

Tikrit University
The College of Petroleum Processes
Engineering
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Department

An Introduction to Petroleum Technology

First Class

Lecture 1

By

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Types of energy in nature

First: Renewable energy:

This energy is called renewable energy because it is renewable continuously, and within short periods of time, it is permanent energy, and nature is the main source for it, and therefore it can be considered of economic value.

Among the most important examples are:

1- Solar energy:

The sun is the main source of energy, as it is one of the most important and most abundant renewable energy sources, as the sun's rays spread in all countries of the world continuously, in addition to that it does not cause any kind of pollution, and it can be used by storing it and converting it to another form of energy and benefit from it in the future.

2- **Wind power**, in this type of energy, air movement is utilized, which occurs due to the rise of hot air to the top and cold air in its place. Use of wind turbines.

3- **Hydropower**: This energy is also called water energy, and this energy was and still is one of the most important sources of renewable energy, and it is generated from the movement of water, where the kinetic energy of flowing water is converted into other forms of energy such as electric energy, and energy projects are established Water in places where water is present, such as dams and lakes, in order to exploit the water energy.

4- **Geothermal energy**:

Geothermal energy The cause of this type of energy is the thermal energy in the earth's interior resulting from the radioactive decay of rocks in the depths, and this thermal energy in the depths moves to the surface of the earth after passing through the various layers of the earth

to appear in several forms, including hot springs, which Its heat can be used in several things, including operating heavy machinery.

The second type: non-renewable energy :

This energy is called non-renewable energy because it is not renewable within a short period of time, as it is replenished through natural processes very slowly, and may not be renewed, and when you start using it, it begins to gradually decrease, as it is threatened with depletion.

Examples include:

1- Hydrocarbons:

The formation of oil requires the presence of a special geological formation, which is the presence of sedimentary rocks rich in organic resources, which are called source rocks, in addition to the presence of rocks with high porosity to preserve oil, and on top of them are impermeable rocks that can trap oil in a tank and prevent it from

migrating to the surface of the earth. This geological formation is called A trap, and when geologists can locate the trap they can predict the presence of the oil and extract it and use it as a major source of energy.

2- Coal:

Coal consists of an essential element: which is carbon, which is a major source of energy, and it is a solid substance that may be black or brown. Where plant resources are exposed to great pressure and high temperature, which turns these plants into this type of energy, which is coal.

3- Oil shale:

It is solid materials and sedimentary rocks that contain solid organic materials, whether plant or animal, that are isolated from oxygen and exposed to very high heat (approximately 575 degrees Celsius), then they are transformed from one form to another form of energy, which is

rock oil or the so-called industrial crude oil. But benefiting from the energy extracted from oil shale has great damage to the environment, including pollution of groundwater and the emission of carbon.

4- **Nuclear Energy:** Nuclear energy occurs in atoms, specifically in the nucleus of the atom, as the nucleus consists of small units that meet together with bonds that bind the nucleus together, and these bonds contain very enormous energy, and when these bonds are broken, nuclear energy is released that can be used Including them in several ways and converting them into other forms of energy such as electrical and thermal energy.

This process takes place in special stations called nuclear plants through either nuclear fission or nuclear fusion, and in general, nuclear energy produces clean energy, but the byproduct of it, which is radioactive materials, is a highly toxic substance that causes many damages and serious diseases.

2-1 General Overview (Petroleum)

The word petroleum originated from the Greek word, "Petra" (meaning rock) and "oleum" (meaning oil).

Literally, it means 'Rock Oil,' and can also be defined as a non-renewable fossil fuel or oil that is found underground.

This is any naturally-occurring flammable mixture of hydrocarbons found in geological formations such as rock strata. Technically, the term petroleum refers to describe any solid, liquid, or gaseous hydrocarbons. It's also known as 'crude oil' or 'mineral oil.'

Petroleum is a complex mixture of hydrocarbon compounds which may be either gas, liquid, or solid depending upon its own unique composition and the pressure and temperature at which it is confined.

Petroleum is one of the most important substances consumed by the man at present time. It is used as a main source of energy for industry, heating, and transportation and it also provides the raw materials for the

petrochemical plants to produce polymers, plastics, and many other products. Petroleum products are all substances made from petroleum.

2-2 Origin of petroleum :

There are two theories that explain the origin of petroleum.

There are organic and inorganic theories, which stated as:

-Organic theory (derived from living matter): states that petroleum evolved from the decomposition of animals and plants that lived during previous geological times.

As these organisms died and are buried by depositing or mixed with silt, sand, and mud on the sea or Ocean floor, then pressure, temperature, Bacteria, and other reactions change these organisms to oil and gas.

-Inorganic theory (not derived from living matter) states that petroleum was formed through a chemical reaction between water,

carbon dioxide, and several inorganic substances such as carbonates and carbides in the earth.

2-2-1 Problems with Inorganic Theories:

- 1- No inorganic theory can account for the necessary quantities of carbon and hydrogen needed to form large petroleum deposits. The abundance of plant and animal life present in sediments is a sufficient source.
- 2- Much crude oil contains porphyrins and nearly all contain nitrogen. The presence of these materials strongly suggests organic origin as they are present in all organic matter. Also, porphyrins of vegetable origin have been found to be more plentiful than those of animal origin.
- 3- Petroleum rotates the plane-polarized light. this property is restricted primarily to organic materials known as optical isomers and further suggests organic matter as the source of petroleum.

One of the most widely accepted theories on the origin of petroleum is the **organic theory** of petroleum formation. The organic theory states that petroleum originates from marine life, which includes single-celled organisms (planktons) and complex organisms such as fishes and crustaceans. These organisms, which contain carbon, die and accumulate in water-rich environments and ocean floors. Following the accumulation of sediment over millions of years, deposited marine organisms became buried under kilometers of sediment. Under increased pressure and temperature due to overburden formation pressure from layers of sediments and organic matter, a mixture of organic chemical compounds called kerogen is formed. At high temperatures in the earth's crust, kerogen releases hydrocarbons, which then migrate towards the surface where they are either trapped in reservoir rocks before reaching the surface or escape to the surface.

2-3 Steps to form petroleum :

- Accumulation of the remains of plants and animals and their burial mud and sedimentary material of ancient seas.

- Decomposition of these remains by pressure and temperature to form petroleum.
- Migration of petroleum from the source rock to the reservoir rock.

2-3-1 Source rocks:

Source rocks are rocks rich in organic matter that can generate hydrocarbon when subjected to high temperature and pressure.

A very important characteristic of the source rock is the total organic content, which is the organic richness of a rock represented as the weight percent of organic carbon (from kerogen and bitumen) and gives a qualitative indication of petroleum potential.

2-3-2 Petroleum Generation from Source Rock:

The requirement for the release of petroleum from source rock is temperature. The earth's interior is characterized by a temperature

increase with depth. The change in temperature of the earth's interior per unit depth change is called geothermal gradient. Large quantities of hydrocarbons are formed around a depth of 1–2 km, with oil generation reaching a peak at 3 km. Gas dominates depths between 4 and 6 km due to the high temperature, which leads to the cracking of oil to form gas. At deeper formation depth, greater than 6 km, kerogen becomes carbonized and is no longer able to produce hydrocarbons.

- Determination of Formation Temperature :

$$\mathbf{T_f = T_s + GG (D/100)} \qquad \mathbf{\dots 2-1}$$

Where: T_f is formation temperature, °f

T_s is surface temperature, °f.

D is a depth of formation, m.

GG is a Geothermal gradient (°f/100m).

To convert temperature from Celsius to Fahrenheit:

$$^{\circ}\text{f} = 1.8 \text{ }^{\circ}\text{C} + 32$$

Where:

°f : temperature in Fahrenheit degree.

°C : temperature in Celsius degree.

2-3-3 Petroleum Migration:

Oil and gas move out of the source beds and accumulate in the reservoir rocks.

The transfer from source rocks to reservoir rocks is called :

Primary migration. where the oil and gas transformation causes micro-fracturing of the impermeable and low porosity source rock, allowing hydrocarbons to move into more permeable strata.

The movement of petroleum within the porous and permeable reservoir beds is known as secondary migration, where the generated fluids move more freely along bedding planes and faults into a suitable reservoir structure.

After its formation, petroleum may migrate from the source rock into a porous and permeable bed where it accumulates and continues its migration until finally trapped. The forces causing the oil migration are:

- 1- Compaction of sediments as the depth of burial increases.
- 2- Diastrophism: crustal movements causing pressure differentials and consequent surface fluid movement.
- 3- Capillary forces cause oil to be expelled from fine pores by the preferential entry of water.
- 4- Gravity promotes fluid segregation according to density differences.





