Gas Technology

About the lecturer:

- Asst. lecturer Ahmed Razzaq Sahal is a Senior Petroleum Engineer in Iraq Oil Ministry at the Field Division.

- M.S. from the University of Baghdad, and B.S. from University of Technology — all degrees in Petroleum Engineering.

- Work as Supervisor Drilling Engineer.

- Email: ahmedrazaq519@gmail.com and Ahmed.razzaq@alayen.edu.iq

About the Course:

- 3 hr per week.

- 3 Units (Theoretical).

The syllabus:

1- Natural gas resources.

2- Natural gas composition and phase behavior.

3- Natural gas properties.

4- Natural gas production.

- Flow of natural gas in porous media.
- Flow of natural gas in wells.
- Flow of natural gas through restrictions.
- Flow of natural gas in pipelines.

5- Gas well performance.

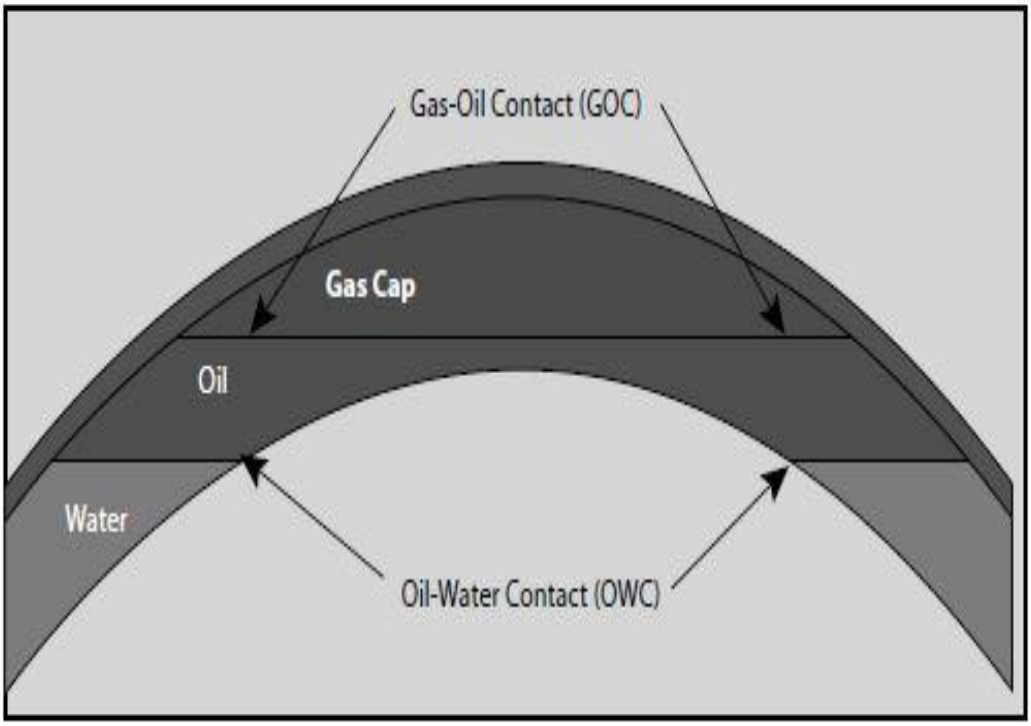
6- Natural gas reservoirs.

7- Introduction to natural gas processing.

Lecture One: Natural gas resources

1.1. Introduction

The presence of gas in a mixture of hydrocarbons depends on their phase behavior, which in turn, depends greatly on the pressure and temperature of the mixture. While a chemical engineer or a chemist would be interested to know the actual composition of the hydrocarbon mixture, petroleum engineers have traditionally opted to discuss it in terms of oil and gas. This of course suggests that what part is oil and what part is gas depends on the vantage point that pressure and temperature provide. Furthermore, the same mixture of hydrocarbons will have a different character in the reservoir than on the surface.



Below, offer some brief definitions of terms used in the petroleum industry to describe natural gas reservoirs.

1.1.1 Non-associated Gas

These are reservoirs that contain almost entirely natural gas at reservoir conditions. They are generally found at greater depth. If the fluid at the surface still remains gas, then it is called "dry gas". If the surface pressures cause some

liquid hydrocarbons to evolve, it is called a "wet gas" reservoir. It must be emphasized that while non associated gas reservoirs are likely to be found at greater depths, upward migration from the source rock, in geologic time, can result in shallow gas reservoirs, and in some cases, such as the Arctic, the cap rock may be the permafrost.

1.1.2 Associated Gas

Almost all oil reservoirs except those classified as extra heavy or tars will produce some natural gas at the surface. Oil will not be shipped in a commercial pipeline or a tanker with gas still in the solution. The term stock tank oil, which is used both as a measure for oil well performance and in commercial pricing of oil, means that all associated gas has been stripped from the liquid at one atmosphere pressure. The gas thus liberated is known as "associated gas".

1.1.3 Unconventional Gas

The term unconventional gas is widely used, but it refers more to the geological setting and rock type rather than to the gas itself, which is nearly all methane. When the term was coined, it implied that these reservoirs presented operational or economic challenges, or both, which would not be ordinarily found in conventional reservoirs.

The most common, **"tight gas"** formed in sandstones or carbonates, refers to low-permeability formations with permeabilities less than 1 md and often as low as 0.001 md. In such "tight reservoirs", it is essentially not possible for much of the gas to flow naturally. Massive hydraulic fracturing, a widely practiced technique in the petroleum industry, was greatly expanded in the 1970s and 1980s and targeted these reservoirs. In the United States and Canada, tight gas occupies a sizeable part of the natural gas industry. In 2007, about 30% of US natural gas was produced from tight gas reservoirs.

Coalbed methane (CBM) refers to methane gas that is found adsorbed in many buried coalbed deposits. Wells drilled in these deposits are hydraulically fractured and allow for the production of desorbed methane. In 2007, about 9% of US natural gas was produced from CBM.

Finally, **shale gas** is gas found in organic shale rocks, which exist in relative abundance in the United States. Shale gas has seen increased activity between

2000 and 2008. Because these reservoirs have virtually no permeability, the choice of well completions has been horizontal wells with multiple hydraulic fractures.

1.2 Natural Gas Resources in Iraq

At nearly 132 trillion cubic feet (Tcf), Iraq's proved natural gas reserves at the end of 2020 were the 12th largest in the world. About three-quarters of Iraq's natural gas reserves are associated with oil, and most of this associated natural gas is in the supergiant fields in the south.

Iraq's dry natural gas production was 378 billion cubic feet (Bcf) in 2019. Iraq consumed 636 Bcf of dry natural gas in 2019, much of which the electricity sector consumed.

According to the World Bank, Iraq flared 632 Bcf of natural gas in 2019, ranking as the second-largest source country of flared natural gas in the world behind Russia. Natural gas is flared because of insufficient pipeline capacity and other midstream infrastructure to move the natural gas from production areas.

Iraq pushed back its target to eliminate natural gas flaring to 2025. Iraq is pursuing several projects to capture more of its associated natural gas and is negotiating agreements with U.S. firm Honeywell UOP, among others, for natural gas capture and processing, power generation, and development of the Ratawi oil field in Basra.

Iraq is also interested in developing its non-associated natural gas fields. At the conclusion of the fifth licensing round, Iraq awarded two blocks in the Diyala Province to Crescent Petroleum. Iraq aims to increase natural gas production by 750 million cubic feet per day (MMcf/d) from these blocks within three years. Iraq is also interested in continuing to develop the 5.6 Tcf Akkas natural gas field, one of the few non-associated natural gas fields in Iraq.

Iraq began importing natural gas from Iran in June 2017 to fuel electric power plants near Baghdad, including the Al-Besmaya, Al-Quds, Al-Mansuriyah, and Al-Sadr stations. Annual natural gas imports averaged 857 MMcf/d in 2019 and averaged 772 MMcf/d for the first half of 2020.

1.3 Utilization of Natural Gas

Natural gas is one of the major fossil energy sources. When one standard cubic feet of natural gas is combusted, it generates 700 Btu to 1600 Btu of heat. Field of utilization:

- Industrial
- Transportation
- Residential

1.4 General Information

Natural gases are commonly classified according to their liquid content as either lean or rich and according to their sulfur content as either sweet or sour.

- **Lean gas:** natural gas with low content of intermediate gases or gas containing 1 gallons or less of compounds heavier than ethane per 1000cf of gas.
- **Rich gas:** natural gas with appreciate amount of intermediate gases or gas containing more than 5-7 gal. of compounds heavier than ethane per 1000cf of gas.
- **Sweet gas:** natural gas contains negligible amounts of acidic gas (H_2S gas content is less than 1 grain/1000scf).
- **Sour gas:** natural gas has unacceptable quantities of acidic gas (H_2S gas content is more than 1 grain/1000scf).

Natural gases are commonly classified according condensate content (the hydrocarbon liquid fraction obtained from a gas stream containing essentially pentanes C_5).

- **Wet Gas:** Gas that contains more than 0.1 US gallons of condensate per 1000cf of gas.
- **Dry Gas:** Gas that contains less than 0.1 US gallons of condensate per 1000cf of gas.