



Republic of Iraq
Ministry of Higher Education
and Scientific Research
Al-Mustaqbal University College
Chemical Engineering and Petroleum Industries
Department

Subject: Fuel Technology
2nd Class

Lecture 6

Important Characterization Properties:

Numerous important feed and product characterization properties in refinery engineering include:

1. Density, Specific Gravity, and API Gravity

Density is defined as mass per unit volume of a fluid. Density is a state function and for a pure compound depends on both temperature and pressure and is shown by ρ . Liquid densities decrease as temperature increases.

Liquid density for hydrocarbons is usually reported in terms of specific gravity (SG) or relative density defined as:

$$SG = \frac{\text{density of liquid at temperature T}}{\text{density of water at temperature T}}$$

The American Petroleum Institute (API) defined the API gravity (degrees API) to quantify the quality of petroleum products and crude oils. The API gravity is defined as:

$$^{\circ}API = \left(\frac{141.5}{\text{specific gravity}} \right) - 131.5$$

A higher API gravity indicates a lighter crude or oil product, whereas a low API gravity implies a heavy crude or product.

Crude Category	Gravity
Light crudes	API > 38
Medium crudes	38 > API > 29
Heavy crudes	29 > API > 8.5
Very heavy crudes	API < 8.5

2. Viscosity

The viscosity of oil is a measure of its resistance to internal flow and an indication of its oiliness in the lubrication of surfaces. There are two types of viscosity: dynamic and kinematics viscosity.

Kinematic viscosity (ν) = dynamic viscosity (μ) / density (ρ)

The unit of dynamic viscosity is poise (0.1 Pa·s). It is more commonly expressed, particularly in ASTM standards, as centipoises (cP). While the kinematics viscosity as centiStokes ($1\text{cSt} = 10^{-6} \text{m}^2 \cdot \text{s}^{-1}$).

2. Pour Point

The pour point of a liquid is the temperature below which the liquid loses its flow characteristics. It is defined as the lowest temperature at which the sample will flow and is a rough indicator of the relative paraffinicity and aromaticity of the crude. A lower pour point means that the paraffin content is low and greater content of aromatics.

3. Flash, Fire and Auto Ignition Point

Flash and fire point are important parameter for safety considerations, especially during storage and transportation of volatile petroleum products (i.e., LPG, light naphtha, gasoline) in a high-temperature environment.

Flash Point (TF): The temperature at which the vapors produced from a fluid will ignite with the presence of an ignition source. Generally flash point increases with an increase in boiling point.

Fire point: The lowest temperature at which the fire will keep burning if ignited by an outside ignition source. Fire point is the temperature well above the flash point where the product could catch fire.

Auto Ignition is the minimum temperature at which a fluid will spontaneously ignite without an external ignition source, such as a flame or spark.

5. Sulfur Content, wt% sulphur is present in the crude oil. crude oils with high sulphur content are termed as sour crude. On the other hand, crude oils with low sulphur content are termed as sweet crude. Crudes with sulphur content lower than 0.5 wt % are termed as sweet crudes. Usually crude oil that has a sulfur content that is greater than 0.5% is considered sour.

6. Octane Number

Octane number expresses the anti-knocking characteristics of petrol. It is also called the antiknock rate of fuel. It is measured for gasoline. Normal heptane (a constituent of petrol) when burnt in a petrol engine knocks it very badly i.e. the anti-knocking value of n-heptane is very poor and it is assigned an octane number equal

to zero. On the other hand, iso-octane (also a constituent of petrol has got a very good anti-knock characteristics, hence it is assigned an octane number of 100.

Definition of octane number. Octane number of petrol is the percentage by volume of iso-octane in a mixture of iso-octane and normal heptane with the same knocking tendency as the petrol in question.

If the octane number of a petrol is 80, then it means that this petrol gives as much knocking as a mixture of 80% iso-octane and 20% normal heptane.

7. Cetane Number

Cetane number is a measurement of the ignition properties of a fuel. It is measured for diesel. Cetane ($C_{16}H_{34}$) has a very short ignition delay hence its cetane number is taken as 100 whereas alpha methyl naphthalene ($C_{11}H_{10}$) has a very large ignition delay hence its cetane number is taken as 0.

The cetane number of a diesel is defined as the percentage of cetane (by volume) in a mixture of cetane and alpha methyl naphthalene which has the same ignition delay as the diesel under test.