Lecture № 9

Complications in the wells and reagents used to prevent (control) these complications

During operation of oil and gas wells some complications can occur, such as :

- asphalt resin paraffin deposits
- salt (scaling) deposits
- hydrate formation
- corrosion of underground equipment.
- sand plugs
- water – condensate plugs on the bottom of the well.

Asphalt resin paraffin deposits

The reasons of deposits of asphalt resin paraffin in tubings :

- temperature reducing
- pressure reducing
- because of the liberation of gas, causing additional reduction in the flow temperature
- by reducing the ability of soluble oil.

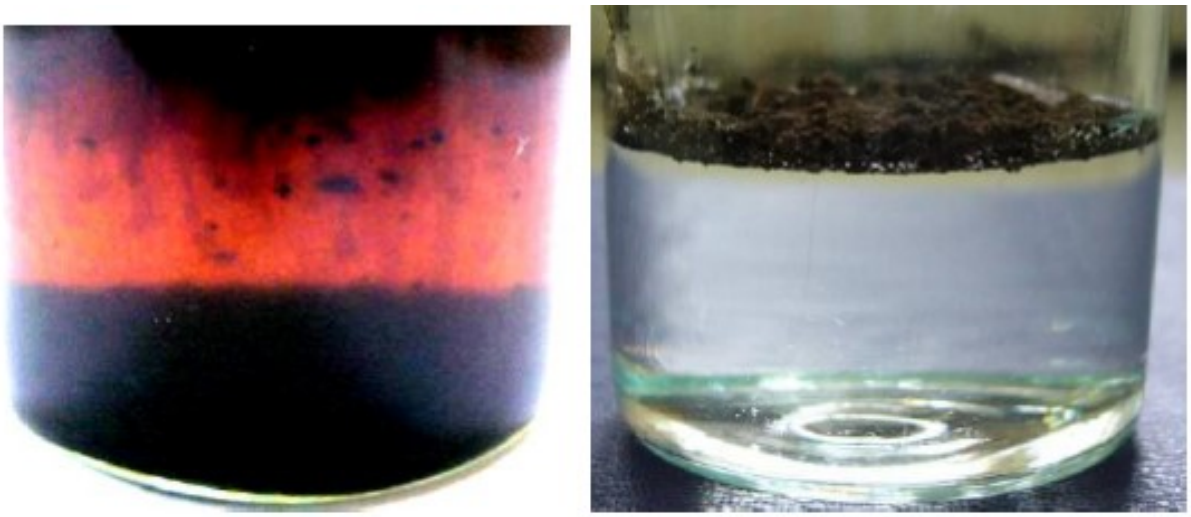
Because of these reasons solid (hard) deposits of asphaltenes, resins and paraffins are formed in oil wells. Preferably, the thickness of asphalt resin paraffin deposits is a few millimeters at a depth of 900 – 300 m, increasing to a maximum at a depth of 200 – 50 meters and again reduced to the wellhead.

Lecture № 9

Asphalt, resins and paraffin deposits in tubings

Paraffins

Asphaltenes



a b

Example of soluble (a) and unsoluble (b) asphaltenes

Crystallization of paraffin is at the interface of different phases, that is mechanical impurities of oil on the inner walls of the equipment. Paraffins, evolved in the volume of oil, almost does not participate in the formation of deposits on the pipe walls. Such crystals are deposited mainly on the bottom of tanks.

Control of asphalt resin paraffin deposits on the surface of underground equipment is made in two ways.

The first way – is to prevent deposits on the surface by hydrophilization equipment or causing the formation of crystals in the volume of paraffin oil.

The second way – the removal of asphalt resin paraffin deposits which were formed. There are such methods of removal of asphalt resin paraffin deposits: chemical method (usage of coating and solvents), thermal method and usage of scrapers (mechanical removal).

The protective coating of pipes hydrophilic materials are very effective for controlling paraffin deposits asphalt resin materials. For the formation of a protective coating applied paint materials (bakelite, epoxy, etc.), and

glass or glass enamel.

Hydrophilization tubing walls, increasing the number of centers of crystallization of paraffin in the stream, increased dispersion of wax particles in the oil is achieved by adding to the flow of chemicals that are water or oil soluble surfactants.

The formation of paraffin crystals in the volume of oil provides the use of inhibitors of paraffin deposits. Thanks to its constant dosage postponement of paraffin on the surface is observed.

As paraffin deposits inhibitors can be used the following products: **HT-54, "Dispersogen V4969" and "Rena-2210".** To remove wax deposits can be used hydrocarbon solvents, heat or scrapers. The easiest solvent paraffin deposits – **kerosene** per 1 m^3 which can be dissolved to 200 kg of wax or resin.

To dissolve asphalt resin and paraffin deposits sometimes use **gasoline**, although the success of its use is only 43 %.

There is also mechanical method of paraffin deposits removal. Mechanical method of removal of paraffin deposits is used sometimes in oil fields. This method consists in the use of scrapers.

The scraper for mechanical removal of asphalt, resin and paraffin deposits

In the case of **thermal method** in the annular space of the well periodically injected

- hot oil (condensate)
- overheated steam
- vapor-air mixture.

As a result wax melts and flows out of the well. For steam used of steam mobile cars installation and for heating oil – dewaxing unit of the mobile type.

Salt (scaling) deposits

The deposition of inorganic salts in the bottomhole zone wells equipment, industrial and communications devices complicates the process of production, preparation and transportation of oil and gas and lead to an increase in operating costs for removal of sediments salts.

Main symptoms:

- lower productivity production wells;
- impulse blockage and industrial communications;
- premature failure electric submersible pump, gas-lift valves, heat exchange equipment, pumps, pumping, etc.

The main method of preventing salt deposits – is the use of special chemicals – **inhibitors of salt deposits**

Inhibitors of salt deposits are **:**

- oil-soluble
- water-soluble
- multi-component.

The chemical nature of one-component inhibitors are divided into **anionic** and **cationic**. In practice, the most widely are used water-soluble inhibitors.

Inhibitors of salt deposits – are chemicals, which when added to the solution of inorganic salts (carbonate, $CaCO_3$, etc.) reduce (slow down) sedimentary formation process and the amount of sediments (the amount of sediments is reduced).

The **mechanism of action of inhibitors salt** deposits associated with the processes of diffusion in solution and **subsequent adsorption on the surface** of the microparticles of salt. The process of sorption the surface of inhibitor molecules accompanied by formation of a fairly stable associations. It further growth inhibitors reduce germ crystals of gypsum, calcite or other soluble salts.

The class **most used** inhibitors **- the class of anionic inhibitor**s - are derivatives of carboxylic acids, derivatives of sulfonic acids and phosphorus derivatives.

Composite chemical reagents or mixture are inhibitors or mixture of inhibitors with other chemicals. In as collateral to act as an inhibitor component usually nonionic surfactant type, or enhance the effect composition or used for another purpose without compromising with the actions of the main component.

Most often in the industry the following **inhibitors** of deposition of salts are used**:** sodium hexametaphosphate, ammophos, polikompleksony, sodium tripolyphosphate, PAF-1 NTF, imported reagents Class SP (SP-181, SP-191K, SP-203) and others.

In recent years, new inhibitors, produced by the domestic industry - such as KTI-C korazol, sodium polyacrylate and import inhibitors of salt deposits (inhibitors from other countries) – such as Dodiskeyl.

Hydrate formation

Hydrate formation is a complex physical-chemical process in the gas-water system. The main factors that determine the process of hydrate formation is :

- pressure,
- temperature,
- gas composition,
- humidity of gas,
- the presence and composition of salts in reservoir water.

Many components of natural gas (methane ethane, propane, isobutane, carbon dioxide, hydrogen sulfide, nitrogen) in contact with water form **gas hydrates** (gas hydrates are solid crystalline compounds which are similar to snow or ice and they at high pressures exist at positive temperatures.)

To prevent the formation of hydrates in gas flow necessary to remove one of the **main factors hydrates exist:**

- high pressure,
- low temperature
- moisture free.

Therefore, the main methods of dealing with hydrates is the lowering of pressure, fever and putting inhibitors. The most common way is the last.

For destruction and prevent the formation of hydrates mainly use **ethanol and glycols** (ethylene glycol, diethylene glycol, triethylene glycol). Their effect is that they bind water, significantly lowering the temperature of hydrate formation and have the ability to spread rapidly hydrated plug.

In addition, many new hydrate inhibitors are proposed.

They include glycol ethers, mono-, di-, tri- and penta etylene glycol, propylene glycol, izobutyl glycol, simple methyl and ethyl esters of mono- and diethylene glycol, 98 % - ethanol; polypropylene.

In addition to methane hydrate inhibitors can be used highly **mineralized water or its mixture with methanol**.

Established that the concentration of methanol to 35 % reduction in the maximum hydrate formation temperature is 20 degrees.

If **calcium chlorine water**, the figure is 27 degrees in the salt concentration of 30 %.

When using a mixture of methanol and calcium chloride hydrate formation temperature decrease the maximum is 35 degrees. There are also hydrate inhibitors which are based in the use of **bishofit**.

Hydrate inhibitors are used to lower the hydrate formation temperature of gas. Methanol and ethylene glycol are the most commonly used inhibitors. Recovery and regeneration steps are used in all continuous glycol injection projects and in several large-capacity methanol injection

units. Injection of hydrate inhibitors should be considered for the following applications:

- Pipeline systems in which hydrate trouble is of short duration.

- Gas pipelines that operate at a few degrees below the hydrate formation temperature.

- Gas-gathering systems in pressure-declining fields.

- Gas lines in which hydrates form as localized points.

Methanol and the lower molecular weight glycols have the most desirable characteristics for use as hydrate inhibitors.