

Tikrit University

The College of Petroleum Processes Engineering

Petroleum Systems Control Engineering

Department

Properties of Petroleum & Natural Gas

Third Class

Lecture 2

By

Jasim I. Humadi

Composition of petroleum

The compounds in crude petroleum oil are essentially hydrocarbons or substituted hydrocarbons in which the major elements are carbon at 85% -90% and hydrogen at 10% - 14%, and the rest with non-hydrocarbon elements—sulfur (0.2% - 3%), nitrogen (< 0.1-2%), oxygen (1% - 1.5%), and organo-metallic compounds of nickel, vanadium, arsenic, lead, and other metals in traces (in parts per million or parts per billion concentration). Sulphur compounds found in petroleum are hydrogen sulphide, thiophenes, mercaptans. Oxygen occurs in combined form in alcohols, phenols, resins and organic acids present in petroleum. Nitrogen compound include pyridines, etc . Inorganic compounds present in petroleum are salt, clay and sand etc. Inorganic salts of magnesium chloride, sodium chlorides, and other mineral salts are also accompanied with crude oil from the well either because of water from formation or water and chemicals injected during drilling and production.

Typical properties of crude oil

Specific gravity = 0.80 - 0.95, viscosity at 37.8°C = 2.3 - 23 cst
carbon/hydrogen ratio = 6 - 8, pour point = 18 - 30°C ,
wax content = 6 -12%, flash point = 15 - 27°C
water content = 0.1 - 1.5%, Salt content = 1.5 - 8%,
Ash content = 0.004 - 0.006%.

Production of Petroleum

- ✚ Petroleum almost always occurs along with gas called natural gas. After drilling in the crust of earth both natural gas and oil flow up through pipe under pressure initially. When the oil pressure decreases, then the residual oil is either sucked by a pump or pressure is created by injecting compressed gas or high pressure water through a pipe bored by the side of oil delivery pipe so that it can flow out.
- ✚ When the oil well contains both oil and gas it is called (**wet well**) and if it contains only gas then it is called a (**dry well**).
- ✚ A sketch of typical oil pool formation inside the crust of earth is given in Fig.1. Hard cap rock and hard rock at the bottom, both are impermeable to oil and gas. Geological studies indicate that petroleum was not formed in the pools where it is found today.

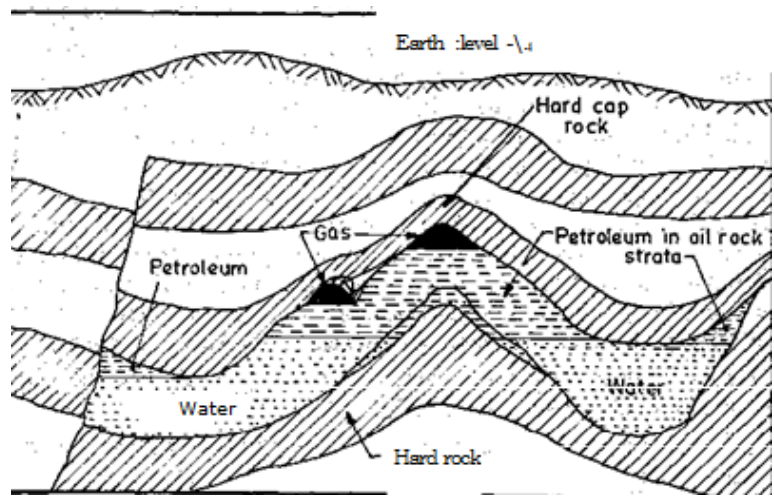


Figure (1): Typical oil-pool formations. In the centre, pool water has forced the petroleum and gas up into a dome, or anticline, in the porous oil rock layer. Hard cap rock prevents the escape of the oil. A fault, at the left, or a stratigraphic.

Pre-Treatment of Oil at Oil Field before Refining

Oil and gas when they come out of oil field are separated. The natural gas is compressed to liquefy it which is used for heating of domestic and industrial ovens. Petroleum oil is made free of:

- + Water
- + Sediments and
- + Salts present in it.

It is then made free of some dissolved gases into it by the process called 'stabilisation'. It is then sent to oil refinery _ for separation into various petroleum products by distillation mainly and auxiliary operations.

Crude oil as it comes out of well may contain up to (25%) water, salts ($MgCl_2$, $-CaCl_2$, $NaCl$ etc.) up to 2000-5000 (mg/litre) and sediments up to (1-1.5%). For refining crude oil, the salt content in it should be < 50 mg/litre and Water $< 03\%$. Excessive water in crude requires extra heat for its distillation, increases its cost of transportation, forms emulsion which absorb materials like resin (hence emulsion breakers are to be used).

Salt in crude oil causes:

- + scaling
- + corrosion
- + reduces heat transfer co-efficient during its processing.

Sediments present in crude causes:

- + erosion
- + scaling.

In mechanical method of separation of impurities from crude oil, it is subjected to centrifuging, filtration and settling after heating it to $120-160^{\circ}C$ at 6-8 atm. pressure. In

physico-chemical method, emulsion breakers are added. But they are costly and cause corrosion & sludge formation.

Stabilization of Crude Oil

Removal of dissolved gases from crude oil by heating it is called its stabilization. Gas accompanied with crude oil must be removed to avoid breathing loss (loss of gasoline, if gas is not removed from oil during pre-refining). Breathing loss occurs due to changes of humidity of ambient air and day and night temperature change also during emptying and filling of crude tanker.

Exploration Techniques

✚ **Geophysical:** In the geophysical methods, gravimetric, magnetometric, seismic, radioactive, and stratigraphic studies of the surface are gathered.

• Gravimetric Methods

- A gravimeter is a very sensitive instrument, usually a spring-type balance with high resolution and accuracy capable of detecting a minute variation in gravity.
- **Porous and oil-containing rock layers and salt have lower density compared to the surrounding non-porous and hard rock layers.**
- **Thus, a gravimetric curve is acquired and analysed for the location of deposit by taking the advantage of gravity variations.**

• Magnetometric Method:

- A variation of magnetic field strength is recorded by a sensitive instrument, called a magnetometer.

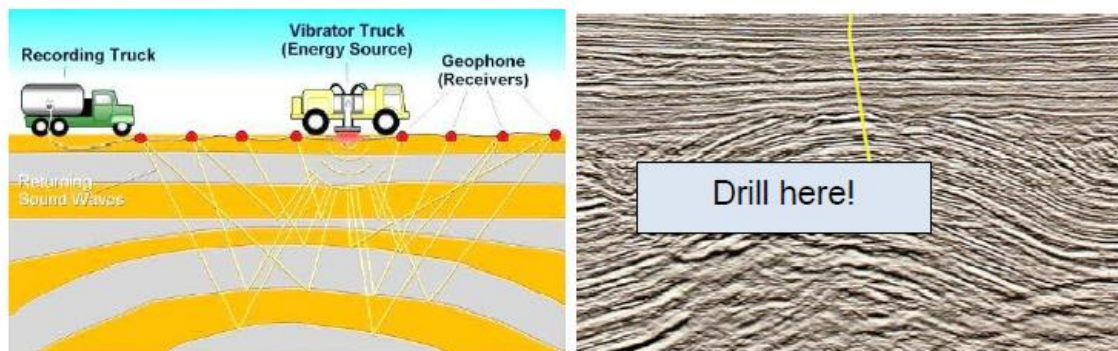
- Igneous non-porous rocks are found to be magnetic as compared to sedimentary rocks containing organic deposits. Thus, a magnetometric survey can also be used to locate oil deposits.

- **Seismic Survey:**

- Seismic surveys are used to locate likely rock structures underground in which oil and gas might be found. Shock waves are fired into the ground.

- These bounce off layers of rock and reveal any structural domes that might contain oil.

- The frequency and time of the reflected signal varies with the density, porosity, and the type of reflecting surface. Various rock deposits at different depths vary with density and porosity.



- ✚ **Geochemical:** Chemical analysis of the surface soil and rocks are carried out by geochemical methods. Geochemical methods employ chemical analysis of the cuttings (rock samples cut by drilling bit) and core (a narrow column of rock taken from the wall of a drilled hole) of the drilled site.

- ✚ **Geotechnical:** are used to measure the mechanical properties of rocks and surface.

✚ **Remote sensing** from satellite is the most recent development for a low cost geological survey. Solar radiation from the Earth's surface varies in intensity and frequency depending on the sub-surface property. This observation is collected via satellite to predict the sub-surface structure.