**7- Technical Properties of Petroleum Oil**

**7.1- Odor**

Oils that contain significant concentrations of unsaturated, certain types of nitrogenous compounds, and/or sulfur-bearing moieties such as mercaptans tend to possess a spread H2S-like odor. In contrast, oils mainly composed of light hydrocarbons, containing high proportions of aromatics, or composed of a mix of paraffins and naphthenes possess a sweet gasoline-like odor.

**7.2- Cloud point**

The cloud point is the lowest temperature at which wax crystals begin to form by a gradual cooling under standard conditions. As temperature decreases below the cloud point, formation of wax crystals is accelerated. Therefore, low cloud point products are desirable under low-temperature conditions.

**7.3- Pour point**

The pour point of a petroleum fraction is the lowest temperature at which the oil will pour or flow when it is cooled without stirring under standard cooling conditions. Pour point is one of low temperature characteristics of heavy fractions. When temperature is less than pour point of a petroleum product it cannot be stored or transferred through a pipeline. Presence of wax and heavy compounds increase the pour point of petroleum fractions. Can be estimating the pour point of petroleum fractions from viscosity, molecular weight, and specific gravity in the following form:

Where

Tp : pour point temperature in kelvin.

SG : specific gravity at standard temperature .

M : molecular weigh.

): kinematic viscosity at 38°C (100°F) in cSt.

**7.4- Flash Point (TF)**

Flash point of petroleum fractions is the lowest temperature at which vapors arising from the oil will ignite, i.e. flash, when exposed to a spark or flame under specified conditions. Therefore, the flash point of a fuel indicates the maximum temperature that it can be stored without serious fire hazard.

Another simple relation for estimation of flash point of hydrocarbon mixtures from vapor pressure was proposed by Walsh and Mortimer

Where P vap is the vapor pressure at 37.8 °C (100°F) in bar and TF flash point in kelvin

**7.5- Fire point**

Fire point of petroleum fractions is the lowest temperature at which vapors arising from the oil will ignite, i.e. fire, when exposed to a spark or flame under specified conditions. Therefore, the fire point of a fuel indicates the maximum temperature that it must not arrival to it to prevent the combustion of the petroleum fractions.

**7.6- Aniline Point (AP)**

Aniline point of a petroleum fraction is defined as the minimum temperature at which equal volumes of aniline and the oil are completely miscible. The higher aniline point with the lower aromatic content and lower aniline point the higher paraffin content. Aniline is an aromatic compound with a structure of a benzene molecule where one atom of hydrogen is replaced by the -NH2 group (C6H5-NH2).

The aromatic content in petroleum fraction may be calculated from aniline point by the following formula:

Where: %A is the percent aromatic content, SG is the specific gravity, and AP is the aniline point in °C.

**7.8- Carbon Residue**

The carbon residue is a property that can be correlated with several other properties of petroleum. It is the nonvolatile compounds leave a carbonaceous residue by destructive distillation under such conditions.

Two test procedures, the Conradson method (ASTM D-129) and the Ramsbottom method (detailed in ASTM D-524), afford estimates of the amounts of residual carbonaceous matter (or "coke") formed by destructive distillation of oils that are substantially nonvolatile at atmospheric pressure.

**7.9- Reid vapor pressure (RVP)**

Reid vapor pressure is the absolute pressure exerted by a mixture at 37.8°C (311 K or 100°F) at a vapor-to-liquid volume ratio of 4. The RVP is one of the important properties of gasoline and jet fuels and it is used as a criterion for blending of products. RVP is also a useful parameter for estimation of losses from storage tanks during filling or draining. An example of the relation for RVP calculation in terms of temperatures at 5, 10, 30, and 50 vol% distilled along ASTM D 86 is given below:

**7.10- Smoke point (SP)**

The smoke point (SP) is a maximum flame length at which a fuel can be burned in a standard wick-fed lamp without smoking. It is expressed in millimeters and a high smoke point indicates a fuel with low smoke-producing tendency for fuels of high hydrocarbon paraffins and low aromatic, and vice versa. Smoke point is a characteristic of aviation turbine fuels and kerosenes and indicates the tendency of a fuel to burn with a smoky flame. The SP of kerosenes may be estimated from the following relation:

Where AP is the aniline point in °C and SG is the specific gravity at 15.5°C.

Measurement of smoke point is described under ASTM D t322**.**

**7.11- Cetane Number and Diesel Index**

For diesel engines, the fuel must have a characteristic that favors auto-ignition. The ignition delay period can be evaluated by the fuel characterization factor called cetane number (CN). The behavior of a diesel fuel is measured by comparing its performance with two pure hydrocarbons: n-cetane or n-hexadecane (n-C16H34) which is given the number 100 and α-methylnaphthalene which is given the cetane number of 0 .A diesel fuel has a cetane number of 60 if it behaves like a binary mixture of 60 vol% cetane and 40 vol% α – methylnaphthalene . In practice heptamethylnonane (HMN) a branched isomer of n-cetane with cetane number of 15 is used instead of a-methylnaphthalene. Therefore, in practice the cetane number is defined as

Higher cetane number fuels reduce combustion noise and permit improved control of combustion resulting in increased engine efficiency and power output. Higher cetane number fuels tend to result in easier starting and faster warm-up in cold weather.

* For high speed city buses in which kerosene is used as fuel the required CN is 50.
* For premium diesel fuel for use in high speed buses and light marine engines the required number is 47
* For marine distillate diesel for low speed buses and heavy marine engines the required cetane number is 38.

Since determination of cetane number is difficult and costly, ASTM D 976 proposed a method of calculation Calculated number is called calculated cetane index (CCI) and can be determined from the following relation:

Another characteristic of diesel fuels is called diesel index (DI) defined as:

Where: AP is the aniline point in °C.

Cetane index is empirically correlated to DI and AP in the following form:

Where AP is in °C; calculated cetane index (CI) is also related to n-paraffin content (%NP) of diesel fuels in the following from

Cetane number of diesel fuels can be improved by adding additives such as 2-ethyl-hexyl nitrate or other types of alkyl nitrates. Cetane number is usually improved by 3-5 points once 300-1000 ppm by weight of such additives is added.

**7.12- Auto ignition Point:**

This is the minimum temperature at which hydrocarbon vapor when mixed with air can spontaneously ignite without the presence of any external source. Values of auto ignition temperature are generally higher than flash point, Values of auto ignition temperature for gasoline it is about 351°C (660°F) and for alcohol is about 500°C (930 °F). With an increase in pressure the auto ignition temperature decreases.

7.13- **Octane number:**

Octane number is an important characteristic of spark engine fuels such as gasoline and jet fuel or fractions that are used to produce these fuels (i.e., naphthas) and it represents antiknock characteristic of a fuel. Isooctane (2, 2, 4- trimethylpentane) has octane number of 100 and n-heptane has octane number of 0 on both scales of **RON** (and **MON**.

There are two types of octane number: research octane number (**RON**) is measured under city conditions while motor octane number (**MON**) is measured under road conditions. The arithmetic average value of RON and MON is known as posted octane number (**PON**). RON is generally greater than MON by 6-12 points, although at low octane numbers MON might be greater than RON by a few points. The difference between RON and MON is known as ***sensitivity*** of fuel. RON of fuels is determined.

Generally there are three kinds of gasoline: regular, intermediate, and premium with PON of 87, 90, and 93, respectively. Required RON of gasoline vary with parameters such as: 1- air temperature, 2- altitude, 3- humidity, 4-engine speed, 5- and coolant temperature.

Improving the octane number of fuel would result in reducing power loss of the engine, improving fuel economy, and a reduction in environmental pollutants and engine damage. For these reasons, octane number is one of the important properties related to the quality of gasoline. There are a number of additives that can improve octane number of gasoline or jet fuels. These additives are tetra-ethyl lead (**TEL**), alcohols, and ethers such as ethanol, methyl-tertiary-butyl ether (**MTBE**), ethyl-tertiary-butyl ether (**ETBE**), or tertiary-amyl methyl ether (**TAME**). Use of lead in fuels is prohibited in nearly all industrialized countries due to its hazardous nature in the environment, but is still being used in many third world and underdeveloped countries. For a fuel with octane number

(ON) of 100, increase in the ON depends on the concentration of TEL added. The following correlations are developed based on the data provided by Speight:

Where ON is Octane number and TEL is milliliter TEL added to one US gallon of fuel.

**7.14- Boiling point:**

The boiling point of a pure compound at a given pressure is the temperature at which vapor and liquid exist together at equilibrium. If the pressure is 1 atm, the boiling point is called the normal boiling point. At this temperature the vapor pressure will equal to atm pressure.

**7.15-Vapor Pressure (Pvap):**

In a closed container, the vapor pressure of a pure compound is the force exerted per unit area of walls by the vaporized portion of the liquid. Vapor pressure can also be defined as a pressure at which vapor and liquid phases of a pure substance are in equilibrium with each other. Vapor pressure increases with temperature. The vapor pressure is also called saturation pressure, psat.