I.3.1 Paraffinic base oils

Paraffinic base oils are containing saturated, straight chain hydrocarbon. Paraffins of high molecular weight raise the pour point of oils and should be removed by dewaxing. [9]

The general properties of these oils are summarized as follows:

- Relatively small variation of viscosity with temperature or have high viscosity index (VI).
- Low volatility for given viscosity and correspondingly high flash point
- Delayed oxidation (with an induction period) forming firstly volatile acids which are more or less corrosive (affecting metals bearings) and then soluble viscous compounds.

Most of the base oils produced in the world is paraffinics and they are available in the full range of viscosities, from light spindle oils to viscous bright stock. [10]

I.3.2 Naphthenic base oils

Naphthenics are made from saturated hydrocarbons made up of methylene group ($-CH_2-$) arranged in ring formation. Important characteristics of naphthenic base oil are their naturally low pour point, because they are wax-free and excellent solvency powers. low viscosity index and poor oxidation stability. [11,12]

I.3.3 Aromatic base oils

Hydrocarbons of this type have closed carbon rings of semi-unsaturated character. Side chains can be attached to any carbon atom, ring structure is more easily attached than either paraffin or naphthene groups, which in service, lead to formation of resinous, asphaltic and

corrosive by-product. Their density is quite and viscosity index low, solvent power high, their importance in the composition of finished oils is very limited.

Some authors mentioned that the existence of optimum aromatic content at which the oil will have its maximum natural oxidation resistance.[13]

The alkyl-aromatics are more easily oxidized than paraffins or naphthenes, probably due to the reactivity of hydrogen atoms situated near to the aromatic nucleus. This splitting of the molecule leads, on the one hand, to products similar to those contained by oxidation of paraffins, and on the other hand, to aromatic oxidation products, which are generally, oil insoluble. The oxidation of motor oils, made up of many different type of hydrocarbon, is therefore a complex phenomenon. [14]

The names paraffinic, naphthenic and aromatic, which are generally used for characterizing base oils should not be taken as absolute, but as an expression to the predominating chemical tendencies of the base stocks.

The choice of one or more base stocks is determined as follows: [15]

(a) As a function of the viscosity of the finished oils to meet all viscosity requirements.

(b) The chemical nature of the base oils used in the blend is detected by the particular application, via diesel or gas engine, two stoke petrol engine, oxidation test etc.

I.4 Lubricating Oils Classification

Lubricating oil is the lifeblood of the engine and the main duty is still to separate and cool all moving parts of the engine in order that they operate with minimum frictional resistance.[9]

At every point where surfaces are in contact, and in relative motion, heat and wear are produced by friction. The problem of lubrication is hat reducing the heat and wear, and therefore the lubricant is used to modify this effect by separating the two surfaces depending chiefly upon the property of lubricants of bring able to wet and adhere to the surface with oil molecules.[9]

The ability of additives to reduce friction depends not only on the chemical structure of additives but also on the structure and strength of additive assemblies on and near the surface of interest. [10,11]

In the crankcase, friction modifiers are used to improve fuel economy performance.[12,16] In this application, friction modifiers need to reduce friction under variety of speed, load and temperature conditions.

I.4.1 Industrial lubricants

General aspects of industrial oils

Industrial lubricants comprise a wide variety of products which, depending on their application, different widely in their chemical and physical properties. With respect to the properties, one can say that industrial lubricants involve all classes of lubricant applied in practice. They include gases (mostly air), various kind of liquid products (mineral oils, animal and vegetable oils, synthetic oils, water based fluids, etc.).[17]

Furthermore, industrial lubricants make use of many additives which comprise practically all the known additive classes used in other

types of lubricants and, additionally, numerous additives that have been developed specifically for industrial lubricants, particularly for water based fluids. Thus, the importance of additives in the formulation of industrial lubricants is difficult to overestimate.

The ISO (International Organisation for Standerdisation) viscosity classification system, as listed in Table (1), is widely used for industrial oils.

Viscosity classification relates to viscosity at 40 °C it consists of a series of 18 viscosity brackets between 1.98 cSt and 1650 cSt, each of which is defined by a number. The numbers indicate, to the nearest whole number, the midpoints of their corresponding brackets.

This system is now used to classify all industrial lubricating oils where viscosity is an important criterion in the selection of the oil, and the viscosity needs to be clearly identified in the brand.

Gear oils

Most gears need oils with some degree or extreme pressure protection to prevent wear, pitting, scoring and tooth breakage. Protection against oxidation, thermal degradation, rust copper corrosion, water emulsification and foaming must also be provided. Viscosities must be tailored to application conditions. Mono and multigrade oils are used, each viscosity grade has distinct criteria for low and high-temperature performance. Accordingly, gear lubricants must meet a number of special requirements to meet their specific needs.

Generally, vehicle manufacturers are filled gear lubricants for life at the factory. Therefore, oils must have excellent thermal stability, carefully tailored frictional characteristics, smooth synchronization and good shift quality.