Research of the process and forecasting scale in the downhole equipment

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Abstract. Fight with scale in the well operation is one of the most important ways to increase the efficiency of oil production. Scale formation in the bottom hole reservoir and downhole equipment reduce their productivity, leading to the current unplanned and costly workovers. The piper describes the characteristics of the process of scaling in wells in the later stages of the development of oil fields.
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Introduction

The most important aim in the oil industry is to increase the efficiency of oil extraction. One of the major directions in solving this problem is the problem of fighting scale in the operation of wells. Buildup of scale cake perforations, casing, production tubing, valves, pumps and downhole completion equipment, thereby clogging the wellbore and preventing fluid flow.

Due to many oil fields of the country entered the period of intensive water cutting the problem of increasing the efficiency of well operation acquires special urgency. The main method of development of oil fields is the reservoirs flooding. In such a case, complex geochemical processes of interaction with the injected water reservoir rock and saturating her liquids leading to formation of produced water saturated with inorganic salts [1].

The main part

The main components of most oilfield deposits are calcium carbonate, calcium sulfate and barium sulfate. In wells deposits of pure scale is rare. Usually they are a mixture of one or more major inorganic components with corrosion products, the particles of sand, and deposits stained or coated with asphalt-resin-paraffin substances. Wells treatment can't be successful without removal the organic component of scale [2].

In order for a scale to form it must grow from solution. The first development within a saturated fluid is a formation of unstable clusters of atoms, a process called homogeneous nucleation. The atom clusters form small seed crystals triggered by local fluctuations in the equilibrium ion concentration in supersaturated solutions. The seed crystals subsequently grow by ions adsorbing onto imperfections on the crystal surfaces—extending the crystal size [3, 4].

Crystal growth also tends to initiate on a preexisting fluid-boundary surface, a process called heterogeneous nucleation. Heterogeneous nucleation sites include surface defects such as pipe surface roughness or perforations in production liners, or even joints and seams in tubing and pipelines.

Scale is found in three forms: as a thin incrustation or loose flakes, in a stratified form, in crystal form. The deposits of the first type have a loose structure, permeable, and can be easily removed. Stratified deposits such as gypsum, are a few layers of crystals, sometimes as a bunch of slivers filling the whole cross section of the pipe. Crystal structures, such as barite and anhydrite, form very solid, dense and impermeable [5].

Radioactive barium salts are the most hard-to-out of scale. Barium is often found in highly mineralized produced waters of the oil fields, where its concentration often reaches 0,15-0,5 gpl. Barite (BaSO4) precipitates already in the presence of low concentrations of sulfate ion. These scale are less soluble. For example, in distilled water at 25 ° C dissolves only 0 0,023 gpl of barite, which is almost 900 times less than the solubility of gypsum [6].

Research has established that stable water saturated with barium sulfate in the surface conditions remain stable at high temperatures existing in oil reservoirs, which causes no complications during their injection into the reservoir. Conversely, water undersaturation with barium sulfate in situ, with the rise to the surface at low temperatures and pressures may be supersaturated with barium sulfate and excrete sediment barite.

Noted that the barite deposits, selected from oil field equipment and tubing have increased radioactivity due to the presence of radioactive isotopes of radium, which are associated in the groundwater with barium. In precipitated radioactive radiobarit that facilitates its detection in wells and in surface communications.

Effect of pressure on the solubility BaS04 studied too little. In general, there is a slight increase in solubility with increasing pressure, particularly pronounced in solutions with a salinity of less than 30-50 gpl. With the increase of mineralization of the effect of pressure effect is negligible [7].

Thermobaric conditions when moving upward flow of fluid along the wellbore have little effect on the change in the solubility of barite in the water.

Mixing of incompatible waters as a result of operation of several productive layers simultaneously or in wells operating one layer, with behind-the-casing flows from related horizons are the main causes of scale in the wells. Often the cause is a breakdown of the technical state of production casing and packer leaks, especially in old fields.

Fighting scale in the downhole equipment has no unique solution, each case has its own approach. Particular importance in addressing such a complex multifaceted problem becomes forecasting of possible complications associated with scaling. For a successful solution requires a constant monitoring of the wells and place in their physical and chemical processes. Great help in this matter could have a card changes in the composition of reservoir water for the various components: chlorides, sulfates, and barite mineralization. These maps were constructed and retraced dynamics of physico-chemical composition of water for 4 years (Fig. 1).

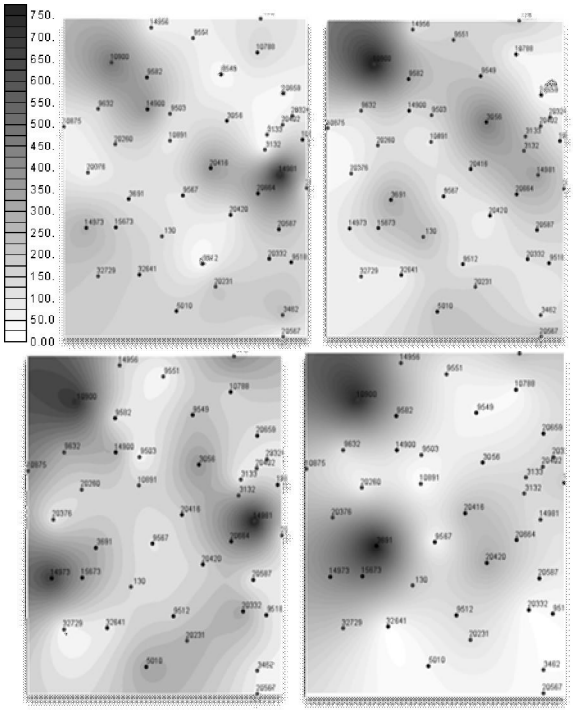
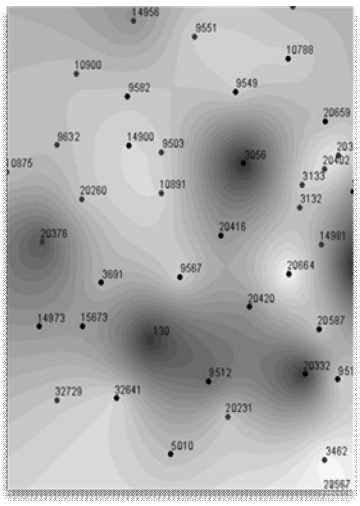
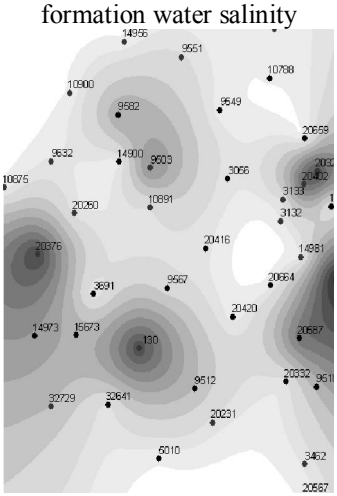


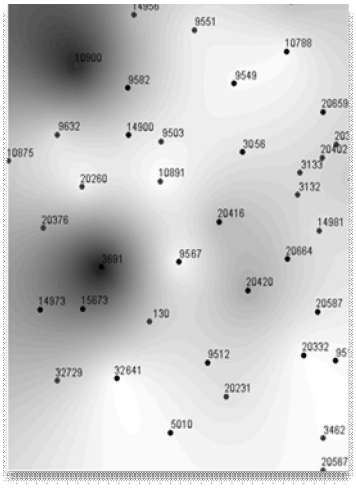
Fig. 1. Content of barium ions in the formation water (gpl)



formation water salinity



the content of sulfate ions



content of barium ions

Fig. 2. Comparison of the results of analyzes of reservoir water for a certain period

The result can be revealed breakdown of the technical state of the production casing, leading to scale in the wells in the following main features. The basic idea is to track changes in the composition of produced water in the dynamics. Thus, the reduction of barium ions in the early stages may indicates leakage of production casing and cement sheath at deposits of the Carboniferous system if density of water is constant, at the same decreasing the density of water indicates leakage at the level of the overlying Permian strata.

Occurrence in the future as part of the water sulfates in the complete disappearance of barium probably indicates the imminent failure of the pump due to scale. An additional feature is the presence of barium sulphate in the solid particulate [8, 9].

For most of the Devonian wells, characterized by the content of barium ions in the range 0,1-0,8 gpl, and low content of sulfate ions in the range 0-0,25 gpl (0,25 gpl - a saturation of sulfate ion for the barite-water to high salinity). Wells under the influence of fresh or waste a download contain barium in the range 0 - 0.1 gpl. For the upper layers of water (except the uppermost Tournaisian and fresh layers) is characterized by a high content of sulfate ions (1 to 12 gpl). If the passing of Devonian wells produced water is of sulfate ion concentration greater than 0.3 gpl, this well requires further study, may be in breach of the production casing. Elevated levels of sulfate ions without breakdown of the technical state of the production casing may be a result of enhanced oil recovery activities or geological and technical measures for involvement in the development of seams and areas previously subjected to the influence of sulfuric acid fringes.

Joint presence of significant quantities of barium ions (from 0.2 gpl l and more) and sulfate ions (from 0,15 gpl and more) is the quite common case, but the most dangerous in terms of scale on the pump and tubing. Moreover, it can be the first sign of breakdown of the technical state to the Devonian wells, still in early stages [10].

Conclusion

In general, for monitoring the content of these elements it is convenient to use an electronic card design, with put options, including on the outside and injection wells. If the lab tests of a well observed "anomaly" in the form of reduced (increased) density, or high (low) values of sulfates in comparison with others (working on the same horizon) and affect (injectors) - is an occasion to begin a more detailed study it for breakdown of the technical state.

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