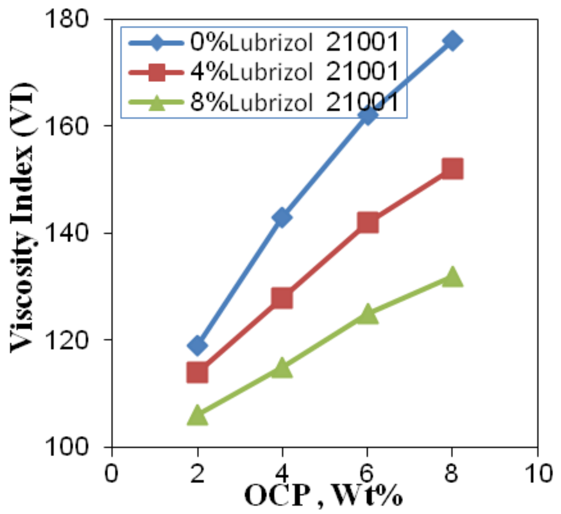

Fig.6 Effect of OCP on VI of 60 stock + 0, 4 and 8 wt% of Lubrizol 21001

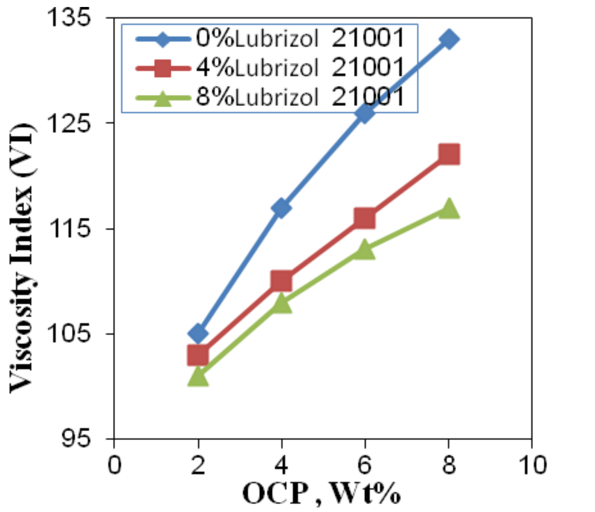

Fig. 7 Effect of OCP on VI of 150 stock + 0, 4 and 8 wt% of Lubrizol 21001

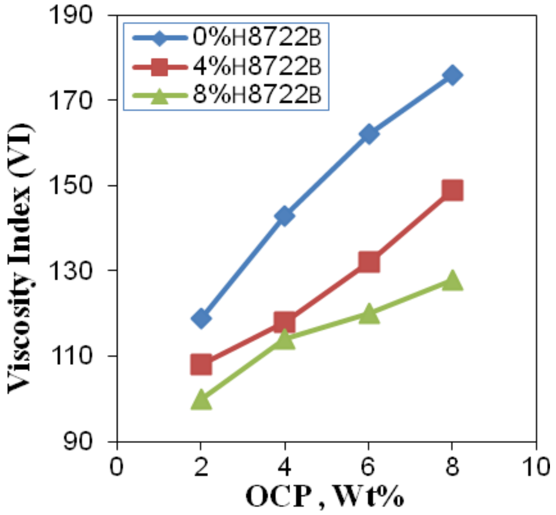

Fig. 9 Effect of OCP on VI of 60 stock + 0, 4 and 8 wt% of H-8722B

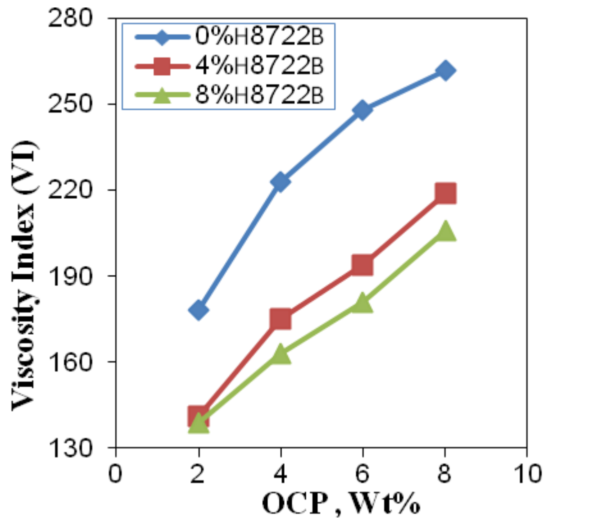

Fig. 8 Effect of OCP on VI of 40 stock + 0, 4 and 8 wt% of H-8722B

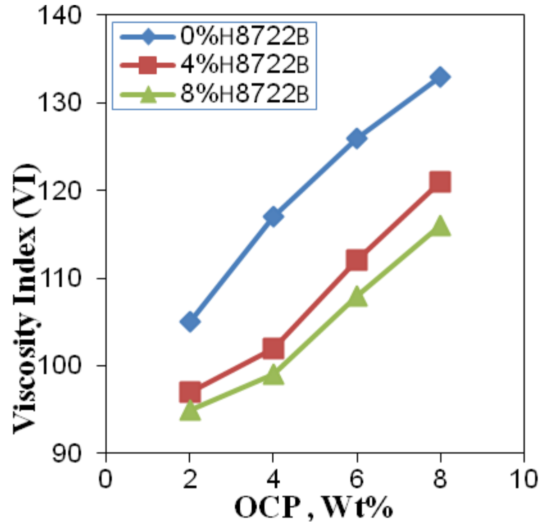

Fig.10 Effect of OCP on VI of 150 stock + 0, 4 and 8 wt% of H-8722B

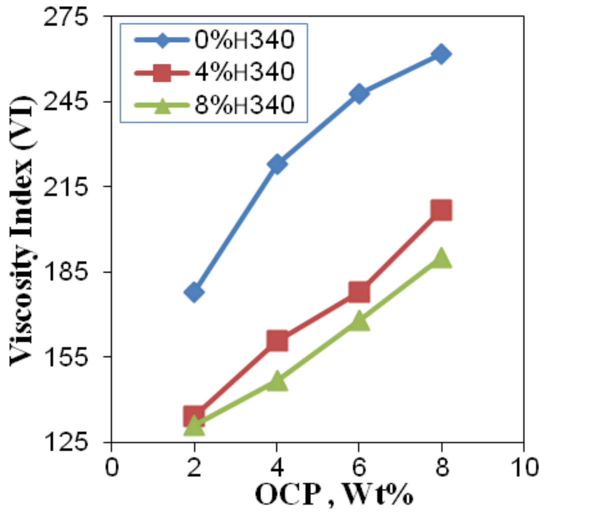

Fig. 11 Effect of OCP on VI of 40 stock + 4 and 8 wt% of H-340

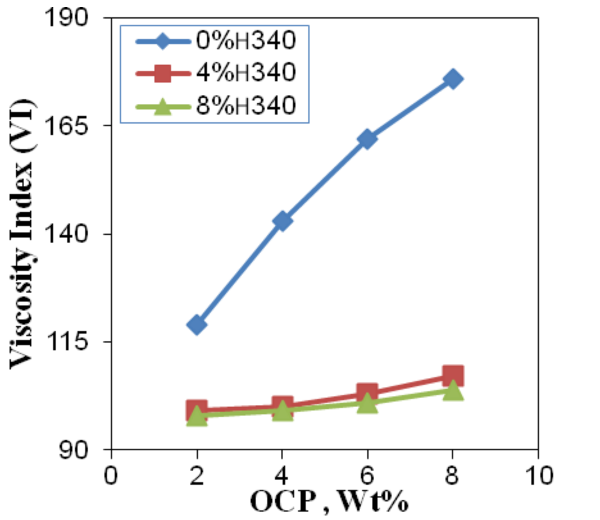

Fig. 12. Effect of OCP on VI of 60 stock + 4 and 8 wt% of H-340

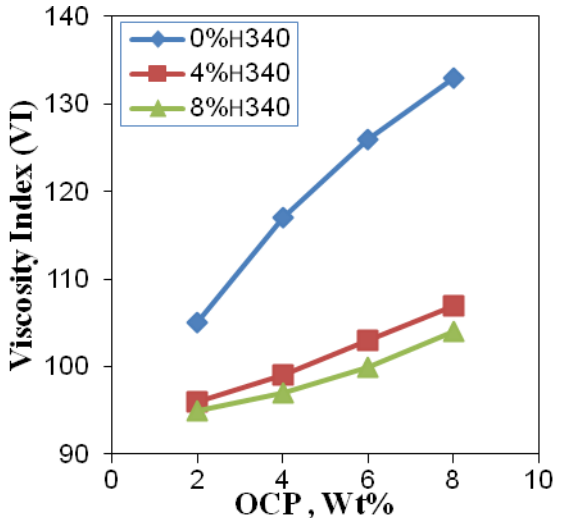

Fig. 13 Effect of OCP on VI of 150 stock + 4 and 8 wt% of H-340

Notations and Abbreviations

C_{OCP}	Concentration of Olefin Copolymer, g/cm^3
ACEA	European Automobile Manufacturers Association
API	American Petroleum Institute
OCP	Olefin Copolymer
OEM	Original Element Manufacturer
PBR	Poly Butadiene Rubber
PIB	Polyisobutylene
SAE	Society of Automotive Engineers
VI	Viscosity Index
VII	Viscosity Index Improver