Tikrit University

The College of Petroleum Processes Engineering

Petroleum and Gas Refining Engineering Department

An Introduction to Petroleum Technology

First Class

Lecture (16)

By

Assistant lecturer

Luay Ahmed Khamees

Composition and Classification of Crude Oils

Crude oil is a complex liquid mixture made up of a vast number of hydrocarbon compounds that consist mainly of carbon and hydrogen in differing proportions. In addition, small amounts of organic compounds containing sulfur, oxygen, nitrogen and metals such as vanadium, nickel, iron and copper are also present (See Table below).

Crude oil consists of a group of chemical elements, namely:

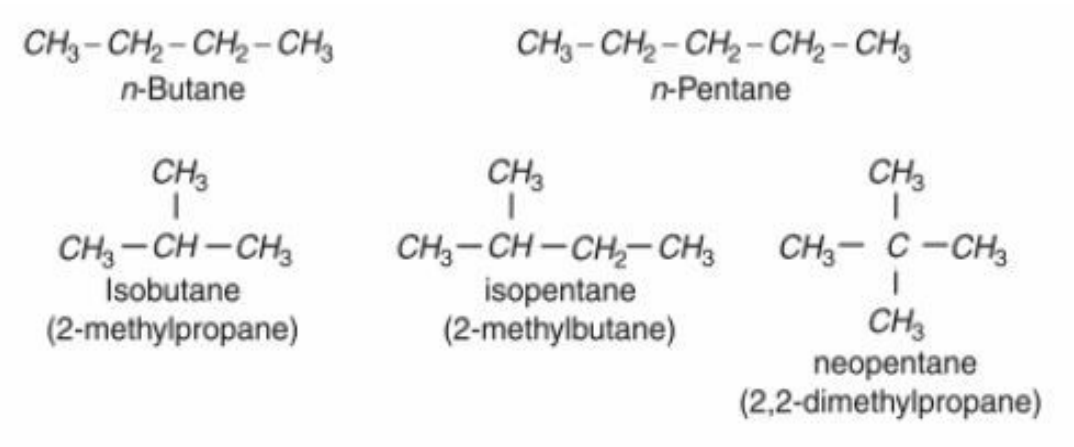
Element	Composition (wt%)
Carbon	83.0–87.0
Hydrogen	10.0–14.0
Sulphur	0.05–6.0
Nitrogen	0.1–0.2
Oxygen	0.05–2.0
Ni	<120 ppm
V	<1200 ppm

The chemical compounds that make up crude oil are:

Hydrocarbon compounds are formed by combining carbon with hydrogen, and the number of carbon atoms in them can range from one to tens. The hydrocarbons found in crude oil are classified into four main types:

1- Paraffins: It makes up 15-60%.
2- Naphthenes: It makes up 30-60%.
3- Aromatics : It makes up 3 - 30%.
4- Asphaltics : It makes up the remainder.

1-Paraffins (also known as alkanes) : General formula: CnH2n+2 (n is a whole number, usually from 1 to 20), straight or branchedchain molecules, can be gasses or liquids at room temperature depending upon the molecule. For example, methane, ethane, propane, butane, isobutane, pentane, hexane.



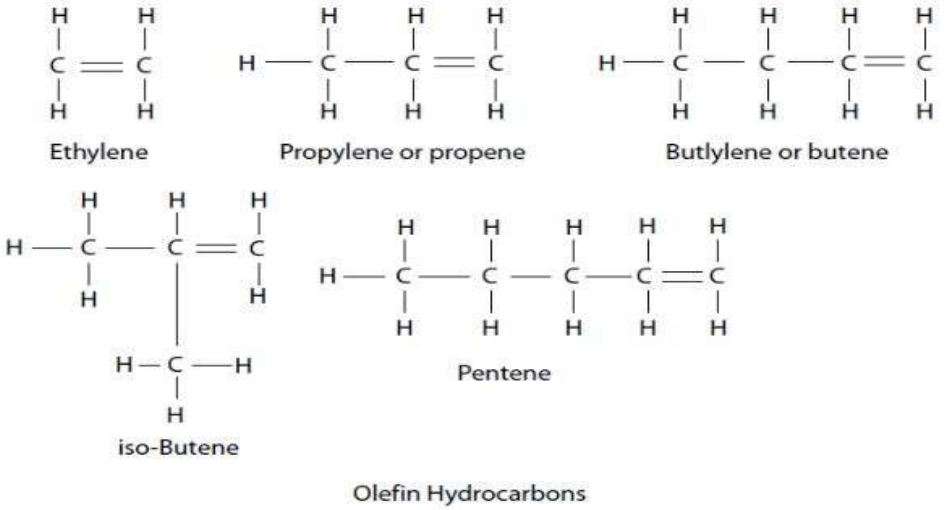
Names of the first ten alkanes

جدول بالألكانات العشرة الأولى

CH_4	CH_4	ميثان	1
C_2H_6	CH_3CH_3	إيثان	2
C_3H_8	$CH_3CH_2CH_3$	بروبان	3
C_4H_{10}	$CH_3CH_2CH_2CH_3$	بيوتان	4
C_5H_{12}	$CH_3CH_2CH_2CH_2CH_3$	بنتان	5
C_6H_{14}	$CH_3CH_2CH_2CH_2CH_2CH_3$	هكسان	6
C_7H_{16}	$CH_3CH_2CH_2CH_2CH_2CH_2CH_3$	هبتان	7
C_8H_{18}	$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_3$	أوكتان	8
C_9H_{20}	$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_3$	نونان	9
$C_{10}H_{22}$	$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_3$	ديكان	10

2- Olefins (also known as alkenes)

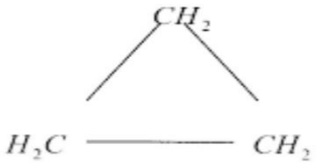
General formula: CnH2n (n is a whole number, usually from 1 to 20), linear or branched chain molecules containing one carboncarbon double-bond, can be liquid or gas. For example: ethylene, butene, isobutene.



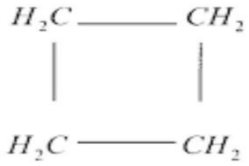
The main difference between olefins and paraffins Olefins mainly contain one or more double bonds between carbon atoms, whereas paraffin does not contain any double or triple bond between carbon atoms.

3- Naphthenes (cycloalkanes)

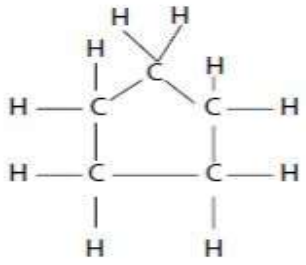
General formula: CnH2n (n is a whole number usually from 1to 20), ringed structures with one or more rings, rings contain only single bonds between the carbon atoms, typically liquids at room temperature. For example: cyclohexane, methyl cyclopentane .

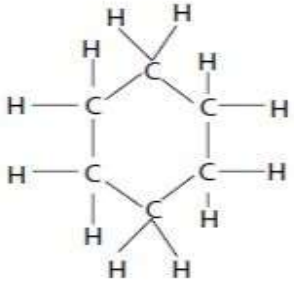


بروبان حلقي



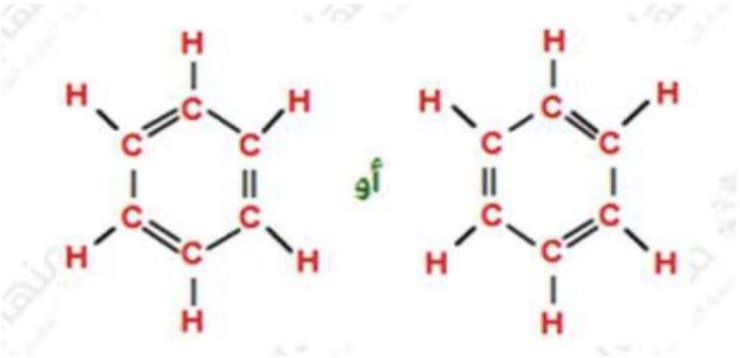
بوتان حلقي


Cyclo-pentane

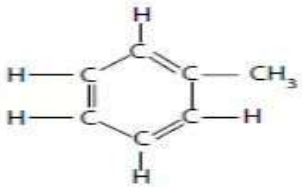

Cyclo-hexane

4-Aromatics

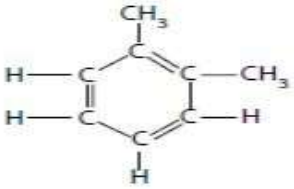
General formula: CnH2n - 6, ringed structures with one or more rings, rings contain six carbon atoms, with alternating double and single bonds between the carbons, typically liquids. For examples benzene, naphthalene.



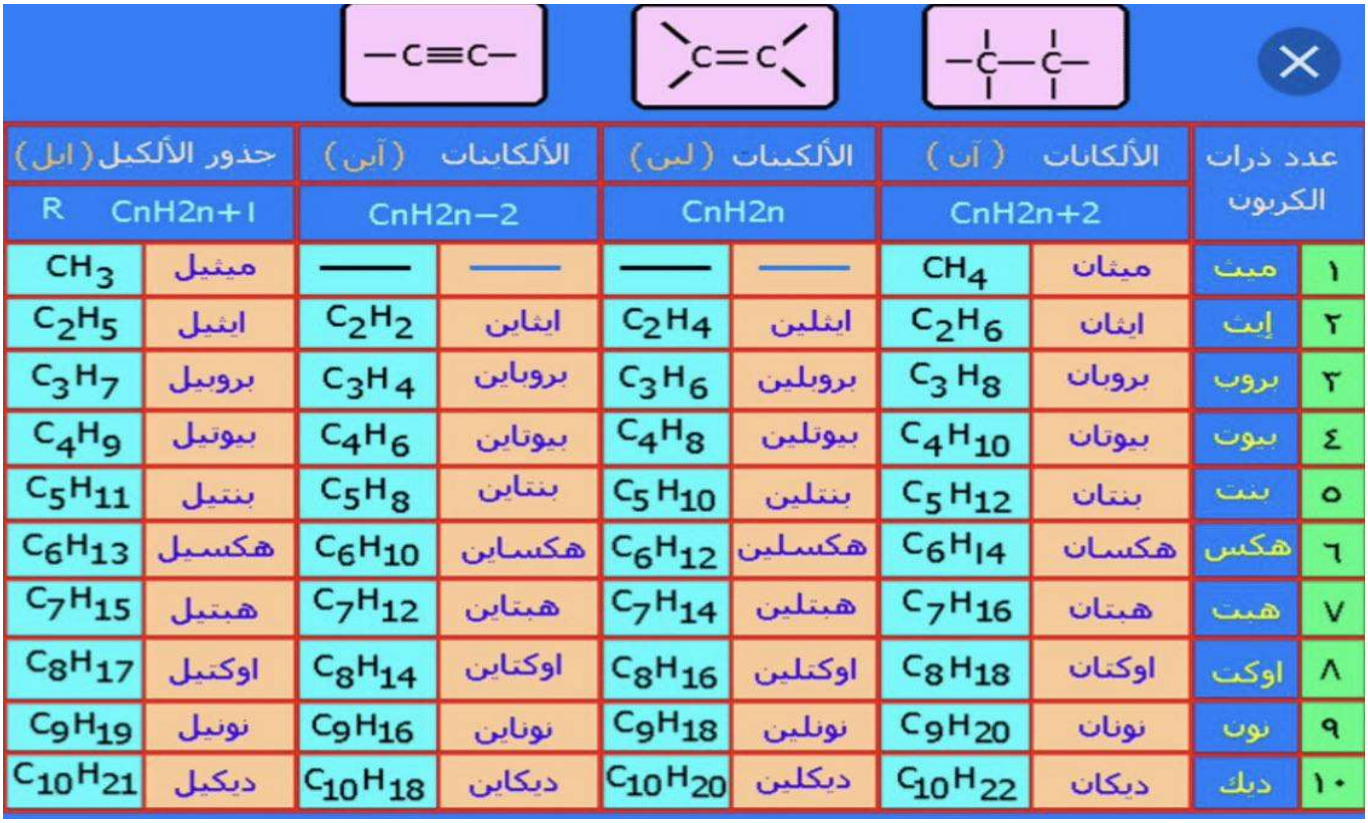
Benzene



Toluene



O-xylene



عدد ذرات الكربون		الألكانات (آن)		الألكينات (لين)		الألكاينات (آين)		جذور الألكيل (ايل)	
		C_nH_{2n+2}		C_nH_{2n}		C_nH_{2n-2}		C_nH_{2n+1}	R
١	ميث	CH_4	ميثان	—	—	—	—	CH_3	ميثيل
٢	إيث	C_2H_6	ايثان	C_2H_4	ايثلين	C_2H_2	ايثاين	C_2H_5	ايثيل
٣	بروب	C_3H_8	بروبان	C_3H_6	بروبلين	C_3H_4	بروباين	C_3H_7	بروبيل
٤	بيوت	C_4H_{10}	بيوتان	C_4H_8	بيوتلين	C_4H_6	بيوتاين	C_4H_9	بيوتيل
٥	بنت	C_5H_{12}	بنتان	C_5H_{10}	بنتلين	C_5H_8	بنتاين	C_5H_{11}	بنتيل
٦	هكس	C_6H_{14}	هكسان	C_6H_{12}	هكسلين	C_6H_{10}	هكساين	C_6H_{13}	هكسيل
٧	هبت	C_7H_{16}	هبتان	C_7H_{14}	هبتلين	C_7H_{12}	هبتاين	C_7H_{15}	هبتيل
٨	اوكت	C_8H_{18}	اوكتان	C_8H_{16}	اوكتلين	C_8H_{14}	اوكتاين	C_8H_{17}	اوكتيل
٩	نون	C_9H_{20}	نونان	C_9H_{18}	نونلين	C_9H_{16}	نوناين	C_9H_{19}	نونيل
١٠	ديك	$C_{10}H_{22}$	ديكان	$C_{10}H_{20}$	ديكلين	$C_{10}H_{18}$	ديكاين	$C_{10}H_{21}$	ديكيل

Classification of crude oil according to its chemical composition:

The hydrocarbon composition is the basis for the chemical classification of crude oil, and this is determined after conducting a simple distillation process of a sample of it at different temperatures. The crude oil has been classified into three groups:

1- Paraffinic oil of origin: This type of oil consists of paraffinic hydrocarbons, and it is free or almost free of asphalt materials, and this type of oil gives good amounts of paraffinic waxes.

2- Naphthalic oil of origin: This type of oil consists of naphthetes and a high percentage of asphalt materials, and contains small amounts of paraffin wax or almost devoid of them. special chemical.
3- Mixed oil: This type of oil consists of a mixture of paraffins and naphthenes and a small percentage of aromatic compounds, and it contains varying amounts of paraffin wax and asphalt materials.

It is worth noting that there is an overlap between these types of oil, and that the largest proportion of crude oil in the world is of a mixed type.

Crude oil is classified according to sulfur content into:

Sour and sweet with respect to the sulfur content in it. If the sulfur percentage is higher than 0.5% is Sour.

If the sulfur content is less than 0.5%, it is sweet.

Crude oil properties :

1- Relative density and specific gravity.
2- Vescosity (internal friction of the fluid)
3- Pour point :is used to find out the concentration of paraffin or aromatic substances in the crude oil, and the higher this degree, the greater the proportion of paraffins.

The pour point 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.

4- Residual carbon: The percentage of carbon in crude oil is one of the most important criteria by which the quality of the oil is judged. Oiling it, and the less carbon is left, the better the value of the oil. This test is called the Conradson test.

5- Salt containt : the percentage of salt content in the crude oil is measured, and it is expressed in the amount of sodium chloride, if it is more than 0.01 Ib/bbl: this affects the price of crude oil, as the presence of salts in the oil leads to the formation of deposits in the pipelines carrying it and a decrease in pressure, It also affects the work of the pumps and causes equipment corrosion, and this requires the removal of those salts before subjecting the crude to refining operations

   If the salt is not removed, severe corrosion problems may be encountered.

6- Flash point :is the minimum temperature at which vapours arising from the oil will ignite, i.e. flash, when exposed to a flame under specified conditions.

   The flash point indicates the maximum temperature that the fuel can be stored without serious fire hazard.

7- Water content.

   The presence of highly saline reservoir water with crude oil causes corrosion of pipes, insulators, tanks and any vessel or tube through which the crude oil passes.

   From an economic point of view, the water present with the oil adds an operational burden to the installations, pipes, pumps, and tanks, as a result of transporting and storing useless water. Crude

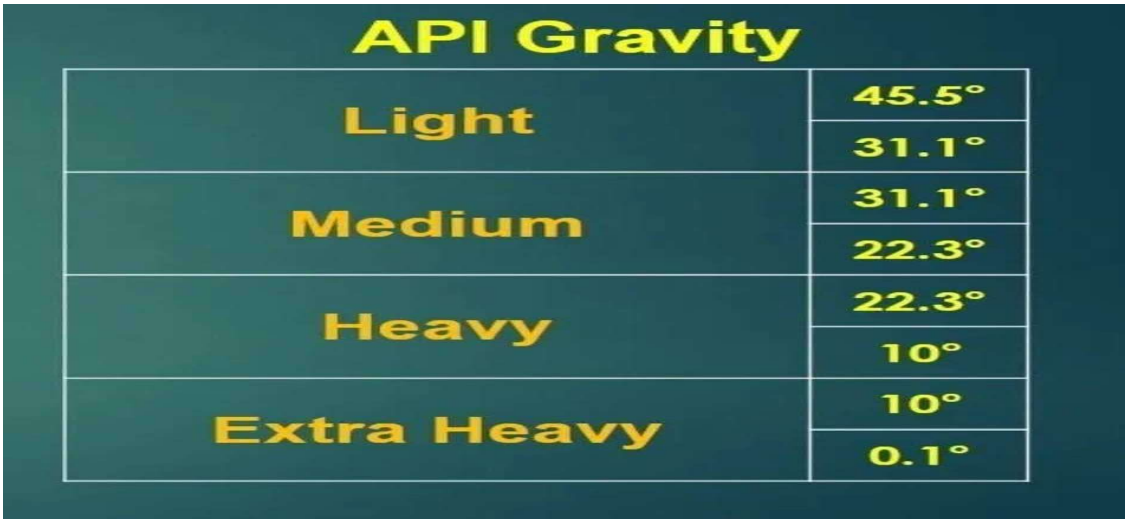
oil must be prepared after treatment so that it contains only (0.5%) of water.

8- Ash content.
   It is the percentage of inorganic residues in crude oil. Most of which are metallic elements, as their presence in crude oil causes problems in steam boilers and industrial furnaces (corrosion and increased sedimentation in their pipes).

9- Boiling point:It is the temperature at which a substance changes from a liquid to a vapor.
   Boiling point: is the degree to which the vapor pressure of a substance is equal to the atmospheric pressure. Thus, the boiling point depends on the pressure. Boiling points that are measured are often published at standard pressure (101325 pascals or 1 atm). At higher altitudes, where the atmospheric pressure is lower, the boiling points also decrease. The boiling points increase with increasing pressure.

Crude oil is classified according to its density into light oil, heavy oil and medium oil.

This density is determined using a special scale devised by the American Petroleum Institute. The oil will be light if its API is greater than 31.1It is heavy if the API is less than 22. And medium if the API is between 22 and 32.



The API is calculated from the following equation:

$$API=\frac{\mathbf{141.5}}{\boldsymbol{Sp.Gr.@60\ °F}} - 131.5$$

Where :

API = American Petroleum Institute.

Sp.Gr : Specific Gravity at 15°C (60 °F)

Specific Gravity is the ratio of the density of oil to the density of distilled water under standard conditions 15°C (60 °F).

$$Sp.Gr = \frac{\boldsymbol{\rho o}}{\boldsymbol{\rho w}}$$

Where :

ρo: density of oil , ρw: density of distilled water

$\rho o = \frac{\boldsymbol{M}}{\boldsymbol{V}}$, M: mass, grams or kilograms. V: volume , cm^3 or m^3 .

ρw= 1 g/cm3 or 1000 kg/m3.