— University of Mosul —
College of Petroleum & Mining Engineering

Petroleum and Gas Chemistry
Lecture 4

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LECTURE CONTENTS

- Classification of Petroleum (Classification as a hydrocarbon resource, Classification by density and API gravity)
- Physical and Chemical Properties of Crude Oil and Oil Products (Density, Specific Gravity, API Gravity, Viscosity, Vapor pressure, specific heat; and heat of combustion)

Classification of Petroleum:

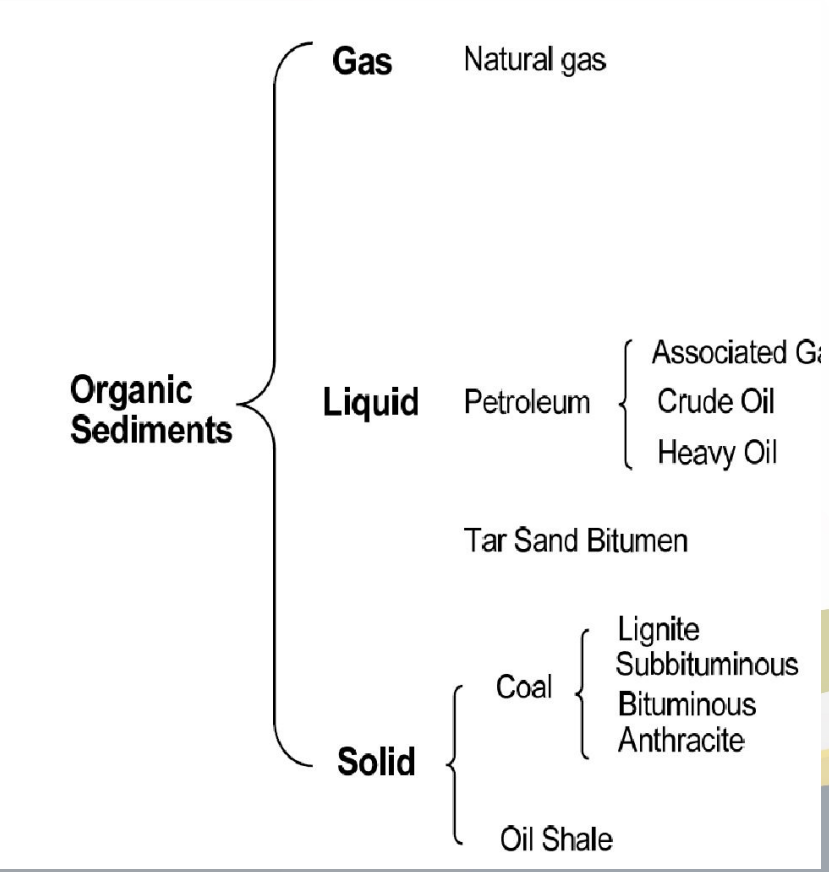
1. Classification as a hydrocarbon resource

Petroleum is referred to generically as a fossil energy resource and is further classified as a hydrocarbon resource. For illustrative (or comparative) purposes in this text, coal and oil shale kerogen have also been included in this classification. However, the inclusion of coal and oil shale under the broad classification of hydrocarbon resources has required (incorrectly) that the term hydrocarbon be expanded to include the macro molecular non-hydrocarbon hetero atomic species that constitute coal and oil shale kerogen. The use of the term organic sediments would be more correct. The inclusion of coal and oil shale kerogen in the category hydrocarbon resources is because these two natural resources (coal and oil shale kerogen) will produce hydrocarbons in high-temperature processing. Therefore, if coal and oil shale kerogen are to be included in the term hydrocarbon resources, it is more appropriate that they be classed as hydrocarbon-producing resources under the general classification of organic sediments.

Thus, fossil energy resources are divided into two classes:

(1) Naturally occurring hydrocarbons (petroleum, natural gas, and natural waxes).

(2) Hydrocarbon sources (oil, shale, and coal) may be used to generate hydrocarbons by applying conversion processes.



The hydrocarbon constituents, separated from petroleum and natural gas, are the hydrocarbon constituents that exist in the reservoir. Naturally occurring hydrocarbons are major contributors to petroleum and natural gas composition. Coal and kerogen do not enjoy this means of separation, and thermal decomposition methods must be applied before producing hydrocarbons. These hydrocarbon products, generated by the thermal process, are not naturally occurring hydrocarbons.

Classification by density and API gravity:

Conventional crude oil and heavy oil have also been defined very generally in terms of physical properties. For example, heavy oils were considered those petroleum-type materials that had gravity somewhat less than 20° API, with the heavy oils falling into the API gravity range of 10 °to 15 ° (e.g., Cold Lake crude oil = 12° API) and bitumen falling into the 5°to 10°API range (e.g., Athabasca bitumen = 88 API). Residua vary depending on the temperature at which distillation is terminated. Atmospheric residuals are usually in the 10° to 15°API range, and vacuum residua are in the range of 2° to 8° API.

Fraction 250°C-300°C (480°F-570°F) *API Gravity*	*Type*	250°C-300°C (480°F-570°F) *API Gravity*	*Type*	*Classification*
>40.0	Parrafin	>30.0	Paraffin	Paraffin
>40.0	Parrafin	20.1-29.9	Intermediate	Paraffin-intermedite
33.1-39.9	Intermediate	>30.0	Paraffin	Intermediate-paraffin
33.1-39.9	Intermediate	20.1-29.9	Intermediate	Intermediate
33.1-39.9	Intermediate	<20.0	Naphthene	Intermediate-naphthene
<33.0	Naphthene	20.1-29.9	Intermediate	Naphthene-intermediate
<33.0	Naphthene	<20.0	Naphthene	Naphthene
>40.0	Parrafin	<20.0	Naphthene	Paraffin-naphthene
33.0	Naphthene	>30.0	Paraffin	Naphthene-paraffin

Physical and Chemical Properties of Crude Oil and Oil Products

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 but the effect of pressure on liquid densities at moderate pressures is usually negligible.

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

$$SG = \frac{Density\ of\ liqued\ at\ temparature\ T}{Density\ of\ water\ at\ temparature\ T}$$

Since the standard conditions adopted by the petroleum industry are 60° F (15.5° C) and 1 atm, specific gravities of liquid hydrocarbons are normally reported at these conditions. Water density at 60° F is 0.999 or almost 1 g/cm3, thus:

$$SG\ (60^{\circ}F/\ 60^{\circ}F)\ = \frac{Density\ of\ liqued\ at\ 60^{\circ}F\ in\ g/cm^3}{0.999 g/cm^3}$$

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:

$$API\ gravity = \frac{141.5}{SG(at\ 60^{\circ}F)} - 131.5$$

Crude Oils API = 10 - 50, crude oils can generally be classified according to API as shown in the table below:

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

The definition of specific gravity for gases is somewhat different. The specific gravity of a gas is proportional to the ratio of molecular weight of gas (Mg) to the molecular weight of air (28.97)

$$SG_g = \frac{M_g}{28.97}$$