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Quality Assessment of Commercial Brands of Lubricating Oils

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ABSTRACT

Different commercial brands of lubricating oils available in the markets of the Punjab province, Pakistan have been tested by measuring physical characteristics like kinematic viscosity, viscosity index, flash point, sulphated ash contents, colour and appearance etc. using ASTM methods. Statistics, based on a period of four years, show that only 22% samples collected by District Administration prove to be true according to their labelled specifications which is an indicative of high level of adulteration in commercial brands of lubricating oils. However, all the samples provided directly by different blending plants of oil marketing companies show conformity with their standard specifications.

INTRODUCTION

The major function of lubricating oils is the reduction of friction and wear by the separation of surfaces, metallic or plastic, which are moving with respect to each other. The oils also act as carriers for many special chemicals such as corrosion inhibitors antiwear agents, load carrying friction modifiers and the foam suppressers. Performance requirements can also include cooling and dispersion and neutralization of combustion products from fuel. The high quality and improved properties of present day lubricants have enabled engineers to design machines with higher power-to-weight ratios which generally have higher stresses, load and operating temperatures than before. Thus it has been possible to develop automobile engines, turbines, gear sets etc. capable of higher speeds and higher specific power output per pound of machinery. In a very different field, lubricants with increased resistance to the effects of radiation have been developed for nuclear power station.

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New base oil refining methods yield stock oils which are more responsive to additive treatment. Research in the field of additives has, in turn, produced lubricant formulations which can operate under the higher piston-ring belt temperatures of super-charged automotive diesel engines and provide the dispersion required to prevent the formation of low-temperature sludges in gasoline engines for stop-start, distance motoring. In spite of the increasing temperatures, load and other requirements imposed on lubricants, mineral oils are likely to continue to be employed in the foreseeable future for the majority of automotive, industrial and marine applications.

Petroleum base lubricating oils are present in the residue boiling above 370°C (689°F) from the atmospheric distillation of selected crude oils of both paraffinic and naphthenic types. This residue is further distilled under conditions of high vacuum into a series of fractions depending on the type of crude oil stock. The number of fractions depends on the type of crude oil and the requirements of the refiner but four to five is a typical number. These basic stock oils are further refined usually by solvent extraction and are suitable for incorporation into finished lubricating oils. The individual refined stock oils from one or more crude sources are blended in various proportions to provide lubricating oils suitable for a wide range of applications. The blending process can be by mechanical or air agitation and can be either by a batch or continuos in-line method.

Classification of Lubricating Oils

In the majority of cases to meet specific applicational requirements, chemical additives are used to enhance the properties of base oils. Additives are to improve such characteristics as oxidation resistance, change in viscosity with temperature, low-temperature flow properties, corrosion and radiation resistance and load carrying capacity. Lubricants frequently contain a number of additives to achieve a balance of properties suitable for the intended application. These must be compatible with the base oils, other additives present and additives which are commonly used by others who manufacture products intended for these lubricating oil formulations require knowledge of the most suitable

crude sources for the base oils, the type of refining required, the types of additives necessary and the possible interactions of these components on the properties of the finished lubricating oil.

Three types of automotive oils are recognized and defined by the Society of Automotive Engineers (James,1960), based on type of use, namely, crankcase oils, transmission and axle lubricating and fluids for hydraulic torque converters and fluid couplings. Each of the three groups of automotive oils has been further classified by the SAE, in terms of viscosity. The property of viscosity is recognized as the most important single characteristic of lubricating oils for automotive use. The viscosity classifications take account of the temperatures at which the oils are to be used. There are seven SAE viscosity classifications for crankcase oils (Wood,1969), five for the conventional transmissions (manually shifted) and rear-axle oils and four tentative groupings for hydraulic torque converter and fluid coupling oils.

Petroleum additives are the materials which when incorporated in finished petroleum products supplement their natural characteristics and improve their performance in existing applications or broaden the area of their suitability. Most modern additives can be classified under the following three categories (Larson,1957):

1- Those designed to protect the finished petroleum product in one way or other from chemical change or deterioration.

2- Those which protect the machine either from harmful substances formed in the fuel or lubricant or from failure of the fuel or lubricant to function properly.

3- Those which improve certain physical properties of the product.

The correct types and properties of lubricants are controlled by the intended applications of lubricants, manufactured to meet many service requirements. These properties can be summarized as minimum coefficient of friction, maximum adhesion to the surfaces to be lubricated, maximum film strength, physical stability with regard to temperature and pressure, chemical stability against oxidation and thermal deposition, freedom from corrosive acids and rusting resistance to emulsion and foaming non-volatility, proper fluidity at low temperature, minimum consistence and purity control of abrasives, fillers soap and addition agents. A large number of chemical compounds are available which will impart some new property to a lubricant or improve existing properties. These compounds must be compatible with other chemical additives as well as with the base lubricants used in the formulations.

Quality Assessment

It is necessary to discuss general characteristics common to most lubricating oils and the methods used to determine these characteristics. New uses and formulation technology for lubricating oils necessitate a constant review of the methods for assessing the quality of both new and used lubricating oils. The traditional physical and chemical tests are still applied but these are being supplemented and in some cases replaced by instrumental techniques based on physico-chemical methods which include infrared, ultraviolet, emission spectroscopy and x-rays absorption and fluorescence methods.

Physico-chemical Tests. Physical tests are comparatively simple laboratory procedures which define the nature of the product by measuring physical properties. Examples are viscosity, flash point, specific gravity, colour and appearance.

Chemical tests define the composition of the lubricating oils by determining the presence of elements such as sulphur, chlorine, phosphorus and methods which are, often, related significantly to the additive contents of the lubricant.

The above mentioned tests are extremely valuable tools for attempting to predict how a specific lubricant formula will perform in full size machinery under many different operating conditions.

Control of product quality at the blending plant is usually based on a supplier's own internal standards. The number of tests applied varies with the complexity of the product and the nature of the applications. The more important tests (viscosity, flash point, sulphated ash, colour etc.) usually are performed on every batch.

The viscosity of a lubricating oil is a measure of its flow characteristics. To meet a particular application, viscosity is generally the most important controlling property for quality measure because the main objective of lubrication is to provide a film between load bearing surface. The selection of the correct viscosity for the oil is aimed at a balance between a viscosity high enough to minimize energy losses through excessive heat generation caused by having too viscous a lubricant. The viscosity of a new oil is of fundamental importance with respect to performance in a specific type of equipment or machine part and always described or specified by the buyer, the seller or both.

Flash point test gives an indication of the presence of volatile components in an oil and it is the temperature to which the oil must be heated under specified test conditions to give off sufficient vapour to form a mixture with air which will ignite in the presence of an open flame.

Sulphated ash test covers the determination of the sulphated ash from unused lubricating oils containing

Table 1. Pakistan Standard Institute specifications for lubricating oils for internal combustion engines.

S.No.	Characteristics of Product	Method Followed by PSI	PSI SPECIFICATIONS S.A.E.GRADE						Multigrade		
			10w	20w	20	30	40	50	10w/30	20w/40	20w/50
1	Flash Point °C (Min)	ASTM D-92	177	201	201	201	201	201	177	201	201
2	Kinematic Viscosity at 100 °C cst(Min)	ASTM D-445	4.1	5.6	5.6	9.3	12.5	16.3	9.3	12.5	16.3
	(Max)		-	-	9.3	12.5	16.3	21.9	12.5	16.3	21 9
3	Pour Point °C (Max)	ASTM D-97	-21	-21	-6	-6	-6	-6	-9	-9	-9
4	Viscosity Index (Min)	ASTM D-2270	90	90	85	85	85	85	120	120	120
5	Copper Strip Corrosion 3Hrs at 100 °C(Max)	ASTM D-130	1	1	1	1	1	1	1	1	1

additives and from additives concentrates used in compounding. These additives usually contain one or more metals like barium, calcium, magnesium, zinc, potassium, sodium and tin etc. The elements sulphur, phosphorus and chlorine may also be present in the combined form. The sulphated ash may be used to indicate the concentration of known metals containing additives in new oils.

In Pakistan, the specifications for internal combustion engine lubricating oil were published in 1963 (PS:343-1963) which covered three classes of internal combustion engine lubricating oils, viz. regular, premium and heavy duty only. The committee responsible for the preparation of this standard reviewed it and decided that the specifications should deal with ten types of engine lubricating oil in two groups and nine viscosity grades suitable for the crankcase lubrication reciprocating internal combustion engine of both spark ignition and the normally aspirated compression ignition types. The revised Pakistan Standard was adopted by the Pakistan Standard Institution in 1981(Table 1).

The present work concerns with the quality assessment of various commercial brands of lubricating oils samples received from blending plants affiliated with oil marketing companies and district administration from different districts of Punjab province, Pakistan during the period 1990-1993.

EXPERIMENTAL

Distilled water and Analytical Reagent Grade Chemicals were used. Calibrated Pyrex glassware and instruments i.e., Viscometer Baths VHC-220 (Gallenkamp, England), Flash Point Tester, Semi-Automatic, Cleveland-DIN-51376 (Lauda, Germany) and Muffle Furnace FSE-621 (Gallenkamp, England) were used throughout this work. Kinematic viscosity, Viscosity index, Flash point, Sulphated ash have been determined by the standard test methods i.e., ASTM D-445, ASTM D-2270, ASTM D-92 and ASTM D-874 respectively.

RESULTS AND DISCUSSION

Physical Characteristics like kinematic viscosity, viscosity index, flash point , sulphated ash , colour and appearance etc. of commercial brands of lubricating oils available in the markets of various districts of the Punjab province, Pakistan were tested for a period of four years. Methods used to determine these characteristics were recommended by the American Society for Testing and Materials (Hall, 1982). The significance of this study was to encompass within one phase an overall view of the lubricating oil quality statistics available in the market and the importance of lubricating oil, when they are used to improve the properties with respect to quality because

Table 2. Standard specifications for lubricating oils of different Oil Marketing Companies in Pakistan.

Lubricating Oils	Physical Characteristics	Flash Point °C (Min)	Kinematic Viscosity at 100°C cSt (Min)	(Max)	Viscosity Index	Sulphated Ash % wt	Copper Strip Corrosion 3hrs at 100°C(Max)	Zinc contents %mm
	Test Methods(ASTM/IP)	D-92	D-445		D-2270	D-874	D-130	IP-117
PAKISTAN STATE OIL LTD								
Castrol GTX 20w/50		220	17.00	19.00	115	0.65	1	-
Casrol RX Super		220	16.00	19.50	115	0.90	1	-
Dieselube 40		220	14.50	15.80	85	0.39	1	-
Motor Oil 30/40		220	12.50	14.00	85	0.39	1	-
Castrol CRD-40		240	9.50	12.00	90	0.90	1	-
Dieseluba D-3(40)		230	13.50	16.00	90	0.90	1	-
Castrol CR -40		215	13.00	16.00	85	0.39	1	-
Castrol CR-50		215	17.00	21.00	85	0.38	1	-
Two stroke Oil		115	10.00	-	85	-	-	-
Gear Oil EP-140		-	25.00	35.00	75	0.048	-	-
Turbo Engine 15w/40		230	15.98	17.00	118	1.20	1	-
SHELL PAKISTAN LTD								
Challenger		200	16.3	21.8	105	-	1	0.102
Mustang 40		200	12.5	16.2	85	-	1	0.090
Grade SD-40		200	12.5	16.2	85	-	1	0.038
Super 30/40		200	12.5	16.2	85	-	1	0.038
Executive 30/40		200	12.5	16.3	85	-	1	0.038
SDE - 40		200	12.5	16.2	85	-	1	0.038
Shell Rotella TX-40		201	12.5	16.5	90	-	1	0.100
CALTEX OIL PAKISTAN LTD								
Five Star SAE-30/40		205	12.50	16.20	90	0.75	1	-
Delo-100 Oil SAE-40		204	12.50	16.20	85	0.57	1	-
Tractor Engine Oil SAE-40		204	12.50	16.20	85	Reported	-	-
T-2 Plus Two Stroke Engine Oil		107	8.50	10.00	80	-	-	-
RPM Delo 300 Oil SAE-40		204	12.50	16.20	100	0.85	1	-
Seven Star 30/40		204	12.50	16.20	85	0.48	1	-
Double Horse Diesel Engine- 40		204	12.50	16.20	80	0.48	1	-
M-2 Two Stroke Engine Oil		110	9.00	11.50	85	-	-	-
G-3 EP Gear Oil-140		205	26.00	32.00	85	-	-	-

Table 3. Analytical and adulteration testing of commercial lubricating oil samples

	YEARS*							
	1990		1991		1992		1993	
	OMC	DA	OMC	DA	OMC	DA	OMC	DA
NO. OF SAMPLES	1	11	35	30	131	347	309	140
STANDARDS	1	0	35	4	131	112	309	3
SUB STANDARD	0	11	0	26	0	235	0	137
% OF STD. SAMPLES	100	Zero	100	13.3	100	32.2	100	2.18

Table 4. Experimental data of physical parameters of adulterated lubricating oils

Physical Parameter	ASTM Method Followed	Calculated Values		
		Minimum	Maximum	Average
Kinematic viscosity at 100 °C cSt(Min)	D-445	7.28	36.42	9.45
Kinematic viscosity at 40°C cSt (Min)	D-445	6.69	386.99	197.25
Viscosity Index	D-2270	66	194	104
Flash Point	D-92	90	186	149

a good quality of lube oil is protected against deterioration by incorporation of high viscosity index lube base oil and additives having antioxidation, antisludge and detergent characteristics. Latest standard specifications for lubricating oils of various local oil marketing companies are given in Table 2. Results of 1004 samples analyzed were compared with their labelled specifications. Data show that only 119 out of 528 i.e., 22 % samples collected by the District Administration proved to be true as per their labelled specifications. However, all the 476 (100 %)samples provided directly by various blending plants of the oil marketing companies located in different areas of Punjab province showed conformity to their specifications (Table 3). Data on sub-standard samples as shown in Table 4 indicate that the calculated average values of the physical parameters do not conform to any of the standard lubricating oil grade.

CONCLUSIONS

It can be seen that the capability for producing quality products exists in the country as is clear from the data based on analysis of the samples provided directly by the manufacturers i.e., oil marketing companies. On the basis of above mentioned facts, it is suggested that strict measures on the availability and use of better quality long drain motor oils in the market would improve the fuel efficiency of the transport sector by 5 to 7 percent. It would also save the national economy and protect the environment from corrosive hazardous gases.

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