CHAPTER 3

EXPERIMENTAL

3.1 Chemicals

3.1.1 Viscosity index improvers

-Polyisobutene was supplied by BP-Amoco. Typical properties and characteristic were:

Kinematic viscosity at 100 °C	220	cSt
Molecular weight	910	$gmol^{-1}$

-Olefin copolymer viscosity index improver was supplied by Chevron Oronite Pte Ltd.. Typical properties and characteristic were:

Kinematic viscosity at 100 °C	860	cSt
Shear stability index	24	

-Hydrogenated styrene-isoprene copolymer viscosity index improver was supplied by Shell International Chemical Company Ltd. Typical properties and characteristic were:

Kinematic viscosity at 100 °C	1,400	cSt

-Polyalkyl(meth)acrylate was supplied by Rohmax. Typical properties and characteristic were:

Kinematic viscosity at 100 °C	1,750	cSt
Shear stability index	30	

3.1.2 Mineral base oil

Mineral base oil was a gift from Thai Petrochemical Industrial.

-150 SN, typical properties and characteristic were:

Kinematic viscosity at 40 °C	30	cSt
Kinematic viscosity at 100 °C	5	cSt
Viscosity index		100

-500 SN, typical properties and characteristic were:

Kinematic viscosity @ 40°C	96	cSt
Kinematic viscosity @ 100°C	10	cSt
Viscosity index		95

3.2 Instruments

3.2.1 Viscometer

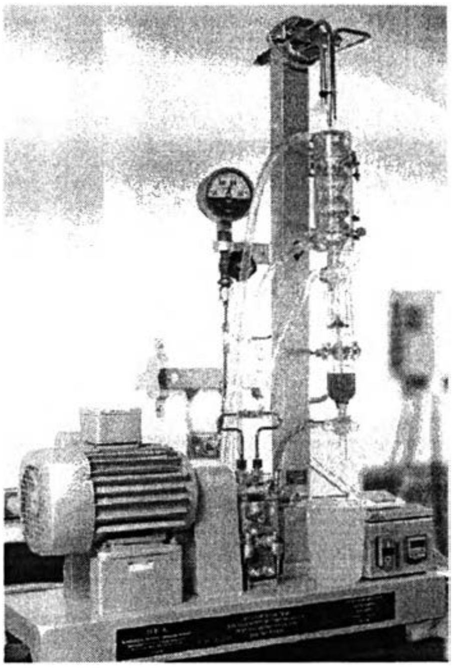
Cannon Automatic Viscometer model : CAV 2000

3.2.2 Cold-Cranking Simulator

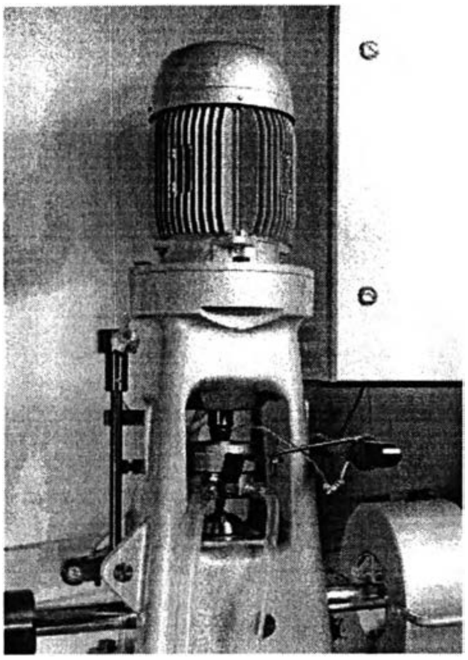
Cannon cold cranking simulator model : CCS-2100

3.2.3 Tapered Bearing Simulator

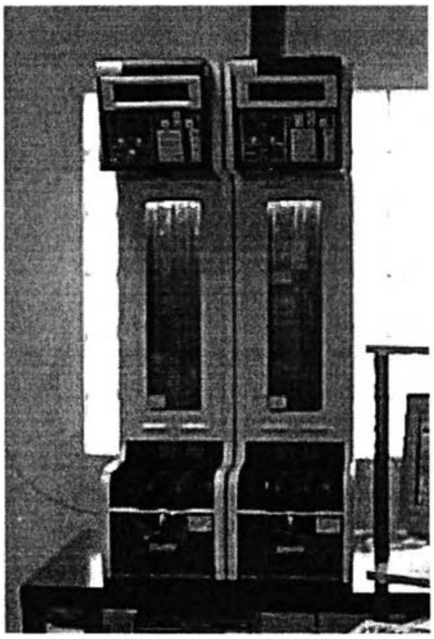
3.2.4 European Diesel Injector Apparatus



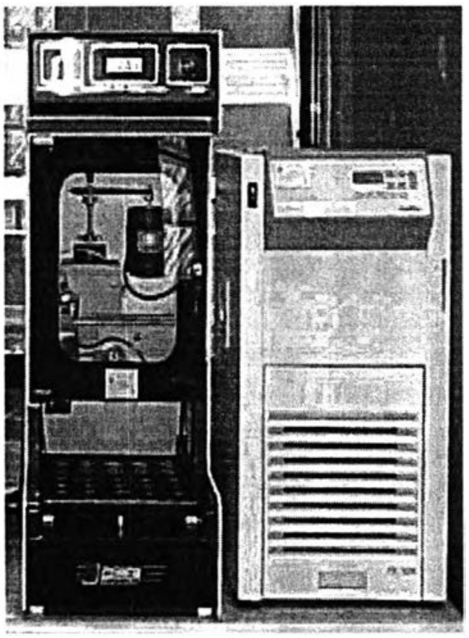
A) European Diesel Injector



B) Tapered Bearing Simulator



C)Automatic Viscometer



D) Cold Cranking Simulator

Figure 3.1 Testing instruments

3.3 Procedures

3.3.1 Preparation of blended lubricating base oil

Mixture of SN 500 (heavier base oil) and SN 150 (lighter base oil) was prepared by using the following ratio: (SN 500 per SN 150) 80.4: 19.6 by weight.

The mixture was then stirred for approximately 30 minutes to ensure that it is uniformly homogeneous.

3.3.2 Preparation of 2, 5, and 9% of olefin copolymer viscosity index improver.

2.0 grams of olefin copolymer viscosity index improver was added in a blending container. Then the mixed base oil (from 3.3.1) was added in the container to give the overall weight of 100 grams.

The mixture was then heated up to below 50°C and stirred at the same time to ensure that the mixture is uniformly homogeneous.

For 5% and 9% concentration of OCP in blended base oil, the procedures were performed using the same method as the 2% but the weight of olefin copolymer viscosity index improver was changed to 5.0 grams and 9.0 grams, respectively.

3.3.3 Preparation of 2, 5, and 9% of hydrogenated styrene-isoprene, polymethacrylate, and polyisobutylene viscosity index improver.

The preparation was as same as the preparation of solution of olefin copolymer but viscosity index improver was changed to hydrogenated styrene-isoprene, polymethacrylate, and polyisobutylene viscosity index improver, respectively.

3.3.4 Preparation of dual viscosity index improver

Dual viscosity index improvers were prepared with the following ratios in Table 3.1. The mixture was then heated up to approximately 80-90°C and stirred to obtain uniformly homogeneous mixture.

Table 3.1 Ratios for blending dual viscosity index improver.

VI improver type		**1st VI improver : 2nd VI improver (By weight)**
OCP	SIP	1:2
OCP	SIP	1:1
OCP	SIP	2:1
OCP	PMA	1:2
OCP	PMA	1:1
OCP	PMA	2:1
OCP	PIB	1:2
OCP	PIB	1:1
OCP	PIB	2:1
SIP	PMA	1:2
SIP	PMA	1:1
SIP	PMA	2:1
SIP	PIB	1:2
SIP	PIB	1:1
SIP	PIB	2:1
PMA	PIB	1:2
PMA	PIB	1:1
PMA	PIB	2:1

3.3.5 Preparation of finished lubricating oil

7.2 grams of pour point dispersant was put in a blending container. Then 108.0 grams of package additive was added. Next 8.8 grams of viscosity index improver was added in the container and 780.0 grams of SN 500 and 199.2 grams of SN 150 were mixed respectively.

The mixture was then stirred for approximately 45 minutes to obtain the uniformly homogeneous mixture.

3.3.6 Determination of base oil, mixed base oil, and solution of viscosity index improver

3.3.6.1 Kinematic viscosity

The kinematic viscosity of all samples was determined using an automatic viscometer model CAV 2000 at temperatures of 40°C and 100°C, according to standard test method ASTM D 445. [9]

3.3.6.2 Viscosity index, VI

The viscosity index of a sample was calculated from kinematic viscosities at temperatures of 40°C and 100°C, according to the following equation in the standard test method ASTM D 2270. [10]

$$VI = \frac{L - U}{L - H} \times 100$$

where L is the kinematic viscosity at 40°C of the zero VI standard

H is the kinematic viscosity at 40°C of the 100 VI standard

and U is the kinematic viscosity at 40°C of sample

3.3.6.3 Viscosity at -15°C, CCS

The cold-cranking simulator of all samples were determined using automatic cold-cranking simulator model CCS-2100 at temperature -15°C, with regards to the standard test method ASTM D 5293. [11]

3.3.6.4 Shear stability, percent viscosity loss (PVL)

The shear stability of the finished products were analysed by European Diesel Injector Apparatus and an automatic viscometer at temperature 100°C then shear stability index was calculated according to the following equations in the standard test method ASTM D 6278. [12]

$$\text{Shear loss (permanent)} = \frac{[\text{KV before shearing}] - [\text{KV after shearing}]}{[\text{KV before shearing}]}$$

$$\text{Shear stability index (SSI)} = \frac{[\text{KV before shearing}] - [\text{KV after shearing}]}{[\text{KV before shearing}] - [\text{KV of the base oil}]}$$

KV = Kinematic Viscosity at 100°C

3.3.6.5 Viscosity at high shear rate and high temperature (HTHS)

The viscosities at high shear rate and high temperature of the finished lubricating oils were analysed by tapered bearing simulator using shear rate $1 \times 10^6 \ s^{-1}$, temperature 150°C. [13]