



**Ministry of Higher Education and Scientific
Research Al-Mustaqbal University College**

**Department of Chemical Engineering and
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Properties of crude oil

2nd Stage

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Petroleum Analysis (Assay)

1. Preliminary assay-inspection data (bulk assay).
2. Full assay (fractional assay).

Crude assay: a procedure for determining the general distillation characteristics and other quality information of crude oil.

The *preliminary assay (Bulk)* provides general data on the oil and is based on simple tests such as distillation range, water content, specific gravity, and sulfur content.

The tests in the preliminary assay are relatively simple and can be completed in a short time.

This assay gives a useful general picture of the quality of a crude, but it does not cover the work necessary to provide adequate data for the design of refinery equipment.

A *full assay (Fractional)* involves the preparation of a true boiling point curve and the analysis of fractions and product blends of the full range of the crude oil.

The following is an explanation of **both bulk and fractional properties**:

Bulk properties include specific gravity, sulfur content, nitrogen content, metal content (Ni, V, Fe etc.) content, asphaltene content, C/H ratio, pour point, flash point, freeze point, smoke point, aniline point, cloud point, viscosity, carbon residue, acid number and refractive index ..

1. API gravity

To specify how light or heavy a crude is.

2. Sulfur content

Sweet (< 0.5 wt.%) or sour (> 0.5 wt.%)?

3. Viscosity and Pour point

Viscosity and pour point determination are performed principally to find out how easy or difficult to pump the crude oil especially in cold weather.

Viscosity is a measure of a fluid's resistance to flow. It describes the internal friction of a moving fluid

A fluid with large viscosity resists motion because its molecular makeup gives it a lot of internal friction. A fluid with low viscosity flows easily because its molecular makeup results in very little friction when it is in motion.

Viscosity is usually determined at different temperatures (e.g. 25 °C /77 °F and 100 °C /212 °F) by measuring the time for a volume of liquid to flow under gravity through a calibrated glass capillary viscometer.

Pour point is the lowest temperature at which a crude oil will flow or pour when it is chilled without disturbance.

The lower the pour point of a crude oil the more the naphthenic and aromatic it is, and the higher the pour point the more paraffinic it is.

4. Flash point

It is the lowest temperature at which sufficient vapor is produced above the liquid to form a mixture with air that a natural ignition can occur if a spark is present.

The *flash point* of a liquid hydrocarbon or an oil fraction indicates its fire and explosion potential.

Liquids with a flash point less than 60.5 °C or 37.8 °C depending on standard been applied are considered flammable, while liquids with a flash point above those temperatures are considered combustible.

5. Freeze and Melting point:

The *freeze point* is the temperature at which the hydrocarbon liquid solidifies at atmospheric pressure.

It's an important property for kerosene and jet fuels, because of the very low temperatures encountered at high altitudes in jet planes.

Similarly the *melting point*, is the temperature that a solid substance liquefies at atmospheric pressure.

A pure substance has the same freezing and melting points.

However, for petroleum mixtures, there are ranges of melting and freezing points versus percent of the mixture melted or frozen.

Melting point increases with molecular weight.

For a mixture, the initial melting point is close to the melting point of the lightest compound in the mixture

In contrast, the initial freezing point is close to the freezing point of the heaviest compound in the mixture.

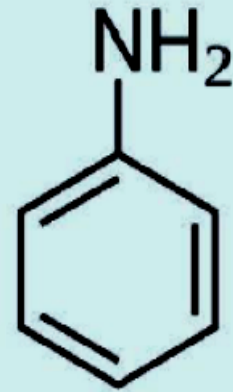
6. Smoke point:

The *smoke point* refers to the height of a smokeless flame of fuel in millimeters beyond which smoking takes places. It reflects the burning quality of kerosene and jet fuels,

7. Aniline point:

Aniline, phenylamine or aminobenzene is organic compound with formula $C_6H_5NH_2$. Consisting of a phenyl group attached to an amino group. Aniline is the prototypical aromatic amine.

Equal volumes of aniline and desired oil are stirred continuously in a test tube and heated until the two components merge into a homogeneous solution.



Heating is stopped and the tube is allowed to cool. The temperature at which the two phases separate out is recorded as aniline point.

Thus, *aniline point* represents the minimum temperature for complete miscibility of equal volumes of aniline and petroleum oil.

It's an important property of diesel fuels and used to estimate the aromatic content of mixtures.

Since, a lower content of aromatics in oil requires a higher temperature for aniline to be miscible, the greater the aniline point, the lower the aromatics in the oil.

For example: Diesel with aniline point 50 °C have higher aromatic percentage than the one with 60 °C , the first one get quicker miscible than the second because (Like dissolve Like).

Aromatics exhibit the lowest aniline points and Paraffins the highest aniline points. Cycloparaffins and olefins exhibit values between these two extremes.

8. *Cloud point:*

The *cloud point* refers to the temperature at which solidable components (waxes) present in the oil sample begin to crystallize or separate from solution.

It's an important specification of middle distillate fuels.

In the petroleum industry, cloud point refers to the temperature which diesel forms a cloudy appearance.

The presence of solidified waxes thickens the oil and clogs fuel filters and injectors in engines.

The wax also accumulates on cold surfaces (e.g. pipeline) and forms an emulsion with water.

Therefore, cloud point indicates the tendency of the oil to plug filters at cold operating temperatures.

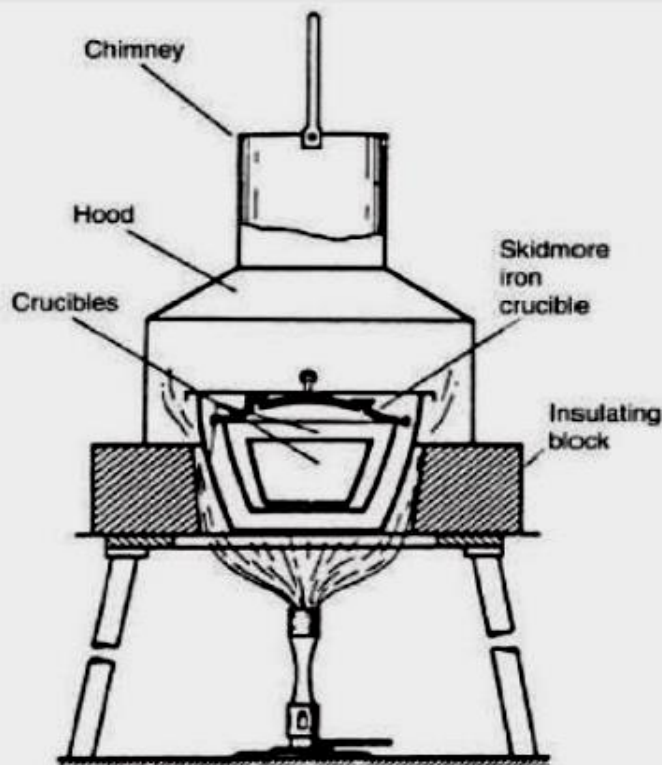
9. Conradson Carbon Residue (CCR):

It determines the amount of carbon residue left after evaporation or pyrolysis of an oil and to indicate relative coke-forming tendencies.

CCR is expressed as the weight percentage of the original sample.

A crude oil with a high CCR has a low value as a refinery feedstock.

Apparatus of Conradson Carbon Residue (CCR)



10. Acid number:

The *acid number* determines the organic acidity of a refinery stream.

11. Refractive index:

The *refractive index* represents the ratio of the velocity of light in a vacuum to that in the oil. It is useful properties for concentration measurement, purity determination and chemical identification.

12. Gross heat of combustion or High heating value (HHV):

The *gross heat of combustion or high heating value (HHV)* is the amount of heat produced by the complete combustion of a unit quantity of fuel.

13. *Water and Sediment*

Determining the amount of water or sediment in petroleum is important, because they lead to difficulties in the refinery.

Example of some difficulties: corrosion of equipment, uneven running on the distillation unit, blockages in heat exchangers, and adverse effects on product quality.

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.

The boiling point, is one of the most important characterization parameters for hydrocarbons and is frequently used in property estimation methods.

The *initial boiling point (IBP)* is defined as the temperature at which the first drop of liquid leaves the condenser tube of the distillation apparatus.

The final boiling point or the *end point (EP)* is the highest temperature recorded in the test.

Bulk properties provide a quick understanding of the type of the oil sample such as sweet and sour, light and heavy, etc.

However, refineries require ***fractional properties*** of the oil sample that reflects the property and composition for specific boiling point range to properly refine it into different end products such as gasoline, diesel and raw materials for chemical process.

Fractional properties usually contains paraffins, naphthenes and aromatics contents, sulfur content, nitrogen content for each boiling-point range, octane number for gasoline, freezing point, cetane index, boiling point curve and smoke point for kerosene and diesel fuels.

It also involves in the analysis of fractions and product blends of the full range of crude oil.

In other word, Fractional properties is the bulk properties but with much more details.