KAPOK SEED OIL
AS VISCOSITY INDEX IMPROVER

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ABSTRACT

Production, supply and development of lubricating oils for domestic use are carried out in Indonesia using domestic base oils and imported additives.

Research on the use of kapok seed oil as a viscosity index improver for lubricating oil is as an effort for supply and development of lubricating oil additive which is produced in the country.

Results of physical and chemical properties analysis indicate that kapok seed oil can be used as a viscosity index improver.

I. INTRODUCTION

In general, this research is related to lubricating oils and particularly to viscosity index of lubricating oils. The viscosity index of a lubricating oil can be increased by using an additive which is called viscosity index improver.

Viscosity index improver is an additive which can be used to increase the relation between viscosity and temperature. Kapok seed oil has high viscosity index, higher than 190. Therefore, kapok seed oil can be used as an additive to increase viscosity index of lubricating oils.

II. KAPOK SEED OIL

Kapok seed oil is obtained from the seed of plant *Ceiba Pentandra.* The oil content of the seed is 18–25 percent. Schematic process diagram of kapok seed oil production is shown in Figure 1. Briefly, kapok seed oil production can be described as following: The cleaned kapok seeds are put into pressing equipment, from which kapok seed oil containing solid particles is obtained. This oil is then flowed throught a filter where solid particles is removed to obtain crude kapok seed oil. Finally this crude oil is refined in a refinery yielding refined kapok seed oil.

At the moment, kapok seed oil in Indonesia is not produced intensively, but still as a pastime product when there is not castor bean will be processed. The Indonesian kapok seed oil production can be seen in Table 1.

Table 1. Indonesian kapok seed oil production

Year	Production, in кg
1981	719 477
1982	723 600
1983	403 795
1984	661 303
1985	512 630

The main constituents of the kapok seed oil are palmitic, oleic and linoleic acids. The oleic acid content, have been found varying from 31.5 to 51.0 percent, while the linoleic acid content is reporter to be between 29.5 to 42.0.

III. VISCOSITY INDEX IMPROVER

Lubricating oil consists of base oil and additives which are added into base oil to impart a new and desirable property not originally present in the oil or reinforces desirable property already possessed in some degree by the oil. Although additives of many divers types have been developed to meet special lubrication needs, their principal in functions are relatively few in number. They are used as dispersant, antioxidant, antiwear agent, pour point depressant,

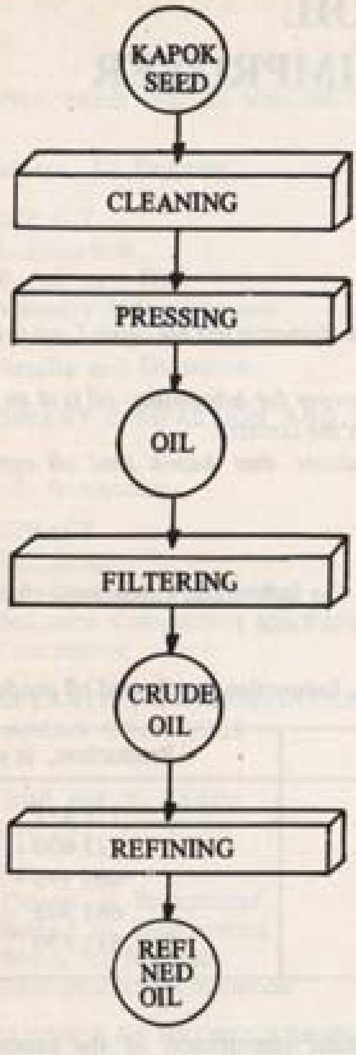

Figure 1. Schematic process diagram of kapuk seed oil production.

corrosion inhibitor, extreme pressure agent, anti foam agent, viscosity index improver etc.

Viscosity Index (VI) is an arbitrary number which indicates the resistance of a lubricant to viscosity change with temperature. The higher its viscosity index value, the greater the resistance of lubricant to thicken at low temperature and thin out at high temperature.

An ideal lubricant for most purposes would possess the same viscosity at all temperatures. All lubricants, including mineral oils, depart from this ideal, some more than others. For example, lubricating oils derived from highly paraffinic crudes have higher viscosity index values than lubricating oils derived from highly naphthenic crudes.

According to their viscocity index, the lubricating oils are divided into three groups as following:

1) Lubricating oils having viscosity index lower than 40 are called low viscosity index (LVI) lubricating oils.
2) Lubricating oils having viscosity index between 40 and 80 are called medium viscosity index (MVI) lubricating oils.
3) Lubricating oils having viscosity index higher than 80 are called high viscosity index (HVI) lubricating oils.

Viscosity index improvers are chemicals which are added to lubricating oils to make them conform closely to the ideal lubricant defined above.

There seem to be three proposed theories of how viscosity index improver function. One of the proposed theories of how they work is that the viscosity index improver molecule is in a coiled configuration at low temperatures, more like a small ball, and as such has very little effect on the viscosity of the fluid; whereas at higher temperatures, the coil stretches out, resulting in a type of thickening of the oil. Another theory involves the principal of solvent-solute interactions. It states that the base oil is a better solvent for the viscosity index improver at a higher temperatures, resulting in greater dispersion of the viscosity index improver molecules. This is said to cause greater thickening of the oil at higher temperatures, than at the lower temperatures where it is barely solubilized by the oil. The third theory states that at the higher temperatures, increase oscillation, rotation, and translation of the macromolecules make it a larger obstacle to free flow, resulting in increased viscosity.

The proposed theories can be summerized as follows:

- Viscosity index improver stretched at high temperature, coiled at low temperature.
- Base oil better solvent at high temperature, but must prevent its precipitation at low temperature
- At high temperature increase oscillation, rotation and translation of macromolecule make it larger obstacle to free flow.

IV. EXPERIMENTAL

A. Physical and chemical properties

Physical and chemical properties of kapok seed oil analyzed using ASTM standard test methods which are used to analyse lubricating oils derived from petroleum oils. The purposed of this analysis is to investigate the kapok seed oil properties.

B. Kapok seed oil as viscosity index improver

The results of analysis of physical and chemical properties indicates kapok seed oil possess a high viscosity index. This enables kapok seed oil to be used as additive to increase viscosity index of lubricating oil viscosity and temperature.

A laboratory test is carried out to study the change in viscosity index, when adding a certain percentage of kapok seed oil in petroleum base oil. Six different kinds of samples are prepared:

- BO = petroleum base oil,
- BOL = petroleum base oil containing 2% volume kapok seed oil.
- BO2 = petroleum base oil containing 5% volume kapok seed oil.
- BO3 = petroleum base oil containing 10% volume kapok seed oil.
- BO4 = petroleum base oil containing 15% volume kapok seed oil, and
- BO5 = petroleum base oil containing 20% volume kapok seed oil.

Viscosity and viscosity index of the samples were measured by using ASTM D 445 and ASTM D 2270 methods.

V. RESULTS AND DISCUSSION

A. Physical and chemical properties

The test results of kapok seed oil properties are shown in Table 2. Kinematic viscosity of kapok seed oil is 59,91 cSt at 100° F and 11.22 cSt at 210°F. The change of viscosity with the change of temperature indicate that kapok seed oil possess a high viscosity index, namely 195.

Pour point of kapok seed oil is 30°F, flash point 620°F and ash content 0.001 % weight.

The test results indicate that kapok seed oil can be used as an additive to improve viscosity index of lubricant base oil. Viscosity index of kapok seed oil is higher than minimum viscosity index of some SAE multiviscosity numbred oils, as shown in Table 3.

Table 2. Kapok seed oil properties test results

Determination	Unit	Result
Specific Gravity at 60/60°F		0.9258
API Gravity at 60°F		21.3
Kinematic Viscosity at :		
100°F	cSt	59.91
210°F	cSt	11.22
Viscosity Index		195
Pour Point	°F	30
Flash Point	°F	620
Total Acid Number	mg KOH/g	0.14
Strong Acid Number	mg KOH/g	Nil
Total Base Number	mg KOH/g	0.01
Ash Content	% wt	0.001

Table 3. Minimum viscosity index of some SAE multiviscosity numbered oils

SAE Multiviscosity	Minimum Viscosity Index, $VI_{min.}$ (ASTM D 2270)
5W – 20	127
5W – 30	180
5W – 50	230
10W – 30	145
10W – 40	169
10W – 50	190
20W – 40	113
20W – 50	133

B. Kapok seed oil as viscosity index improver

The test results of viscosity and viscosity index of petroleum base oil and its blends with kapok seed oil are shown in Table 4. The viscosity of the mixture will increase with the increasing of kapok seed oil content in the base oil as shown in Figure 2.

Furthermore, the increasing of viscosity index of petroleum base oil blended kapok seed oil was investigated. The base oil in this experiments was a refined mineral lubricating base oil having the following properties:

- Kinematic viscosity at 100°F 25.93 cSt
- Kinematic viscosity at 210°F 4.71 cSt
- Viscosity index 102

Table 4. Viscosity and viscosity index test results

Sample	Kinematic Viscosity at :		Viscosity Index	Increase in Viscosity Index
	100°F, cSt	210°F, cSt		
BO	25.93	4.71	102	Baseline
BO1	26.71	4.82	111	9
BO2	27.58	4.94	113	11
BO3	28.74	5.18	122	20
BO4	30.01	5.46	131	29
BO5	31.16	5.78	141	39

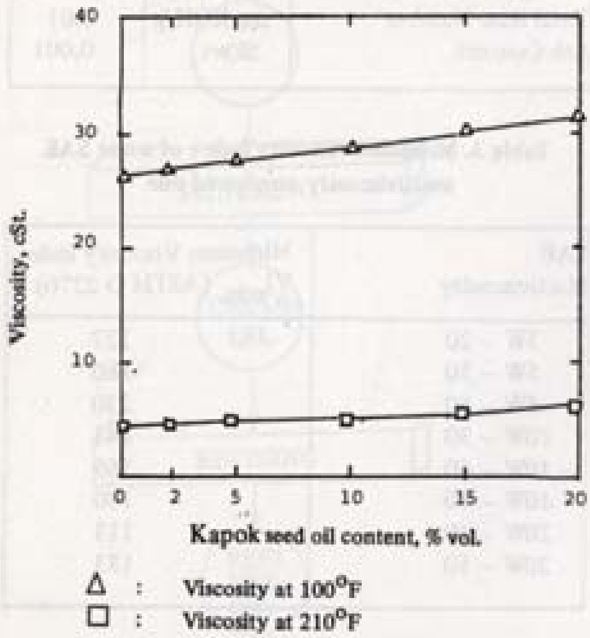

Figure 2. Viscosity of the mixture as a function of kapok seed oil content in the base oil

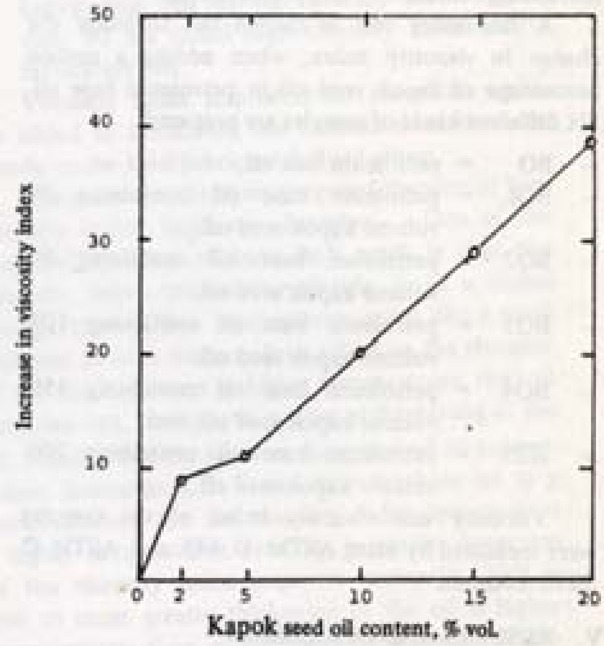

Figure 3. The increase in viscosity index of the mixture as a function of kapok seed oil content in the base oil.

The test results of viscosity index shows that increasing kapok seed oil content in the mixture will also increase viscosity index. In these examples, the addition of 2 % volume kapok seed in base oil, increase viscosity index of the mixture about nine points, and with addition of 20 % volume, the viscosity index of mixture reached to 141 or increased 39 points. The increasing of viscosity index with the increasing of addition kapok seed oil in the petroleum base oil is shown in Figure 3.

VI. CONCLUSION

- Base on the study, it could be concluded that:
- Kapok seed oil can be mixed (miscible) with petroleum base oil in various composition.
- Kapok seed oil can be used as an additive to increase viscosity index of lubricating base oil or as a viscosity index improver.

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