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A New Spot Test for Quality Control of Lubricating Oils

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ABSTRACT

Most of the lubricating oils marketed are commonly blended with a suitable dosage of the recommended additives. Hydrocarbon Development Institute of Pakistan (HDIP) has developed a field spot test, by which a standard lubricating oil (containing additives) can be distinguished from a fake lubricating oil (without additives). This spot test is first of its kind in Pakistan.

INTRODUCTION

Refining

Lubricating base oils are obtained from the heavy crude oils, which are suitable for the lube refineries. The portion of crude oil which is left behind the distillation recovery of diesel (the atmos bottom) contains lube oil, wax and asphalt. Further distillation under vacuum is carried out to avoid the cracking of hydrocarbons. The vacuum distillation yields the following raw base lurbricating oils:

i) Jute batching oil
ii) 100 Neutral spindle oil
iii) 400 Neutral

The vacuum bottom is further treated with propane to extract the high viscosity lube oil from asphalt. This lube oil is called bright stock.

The raw or straight distilled lube oils are further passed through a number of processes to further improve their qualities.

Viscosity Index (VI) Improvement

The straight distilled lube oils are treated with Furfural to improve the VI of the lube oils. The aromatics and olefins are removed from the base oils after going through this process. These oils are, classified as MVI or HVI oils.

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Dewaxing

The quality of the lube oil is further improved by the removal of wax from the lube oils. The oil is mixed with Toluen and Methyl ethyl ketone and chilled to a very low temperature. When the wax is crystallized the oil is passed through rotary filters and the wax is separated.

Hydrofinishing

This lube oil is further treated with hydrogen gas at high temperature and pressure and passed through a reactor packed with catalysts. The unstaturated hydrocarbons get saturated and the colour of the oil is improved and becomes stable. The lube which has passed through above mentioned processes is termed as base oil which is of different grades.

BLENDING

Different base oils are blended in the desired formulation and the additives are added to make a suitable oil which has all the qualities to lubricate the moving components of an engine and reduce the friction. In general practice the additives are classified as:

i) Viscosity Index (VI) improvers
ii) Emulsifiers
iii) Extreme Pressure (EP) additives
iv) Anti-oxidents
v) Anti-rusts

ADDITIVES FOR LUBRICANTS

The essential additives for lubricants are described in Table 1. Additives used in diesel and gasoline engines require low-metallic based sulphonates for high temperature detergency. Metallic phenates are used as high temperature oxidation inhibitors. The sulphur dioxide is produced on combustion and to neutralize this corrosive product, the additives must provide sufficient alkalinity, otherwise corrosion of engine parts will take place.

Table 1. Additives in engine lubricants (after O'Brien and Kay, 1974).

Additives	Presence of Additives		
	Diesel lube	Gasoline lube	Diesel-Gasoline lube
a. Low based metallic sulphonate detergents	yes	no	yes
b. High based metallic sulphonate inhibitors	sometimes	yes	yes
c. Calcium phenate inhibitor	yes	sometimes	yes
d. Zinc dithiophosphate oxidation and wear inhibitor	sometimes	yes	yes
e. Ashless dispersants	no	yes	yes
f. Ashless inhibitors	no	sometimes	yes

Additionally, zinc dithiophosphate is used specially in diesel engines as oxidation and wear inhibitor.

For the gasoline engine lubricants, ashless dispersants are preferred for the control of low temperature sludge and varnish. The overbased metallic sulphonates are added to inhibit rust formation. Zinc dithiophosphate as oxidation and wear inhibitor is added to supplement the metallic additive. Multifunctional diesel and gasoline engine lubricants must have all these additives in the proper dosage.

The properties of any lubricant depends on the properties of the additives and dosage of the additive used in a formulation.

Dispersants

The dispersants are used in gasoline engine lubricants to control the accumulation of sludge and varnish deposits, primarily in low temperature operations. Most of the dispersants are not stable at high temperature, hence are unfit for diesel engine lubricants.

ROLE OF DISPERSANTS/EMULSIFIERS

With the proper selection of detergents, corrosion inhibitors and high temperature dispersents, the formulation which exhibits the CD level of diesel engine performance, can be developed ranging from SB through SE level. The requirement of dispersants/detergents in multipurpose diesel-gasoline engine lubricants is as follows.

Lubricant	Dispersant Conc. % Volume	API/ASTM/SAE Performance Grades
Oil L	None	SB
Oil M	1	SC/CD
Oil N	2.5	SD/CD
Oil O	3.5	SE/CD

The role of dispersants/detergents is important in SD and SE level lubricating oils. These dispersants and detergents have definite chemical characteristics which are utilized in developing the spot test for a standard lubricating oil. The test is spontaneous and colour developed is very clear. The source of light will not interfere. However, the red colour of oil poses some problem to clearly differentiate between the original and developed colour. Therefore, it is recommended that for all types of lubricating oils the use of red colour should be avoided.

Detergents

These are the engine lubricant additives, which are used basically to prevent carbon and laequer formation in the

Table 2. Blending/Formulation and Oil Analyses Results (after Crikos et al., 1977)

	SAE Viscosity						
	30	20W/20	20W/40	10W	10W/40	10W/40	Test Method ASTM
	Detergency level Supplement 1			High Quality Supplement			
Detergent-dispersant Package (%wt)	2.5	3	5	5	5	6.3	-
Zinc di-alkly di-thiophosphate (%wt)	0.5	0.5	0.2	0.2	0.2	0.2	-
Polymer additive (%wt)	-	1.2	5.0	0	9.0	9.0	-
Viscosity at 100°C(cSt)	10.89	8.4	14.49	7.16	16.60	15.38	D445
Viscosity at 210°F(cSt)	11.2	8.63	14.88	7.30	16.89	15.75	-
Viscosity Index	88	108	121	102	142	139	D567
Sulphated Ash (%)	0.5	0.51	0.69	0.74	0.76	1.04	D974
Total base no (mg KOH/g).	29	3.6	5.8	5.8	5.8	7.3	D664

piston during combustion. The temperature in the piston is highest in the engine parts. The metallic sulphonates are used to provide high temperature detergency in the CD level of lubricating oil for diesel and gasoline engines. Proper selection of detergent strongly influences the performance of lubricating oil which results in better performance of the engines. The sulphonates are not helpful in dispersancy.

Oxidation Inhibitors

Calcium phenates were previously used in multipurpose lubricating oils to inhibit the oxidation at high temperature but they influence low temperature sludge and varnish formation in gasoline engine. The calcium phenates are now substituted with other inhibitors.

Viscosity Improvers

The long-chain macropolymers are destroyed mechanically by high shearing stress in the bearings and between rings and cylinders. The mechanical destruction of marcopolymers results in irreversible viscosity loss. The viscosity losses are influenced by other factors also, like line fuel dilution, solid contamination and oil degradations.

Anti-wear additives like zinc dithiophosphates are used as viscosity improver.

BLENDING/FORMULATION

The refined base oils are blended with the proper dosage of additives. The blending is carried out with the different MVI and HVI grade to obtain the required properties of the lubricating oil. These physical properties are further improved by addition of additives to acquire the API/ASTM/SAE performance level e.g. SE.

The lubricating oil can be evaluated by its properties like viscosity Index, Sulphated Ash and Total Base Number. These properties will be very much correlated with the quantity and type of the additives used in the blending/formulation of the oil, this has been summarized in Table 2.

DEVELOPMENT OF SPOT TEST FOR LUBRICANTS

As briefly described above the additives in the lubricants play very important role in its performance. The fake

Table 3. Analysis results with detector.

S. No.	HDIP Code	Sample Type	Behaviour	Result
1.	BC-1299	Delo-150	CRC	AS
2.	BC-1300	Delo-150	"	AS
3.	BC-1301	Delo-150	"	AS
4.	BC-1302	Delo-300	"	AS
5.	BC-1303	Delo-300	"	AS
6.	BC-1304	Delo-300	"	AS
7.	BC-1305	Delo-300	"	AS
8.	BC-1298	Challenger	"	AS
9.	BC-1292	Delo-150	"	AS
10.	BC-1294	Delo-150	"	AS
11.	BC-1268	Delo-150	"	AS
12.	BC-1264	Delo-300	"	AS
13.	BC-1220	Delo-300	"	AS
14.	BC-1234	Challenger	"	AS
15.	BC-1256	Challenger	"	AS
16.	BC-1258	Mustang	"	AS
17.	BC-1247	Challenger	"	AS
18.	BA-2448	Mobil Oil	NC	NAS
19.	BA-2413	Mobil Oil	CRC	AS
20	BA-2359	CR-40	"	AS
21.	BA-2406	Mobil Oil	"	AS
22.	BA-2416	Mobil Oil	"	AS
23.	BA-2411	Mobil Oil	"	used Oil.
24.	BA-2452	CR-40	"	AS
25	BA-2451	Delo-150	"	AS
26.	BA-2469	Mustang Oil	"	AS
27.	BA-2450	Delo-400	"	AS
28.	BA-2419	Mobil Oil	NC	NAS
29.	BA-2468	GTX	CRC	AS
30.	BA-2410	used oil	"	used oil.
31.	BA-2459	Challenger	"	AS
32.	BC-1251	Challenger	"	AS
33.	BA-2438	EP-140	NC	NAS
34.	BA-2431	GTX	"	NAS
35.	BA-2432	CR-140	"	NAS
36.	BA-2440	T-2	"	NAS
37.	BA-2377	semi recl. oil	"	NAS
38.	BA-2371	semi recl. oil	"	NAS
39.	BA-2376	semi recl. oil	"	NAS
40.	BC-1167	Challenger	CRC	AS
41.	BC-1182	Challenger	"	AS
42.	BC-1186	Challenger	"	AS
43.	BC-1198	Challenger	NC	NAS
44.	BA-2294	Mobile Oil	CRC	AS
45.	BC-1217	-	"	AS
46.	BC-1219	-	"	AS

i) CRC: Crimson Red Colour.
ii) NC: No Colour.
iii) AS: According to Specification.
iv) NAS: Not According to Specification.

lubricants not only give poor performance but also adversly affect the engines. The quality of lubricants can only be certified in a properly equipped laboratory. The users of lubricants are not in a positon to ensure its quality. In order to overcome this problem and to enable the users of lubricants to differentiate between the fake and standard lubricants, HDIP's Petroleum Testing and Research Laboratories, Islamabad have developed a detector for this purpose. This detector can be used as a spot test in the field, or at a petrol pump.

The detector developed is based on the chemical reactions with the additives essentially present in the lubricants. If there is no reaction, it means no additive is present in the oil under test. This spot test is very convenient to carry out. The good quality oil i.e. API, SE level oils will produce a dense crimson red colour with this test. The detector solution is also free from health hazards.

A number of previously analysed samples were retested with this detector, the results were found matching. A list of samples tested with these detectors and their lab results are given in Table 3.

CONCLUSION AND RECOMMENDATIONS

The present study has revealed that the behaviour of natural colour lubricating oil is very convenient for this spot test in the field or at petrol pumps. This spot test merits introduction in the country and can be helpful for preventing production of fake lubricating oils.

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