Institute of Natural Resources
Department of Fuel Engineering and Chemical Cybernetics

Crude oil: composition, classification, properties, origin

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• Plan

- Petroleum - Crude oil
- Composition of Crude oil
- Classification of Crude oil
- Properties of Crude oil

Petroleum - Crude oil

Crude oil (also called Petroleum) – is a naturally occurring brown to black flammable liquid consisting of a complex mixture of hydrocarbons.

Origination is not established!

The most popular version of oil origin:

crude oils derived from marine animal and plant debris subjected to high temperatures and pressures.

Petroleum - Crude oil

Figure 1. Colour of crude oils

Petroleum - Crude oil

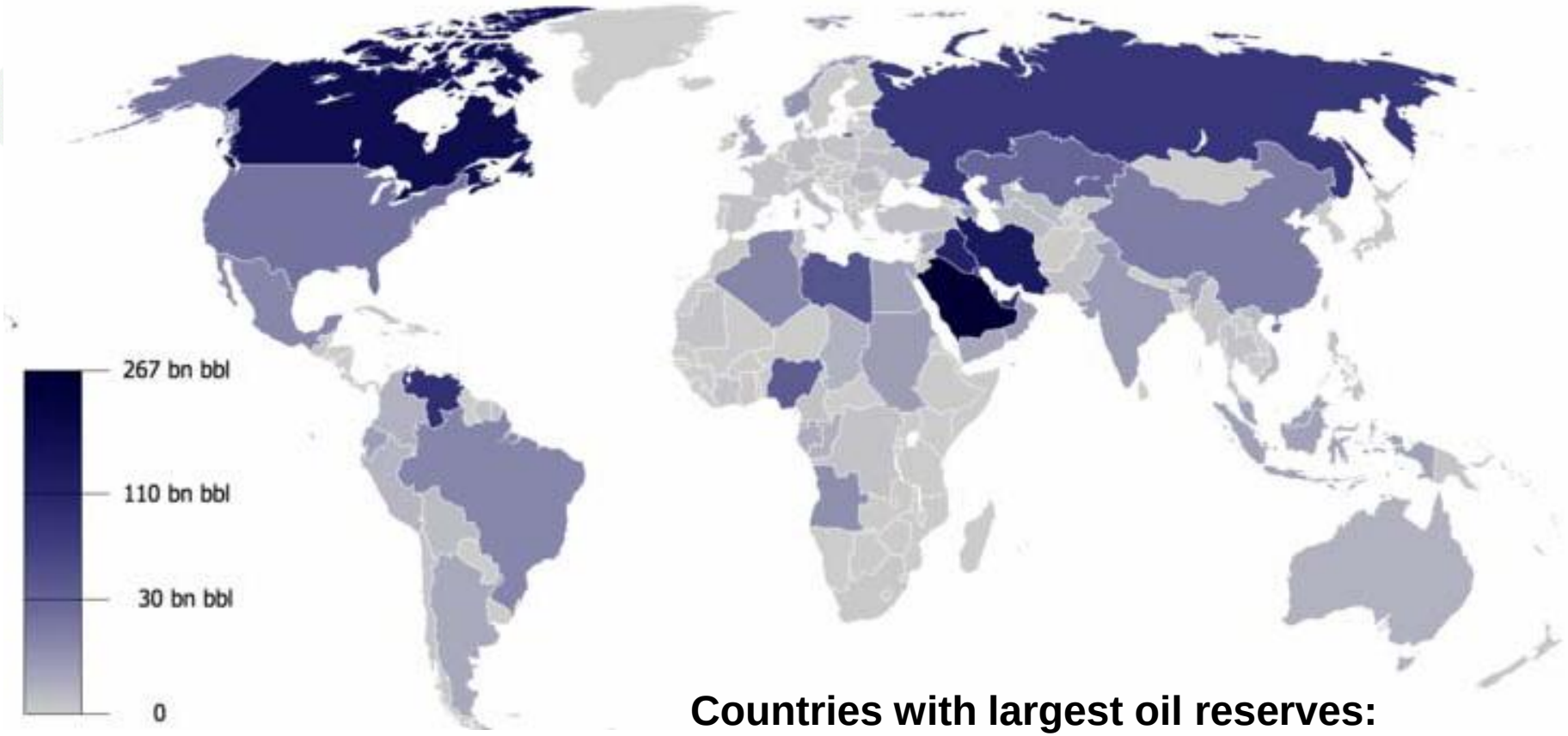


Figure 2. Proven Oil Reserves

Countries with largest oil reserves:
Venezuela, Saudi Arabia, Canada, Iran, Iraq, Kuwait, United Arab Emirates, Russia, Kazakhstan, Libya, Nigeria, Qatar, China, United States, Angola, Algeria, Brazil

Petroleum - Crude oil

Crude oils are not used directly as fuels or as feedstocks for the production of chemicals.

Fractions of crude oils can be used as:

- ✓ fuels,
- ✓ lubricants,
- ✓ feedstock to the petrochemical industries.

World consumes about 88 million barrels of oil each day!

Composition of Crude oil

- ✓ **elementary** (contents of particular elements),
- ✓ **chemical** (contents hydrocarbon groups),
- ✓ **fractional** (contents of fractions different with respect to boiling temperature).

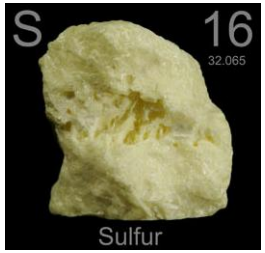
Basic elements in Crude oil

All crude oils are mainly constituted of **hydrocarbons** mixed with variable amounts of **sulfur**, **nitrogen**, and **oxygen** compounds.

Composition by weight:

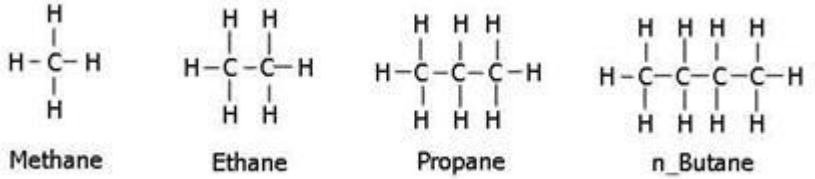
Element	Percent range
Carbon	83 to 87%
Hydrogen	10 to 14%
Nitrogen	0.1 to 2%
Oxygen	0.05 to 1.5%
Sulfur	0.05 to 6.0%
Metals	< 0.1%

Other elements present in crude oil, like:
vanadium, iron, manganese, cobalt, phosphor and microelements are in concentration of order of 10^{-3}–10^{-5} %.



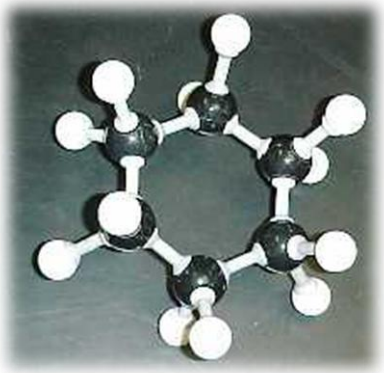
Types of Crude oil Hydrocarbons

Paraffins



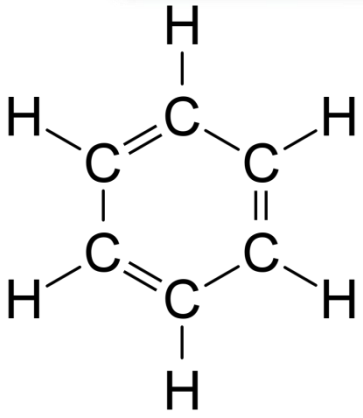
saturated hydrocarbons (C_nH_{2n+2}) present in all fractions of oil (methane CH_4, ethane C_2H_6, propane, C_3H_8)

Naphthenes



cyclic saturated hydrocarbons (C_nH_{2n}) present in heavy crude oils (cyclopropane C_3H_6, cyclopentane C_5H_{10})

Aromatics

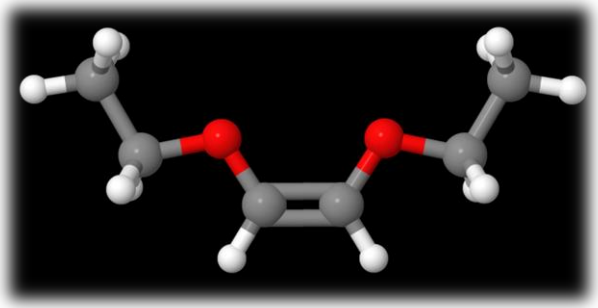


ring compounds containing one or more sixmembered rings (C_6H_6 – benzene)

Types of Crude oil Hydrocarbons

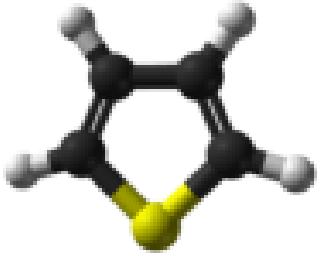
Olefins

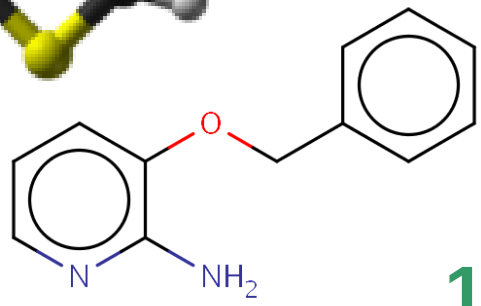
unsaturated hydrocarbons (C_nH_{2n}) – they do not exist normally in crude oil, but are produced during oil processing in refinery (ethylene C_2H_4, propylene C_3H_6)



Heterogenic compounds of:

- ✓ sulfur (hydrogen sulfide, mercaptans, tiophenes),
- ✓ nitrogen (piridine, amines)
- ✓ oxygen (acids, esters, phenoles)
- ✓ alcohols, ketones.

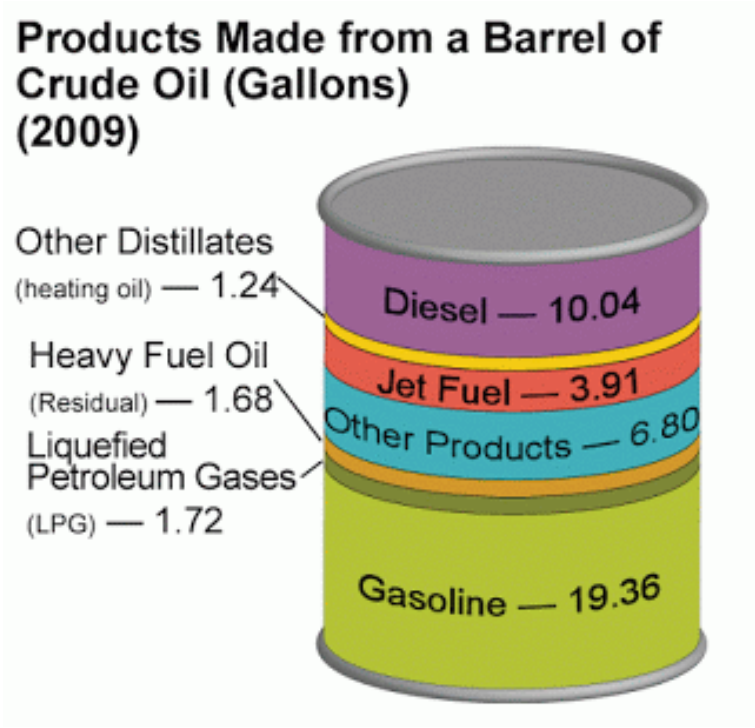




Fractions of Crude oil

- ✓ **refinery gas**: 62 – 80 C,
- ✓ **gasoline**: 80 – 180 C,
- ✓ **kerosene**: 180 – 240 C,
- ✓ **diesel**: 240 – 350 C,
- ✓ **vacuum gasoil**: 350 – 500 C,
- ✓ **tar**: above 500 C.

} **residue**



Fractions of Crude oil

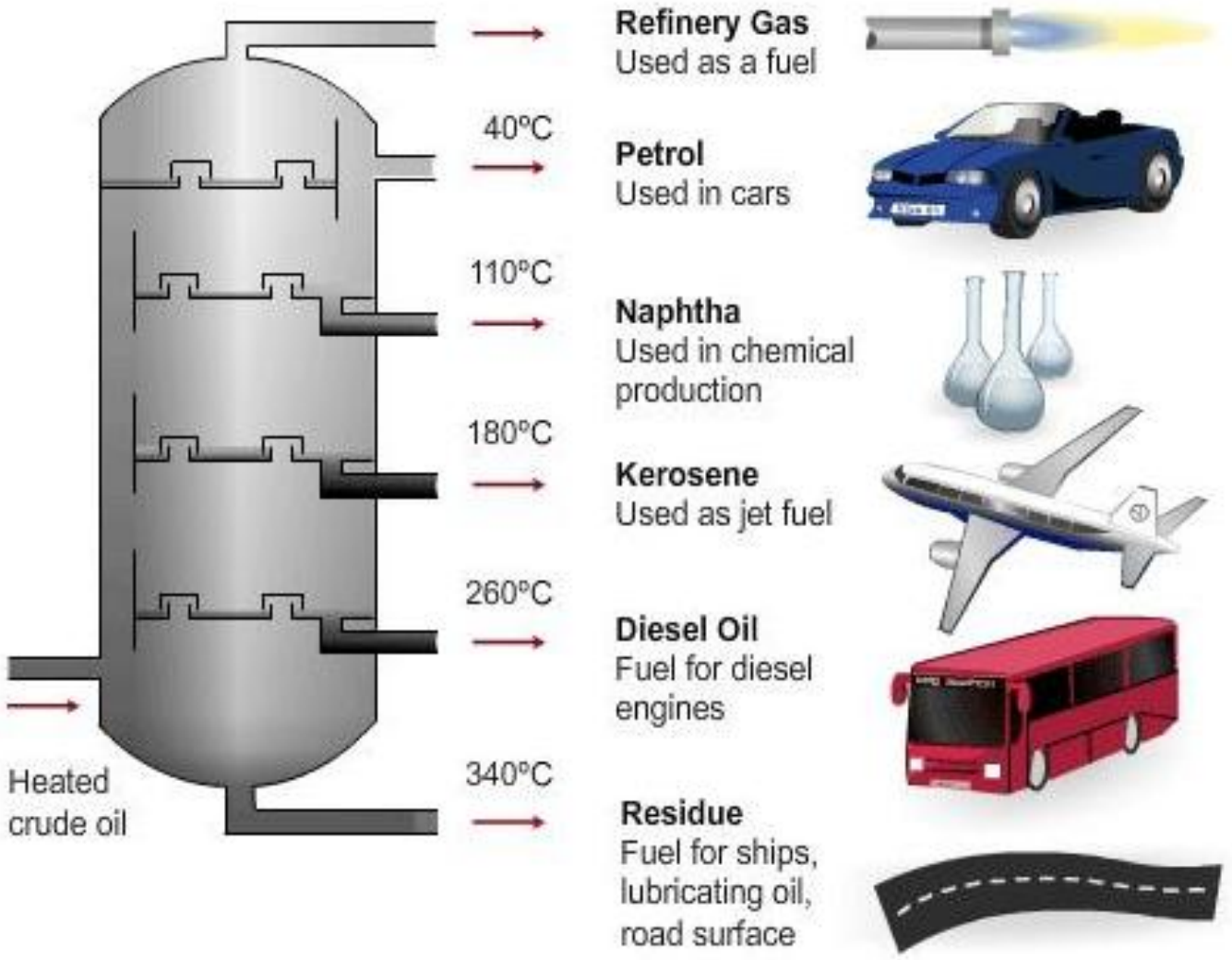


Figure 3. Fractions of Crude oil

Classification of Crude oil

There is no single method of oil classification!

The primary simple systems of oil classification used the easily to measure parameters:

- ✓ density,
- ✓ sulfur content,
- ✓ content of resins and asphalts groups,
- ✓ content of paraffines.

Classification of Crude oil

Classification of Crude oil regarding sulfur content:

- **low-sulfur oil**: S < 0.5%
- **sulfur oil**: S = 0.5 – 2%
- **high-sulfur oil**: S > 2%

Classification of Crude oil

Classification of Crude oil regarding density:

- **light oil**: $\rho < 0.87$ kg/m$_3$
- **medium oil**: $\rho = 0.87 – 0.91$ kg/m$_3$
- **heavy oil**: $\rho > 0.91$ kg/m$_3$

Classification of Crude oil

Classification of Crude oil regarding paraffines:

- **low-paraffin oil**: paraffin< 5%
- **paraffine oil**: paraffin 5-10%
- **high-paraffin oil**: paraffin >10%

Classification of Crude oil

Type of oil	Composition
Paraffine	Paraffins > 75%
Naphthene	Naphthene > 70%
Aromatic	Aromatics > 50%
Asphalt	Resins and asphaltes > 60%
Paraffine-naphthene	Paraffines = 60-70%, naphthenes > 20%
Paraffine-naphthene-aromatic	Paraffins, naphthenes and aromatics approx. equal content
Naphthene-aromatic	Naphthenes or aromatics > 35%
Naphthene-aromatic-asphalt	Naphthenes, aromatics or asphalts > 25%
Aromatic-asphalt	Aromatics or resins > 35%

Properties of Crude oil

- Density
- Molecular weight
- Viscosity
- Pour point
- Gas content (gas oil factor GOR)