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Role of Chemistry in Oil and Gas Extraction

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Abstract: Crude oil and natural gas are both refinery feed stocks; together, they are the main raw materials used for many petrochemical products and fuels, which play a vital role in human life. Crude oil and natural gas can also influence the national economy. We cannot think about present human life without considering the importance of crude oil and natural gas. Day by day, oil and natural gas extraction is becoming a challenge, as oil and gas extraction is moving towards deep sea extraction and ultra-deep sea extraction. Easy oil extraction, such as onshore drilling and shallow water drilling with available technology, has been taken and it is now essential to extract tougher areas with new technology. Chemistry is playing a vital role in realizing the petroleum engineers' dream.

Key Words: Crude Oil, Gas, Extraction, Flow Assurance

DRILLING

It is essential that the borehole pressure, the hydrostatic pressure exerted by the column of "mud" in the wellbore, is a little more than the formation pressure, the pressure in the pore space of formations being drilled. If, for some reason, the formation pressure is greater than the borehole pressure, an influx of fluid flow into the borehole, known as a kick, will occur. If no action is taken to stop the influx of fluid into the borehole, the formation fluids will flow in an uncontrolled manner at the surface. This is known as a blowout. When pressure control over the well is lost, it can cause severe consequences as mentioned below.

1. Loss of human life.
2. Loss of rig and equipment.
3. Loss of reservoir fluids.
4. Damage to the environment.
5. Huge costs to get the well under control again.

The mud is circulated by the drilling crew to remove the drill cuttings and to maintain the hydrostatic pressure of the mud column; this pressure should not be too high, as high pressure can cause formation damage. [1].

The onsite chemist measures mud densities and any ingress of hydrocarbons into the mud. The chemist's observations are highly important, so that early action may be taken to ensure the drilling operations are safe and successful.

STIMULATION (MATRIX ACIDIZING)

Formation damage due to drilling, cementing and completion activities could lead to the reduction of permeability of nearby wellbore areas. Matrix (stimulation) treatments are a common form of well intervention aimed at removing formation damage and restoring the well to its natural, undamaged inflow performance. The majority of the acid stimulations of clastic reservoirs are carried out with "mud acid", a mixture of hydrochloric (HCl) and hydrofluoric (HF) acid. [2]

PVT (PRESSURE, VOLUME, TEMPERATURE) ANALYSIS (INPUTS TO DESIGN SURFACE FACILITIES)

PVT laboratory analysis is vital for many petroleum engineering design calculations. The onsite chemist plays an important role in doing the PVT analysis and giving inputs to the petroleum engineers. Reservoir fluid analysis provides some of the key data for the petroleum engineer. The quality of sampling and testing is important to ensure that correct physical property values are used in various

design procedures. PVT analysis of a reservoir fluid determines:

1. The correlation between pressure and volume at reservoir temperature.
2. Various physical constants that enter into reservoir engineering calculations.
3. The effect of separator pressure and temperature on oil formation volume or gas/oil ratio.
4. Chemical composition of the most volatile components.

Using PVT analysis, chemists carry out downhole (reservoir conditions) sampling and test the sample at downhole conditions. This gives the measurement of the fluid at reservoir conditions. Sampling and testing are carried out with specialized equipment by experienced chemists. [3]

FLOW ASSURANCE

Flow assurance is an important function to ensure the desirable flow of hydrocarbon fluids.

Some crude oils having more wax, ceasing to flow at ambient temperature. In this type of crude oil, a chemical known as pour point depressant (PPD) is used. The PPD decreases the congealing temperature of crude oil, making the crude oil flow freely at ambient temperature. This PPD requirement is critical in cold climates. Chemists test the flow in the laboratory by mixing PPDs in various dosages with the crude oil to determine the required amount of and the dosage rate of PPD, needed for flow to be maintained at field temperature.

Along with crude oil, water is also frequently produced. Sometimes water is injected into the reservoir to maintain reservoir pressure. When it comes to handling produced water and preparing water for injection to the reservoir), it is essential to prevent scale formation, monitor and prevent microbiological corrosion, measure particle sizes, and check corrosion tendencies. The chemist's role is important in testing the water in the laboratory for these tendencies and recommending the chemical treatment (corrosion inhibitors, scale inhibitors, or biocides) along with required dosage rates.

NATURAL GAS DEHYDRATION OPERATIONS

It is essential for natural gas dehydration to be transported. Moisture in natural gas can cause hydrates, physical mixing of moisture with hydrocarbons to form ice-like crystals, which can clog pipelines and cause pipeline corrosion. Trithylene Glycol (TEG) is used in natural gas dehydration to remove the moisture. Anhydrous TEG concentration plays a vital role in gas dehydration. This reaction increases rapidly at higher purities of TEG (i.e., less moisture content). Gas-stripping technology is being used to get a high purity of TEG, for the purpose of optimizing the performance. Testing and reporting the TEG purity is a critical parameter for gas dehydration operations. Chemists use specialized equipment and standard test methods for measuring the water content in TEG.

Similarly, measuring the moisture in dehydrated gas for natural gas transportation is important. Chemists use specialized equipment known as a Bureau of Mines meter, which is employed with standard test methods. The test results are used as inputs for calibration and fine-tuning of online moisture analyzers. Chemists continuously monitor the process chemistry and advise the operations department, preventing huge losses to operations caused by corrosion in the pipelines or completely disturbing the dehydration unit. [4]

OIL FIELD PROCESSING OF CRUDE OIL

Crude oil flows through separators, separated by high pressure, medium pressure, and low pressure. These separators are designed as per the inputs of the PVT chemistry report, and separate water and volatile hydrocarbons. Chemicals, like demulsifiers, are required to break the water and crude oil emulsion, making the crude oil free of water. Chemists test de-emulsifiers in the laboratory for suitability and to confirm the dosage rate. High dosage rates may cause reverse emulsion in the case of some demulsifiers, while low dosage cannot remove water from crude oil. Water is a critical parameter for the sale of crude oil.

CRUDE OIL ANALYSIS

Crude oil is transported to a refinery, mostly by cargo tanker ships. The main parameters to be tested are vapor pressures, water content, density, and salt content. Density of crude oil is the key parameter for calculating the price of crude oil. A sample is collected by an experienced chemist using standard methods, and the density is tested by following standard method. Variation in density, to even the third decimal, can cause great variation to the price of crude oil. Vapor pressure is also an important parameter, particularly if the vapor pressure is higher than 10 psi, which is very dangerous for transportation. It is required to eliminate water and salt content from the tank. Crude oil analysis is critical for crude export and chemists play an important role in this export by providing accurate data.

INTERNAL CORROSION

Oil and gas pipelines are costly and time consuming projects. Ensuring the integrity of these pipelines is essential. Internal corrosion can be understood and prevented only by a chemist. The most suitable corrosion inhibitor should be selected, or tailor-made chemical blends should be prepared by experienced chemists based on the operating and process conditions. The concentration of corrosion inhibitor in the fluid should be checked regularly to ensure the correct dosage rate. This also gives a good idea of the corrosion inhibitor's performance.

Similarly dissolved gases, such as oxygen, hydrogen sulfide, and carbon dioxide, should be tested *in situ* by using field test kits prepared using standard test methods.

Collecting real time data from online monitors, field test kits, and instructing operation teams for proper actions in order to prevent corrosion, is in the hands of chemists only.

CONCLUSION

Chemistry plays a key role in the process of oil and gas extraction. From the designing, drilling, commissioning and operating stage, chemists have valuable inputs in making operations safe, successful, and profitable.

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