

# Application of Group III Base Oil to Heat Treating Oils

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There are numerous types of base oils used in heat treating oils. In this paper, we have examined the composition of Group III base oils for use in heat treating oils based on the results of base oil composition, brightness, and stability.

**Keywords:** Heat treating oil, Group III base oil, Oxidation stability, Brightness

## 1. Introduction

In recent years, energy conservation and longer service life are being promoted for lubricants. The main component of lubricating oil is base oil, which is blended with additives for various applications and conditions. The American Petroleum Institute (API) classifies base oils used as main ingredients into Group I through Group V based on composition and structure (Table 1).<sup>1)</sup>

Table 1 Classification of base oils

	Saturated /%		Sulfur /%	Viscosity Index
Gp-I	<90	and/or	>0.03	80~119
Gp-II	≥90	and	≤0.03	80~119
Gp-III	≥90	and	≤0.03	≥120
Gp-IV	PAO (Poly-Alpha-Olefin)			
Gp-V	All other base oils not included in Group-I~IV			

Nowdays, older and smaller refineries producing Group I, etc., have closed, expanded, and shifted to the production of base oils that meet economic and social demands for higher quality, and the production volume of Group I base oils has continued to decline year by year. Therefore, due to the aforementioned background, Group III base oil must be used as heat treating oil from the viewpoint of availability and economic efficiency. In general, Group III base oil is said to have excellent oxidation stability due to its high degree of refinement and low sulfur and nitrogen content.

As an example, Figure 1 shows the values of kinematic viscosity ratio of lubricating oil oxidation stability test (ISOT, JIS K 2514-1) for internal combustion engine oil and heat treating oil (in accordance with JIS K 2242) used in lubricating oil.

$\eta$  : Kinetic viscosity at after test.

$\eta_0$  : Kinetic viscosity at before test.

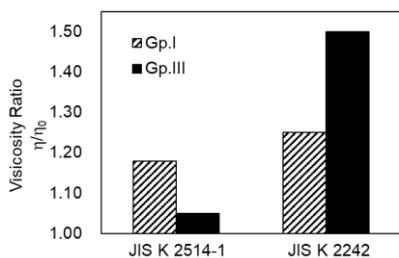


Figure 1 Viscosity ratio

Figure 1 shows that in some cases, Group III base oil degraded faster than Group I base oil under severe degradation conditions such as the oxidation stability test (JIS K 2242) for heat treating oils. In the future, heat treating oil formulations will need improved stability when Group-III base oils are used. This study was examined by adding Group I base oil. Group I base oils are less effect of oxidation.

In addition, the brightness (metallic luster of the quenched material), which is required as a secondary performance of heat treating oil these days, is also examined in the same way<sup>2)</sup>.

Heat treating oils are classified by JIS as shown in Table 2. In this paper, we focus on JIS Class 1, No. 2, and studied formulations using Group III base oil.

Table 2 Quality and property (JIS K 2242)

Classification		Kinetic viscosity	
		40°C	100°C
		mm <sup>2</sup> /s	mm <sup>2</sup> /s
Class 1	No.1	30 max.	-
	No.2	26 max.	
Class 2	No.1	-	20 max.
	No.2		35 max.
Class 3	No.1	-	30 max.
	No.2		50 max.

## 2. Experiments and Results

### 2.1 Adjustment of samples

Table 3 shows the general properties of the base oils used in this study.

Table 3 Properties of base oil

Base Oils	API	Viscosity@40°C mm <sup>2</sup> /s	Sulfur mass%
3A	Gp.III	18.71	0.00
3B		31.70	0.00
3C		46.37	0.00
1A	Gp.I	23.69	0.71
1B		24.16	0.46
1C		28.66	0.30
1D		27.37	0.22
1E		27.52	0.17
1F		30.26	0.06

Heat treating oil (commercially product) consists of base oil and various additives. In order to study JIS Class 1 No. 2 heat treating oil, the kinematic viscosity of the mixed oil was adjusted to be 21 mm<sup>2</sup>/s, considering the maximum kinematic viscosity of 26 mm<sup>2</sup>/s and the viscosity increase due to additives required for the commercially product. Table 4 shows the amount of each base oil added to base oil 3A.

Table 4 Mixture oil adjustment

Samples*	Add base oils	Added rate /%	Viscosity@40°C mm <sup>2</sup> /s
1	3B	18.4	21.08
2	3C	11.2	21.09
3	1A	28.9	20.71
4	1B	26.8	20.64
5	1C	16.4	20.80
6	1D	18.3	20.86
7	1E	18.0	20.62
8	1F	14.7	20.89

\*The main base oil is 3A

## 2.2 Oxidation stability

Oxidation stability tests were then conducted on the sample 1~8 at 24 and 48 hours. The index of degradation was determined by the increase in viscosity ratio and total acid values (JIS K 2501). The kinematic viscosity and total acid value are shown in Figure 2 and Figure 3.

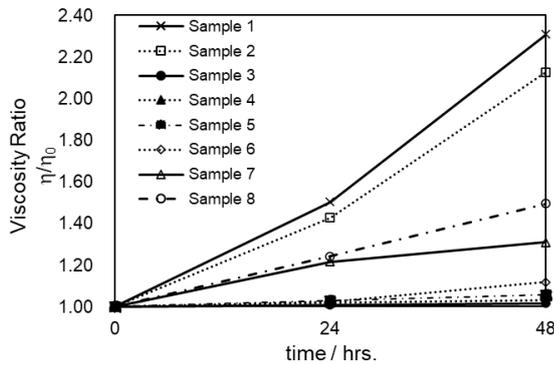


Figure 2 Viscosity ratio

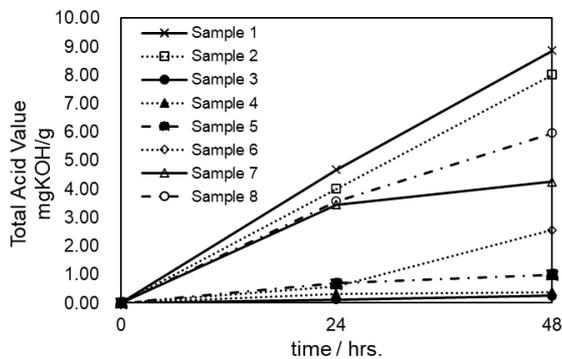


Figure 3 Change in total acid value

From Figures 2 and 3, it was observed that the sample with Group I base oil was more effective in suppressing the increase in kinematic viscosity ratio and total acid value than the mixed oil consisting only of Group III.

## 2.3 Brightness of new samples

For the brightness test, a test piece (SUJ-2, φ15×25 mm) is heated to 850°C under the inert gas and quenched into sample oil. Evaluate brightness by the luster of the test piece. Judgments were used by the standard test piece shown in Figure 5 and were graded at three levels: Excellent, Fair, and Poor. Table 4 shows the brightness results for samples 1~8.



Figure 4 Standard test piece

Table 5 Results of brightness

Samples	Brightness
1	Poor
2	Poor
3	Excellent
4	Excellent
5	Excellent
6	Fair
7	Fair
8	Fair

Table 4 shows that the sample with the addition of Group I base oil has better brightness than the sample consisting only of Group III.

## 3. Summary

Both the change in viscosity ratio and total acid number after the oxidation stability test, as well as the brightness in new samples, were improved in the sample with the addition of Group I over the sample consisting only of Group III. This detail will state my presentation.

## 4. Reference

- 1) Tagawa.K: *JXTG Technical Review*, 2017, Vol.59-3, 102-107
- 2) Asada.S: *Journal of Japanese Society of Tribologists*, 1996, Vol.41-8, 647-652
- 3) Japanese Industrial Standard, Heat treating fluids, JIS K 2242 (2012)