Republic of Iraq

Ministry of Higher Education and Scientific Research

Al-Mustaqbal University College

Chemical Engineering and Petroleum Industries Department

Subject: Oil and gas field Processing

3rd Class

Lecture one

Petroleum and Gas Field Processing

Petroleum and gas field processing operations, referred to as surface petroleum operations (SPO), cover the myriad procedures required to handle the crude oil mixture between the well head and the delivery points for refining operations and other usages. Oil field operations in general encompass three main phases, as shown in the following block diagram.

UPSTREAM:

This refers to anything having to do with the exploration and production of oil and natural gas. Geologic surveys and any information gathering used to locate specific areas where minerals are likely to be found is commonly called exploration The term 'upstream' also includes the steps involved in the actual drilling and bringing oil and natural gas resources to the surface, referred to as production.

MIDSTREAM:

The 'midstream' segment of the oil and natural gas industry refers to anything required to transport and store crude oil and natural gas before they are refined and processed into fuels and key elements needed to make a very long list of products we use every day. Midstream includes pipelines and all the infrastructure needed to move these resources long distances, such as pumping stations, tank trucks, rail tank cars and transcontinental tankers.

DOWNSTREAM:

The final sector of the oil and natural gas industry is known as 'downstream.' This includes everything involved in turning crude oil and natural gas into thousands of finished products we depend on every day. Some of the more obvious products are fuels like gasoline, diesel, kerosene, jet fuels, heating oils and asphalt for building

roads. But long-chain hydrocarbons found in both oil and natural gas are used to make far less obvious products like synthetic rubbers, fertilizers, preservatives, containers, and plastics for parts in countless products. Oil and natural gas products are even used to make artificial limbs, hearing aids and flame-retardant clothing to protect firefighters. In fact, paints, dyes, fibers and just about anything that is manufactured has some connection to oil and natural gas.

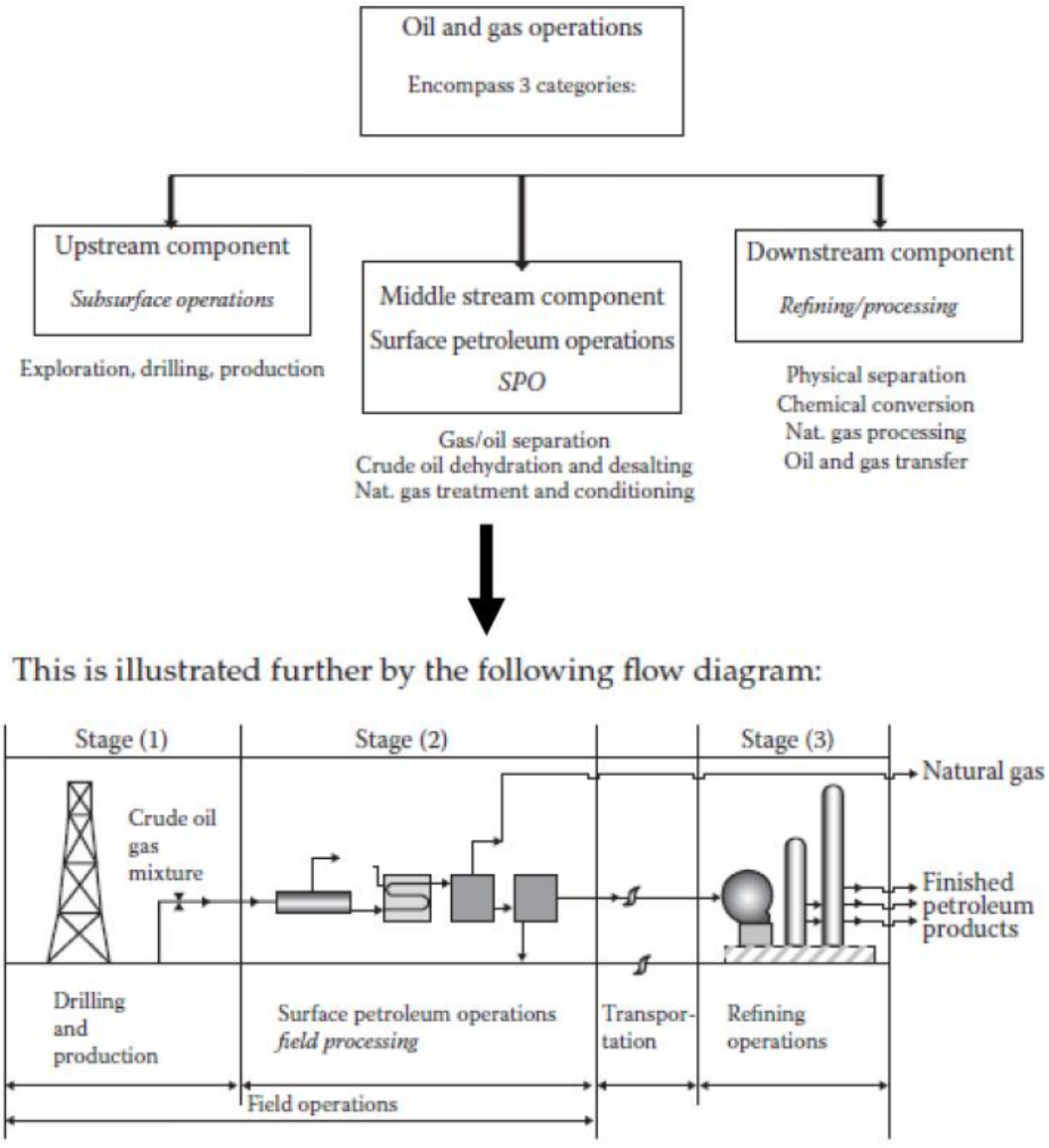

Figure 1-1. Oil and gas operation schematic

What Is a Unit Operation:

Unit operation is a basic step in a process that involve a physical change or chemical transformation during the process such as separation, crystallization, evaporation, filtration, polymerization, isomerization, and other reactions.

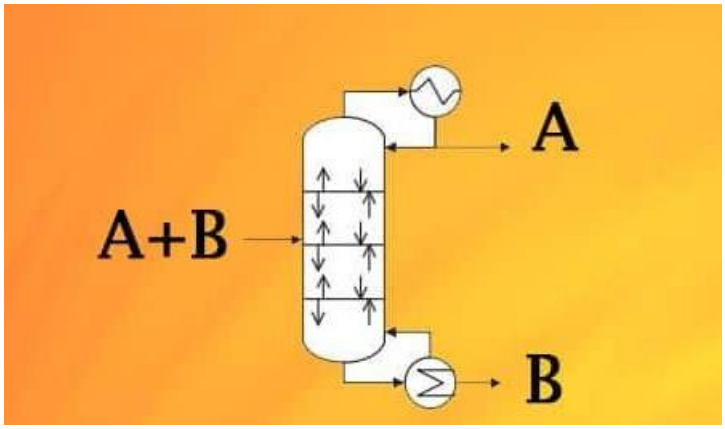

Figure 1-2. Unit operation

Chemical engineering unit operations consist of four classes:

- Heat Transfer Operation: Unit operations where temperature difference is driving force, including evaporation and heat exchange.
- Mass Transfer Operations: Unit operations where concentration gradient is driving force, including gas absorption, distillation, extraction, adsorption, and drying.
- Fluid Flow Operations: Unit operations where momentum gradient is driving force, including fluids transportation, filtration, and solids fluidization.
- Mechanical Operations: Operations based on some external mechanical force, including solids transportation, crushing and pulverization, and screening and sieving.

Important unit operations:

Some important unit operations carried in chemical industries are:

• Distillation.

• Drying.

• Evaporation.

• Gas Absorption & Desorption.

• Liquid-Liquid Extraction.

• Solid-Liquid Extraction (Leaching).

• Crystallization.

• Adsorption.

What Is a Unit Processes

The unit process is a process in which chemical changes take place to the material present in the reaction, as a result of chemical reaction taking place. The entering and leaving materials are differ from each other chemically, for instance combustion of coal. Coal and air enters, and flue gases and residues leave the combustion chamber. Combustion is therefore a unit process. Unit processes are also referred to as chemical conversions. In simple terms, the process which involves chemical changes are known as Unit Processes. Some examples of such chemical reactions are; sulphonation, nitration, halogenation, alkylation, hydrolysis, hydrogenation, oxidation, reduction, etc.

Historical development of oil formation theories

Petroleum and other hydrocarbons have been known to mankind since the dawn of civilization. The word petroleum derives from the Latin words petra, meaning rock, and oleum, denoting oil, which combined literally means rock-oil.

Petroleum is a naturally occurring brown to black oil comprising mainly of hydrocarbons found under the crust of the earth . It is obtained, from the ground either by natural seepage or by drilling wells to various depths. Either petroleum oil flows out itself due to underground gas pressure or these are mechanically pumped out.

Several theories have been proposed to explain the formation and origin of oil and gas (petroleum); these can be classified as the organic theory of petroleum origin and the inorganic theory of origin. The organic theory provides the explanation most accepted by scientists and geologists.

Modern Theory (Organic Theory): According to modern views, petroleum is believed to be formed by the decay and decomposition of :

- Marine animals.
- Vegetable organism of the pre-historic forests.

When these microscopic plants, and sea animals died, they sank to the bottom of the sea. Over millions of years, layer after layer of sediment, pressure, temperature, bacteria, and other reactions caused these dead organisms to change into oil and gas. The rocks where oil and gas were formed are known as the source rock.

There are a number of compelling reasons that support an organic theory. First and foremost, the main components of plants and animals are the same as the main components of crude oil (H, C, O, S). Second, Nitrogen and porphyrins

(chlorophyll derivatives in plants, blood derivatives in animals) are found in many petroleums.

Accumulation of Oil and Gas:

The oil, gas, and salt water occupied the pore spaces between the grains of the sandstones, or the pore spaces and cracks of the limestones and dolomites. Whenever these rocks were sealed by a layer of impermeable rock, the cap rock (Sedimentary rocks to trap oil and gas), the petroleum accumulating within the pore spaces of the source rock (rocks that contain sufficient organic material to create hydrocarbons when subjected to heat and pressure over time), was trapped and formed the petroleum reservoir. However, when such conditions of trapping the petroleum within the source rocks did not exist, oil gas moved (migrated), under the effects of pressure and gravity, from the source rock until it was trapped in another capped (sealed) rock. Gas, oil, and water segregate within the trap rocks, because of the differences in density. Gas, when existing, occupied the upper part of the trap and water occupied the bottom part of the trap, with the oil between the gas and water.

The geologic structure in which petroleum has been trapped and has accumulated, whether it was the source rock or the rock to which petroleum has migrated, is called the petroleum reservoir.

In summary, the formation of a petroleum reservoir involves first the accumulation of the remains of land and sea life and their burial in the mud and sedimentary materials of ancient seas. This is followed by the decomposition of these remains under conditions that recombine the hydrogen and carbon to form the petroleum mixtures. Finally, the formed petroleum is either trapped within the porous source

rock when a cap rock exists or it migrates from the source rock to another capped (sealed) structure.

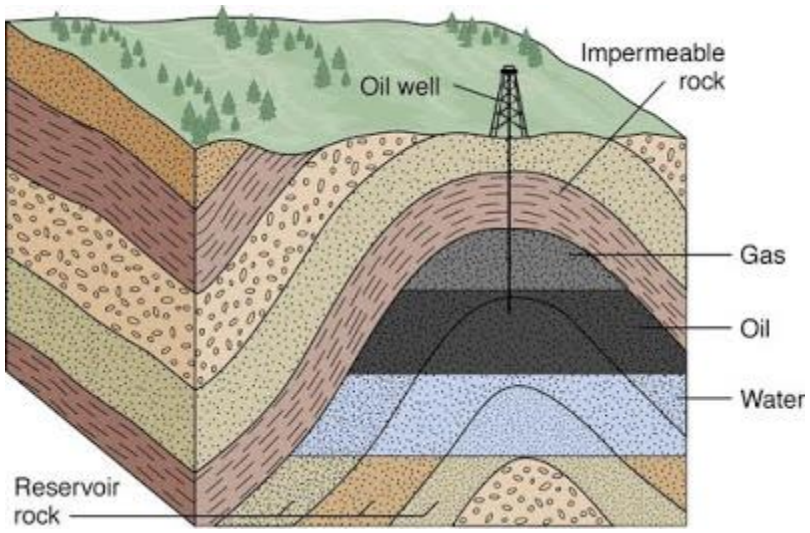

Figure 1-3. Petroleum reservoir