FEATURES OF ENCAPSULATED INHIBITORS APPLICATION FOR DOWNHOLE EQUIPMENT PROTECTION

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Protecting downhole equipment from salt deposits is one of the main tasks of oil production. Intensive formation of mineral deposits is observed mainly during the production of flooded oil, namely in the working bodies of electrical submersible pumps and sucker rod pumps, tubing, flow lines of oil and gas gathering manifolds. The accumulation of salt deposits in the well and field gathering systems, preparation of oil well products leads to failures of oilfield equipment, which in turn leads to oil losses and significant material costs.

The salts precipitation occurs when the physicochemical, thermodynamic equilibrium is disturbed, and also if the salts concentration in the aqueous solution exceeds the equilibrium concentration for these conditions. A salt deposition is influenced by factors such as pressure drop, change in fluid temperature, mixing of the same type of water and different concentrations with a change in their chemical composition, and choking. The following types of salts prevail in the fields of Western Siberia: $CaCO_3$ (calcite), $CaSO_4 \cdot 2H_2O$ (gypsum), $CaSO_4$ (anhydrite) [1].

The most common method of protecting downhole equipment from salt deposits is the use of chemicals. Chemical scale inhibitors are divided into liquid and solid reagents. Currently, solid (encapsulated) inhibitors are gaining relevance, which in practice are used not only to protect downhole equipment, but also in well completion, and a well treatment of the bottom-hole zone.

The first samples of encapsulated products looked like classic capsules, consisting of a shell, inside of which the active substance was located. The classic “capsules” also had several drawbacks, the main of which was the high cost associated with the complexity of the technology for their preparation, and the high dependence of the properties on the opening of the shell in the face of the well. To eliminate the shortcomings at the second stage of technology development, encapsulated products were obtained in the form of a “sponge”, which was used as a biodegradable polymer porous material, inside of which there was an active base. However, the products of the third “caramel” type have become the most modern, balanced and effective product in the evolutionary lineup (Figure 1) [3].

In this paper, we consider the use of encapsulated inhibitors as an alternative to liquid reagents, since the methodology for the use of a granular scaling inhibitor involves a reduction in the number of technological transport approaches and the use of technological equipment (unit for dosed supply of a chemical reagent) to the objects of protection. A new type of sustained-action reagents is one of the promising methods for controlling inorganic salts in the system of production, collection and transportation of well products.

The product consists of granules with a water-soluble membrane (Figure 1), containing a mixture based on phosphonic acids, their salts and a combination of components that ensure the stability of the commodity form.

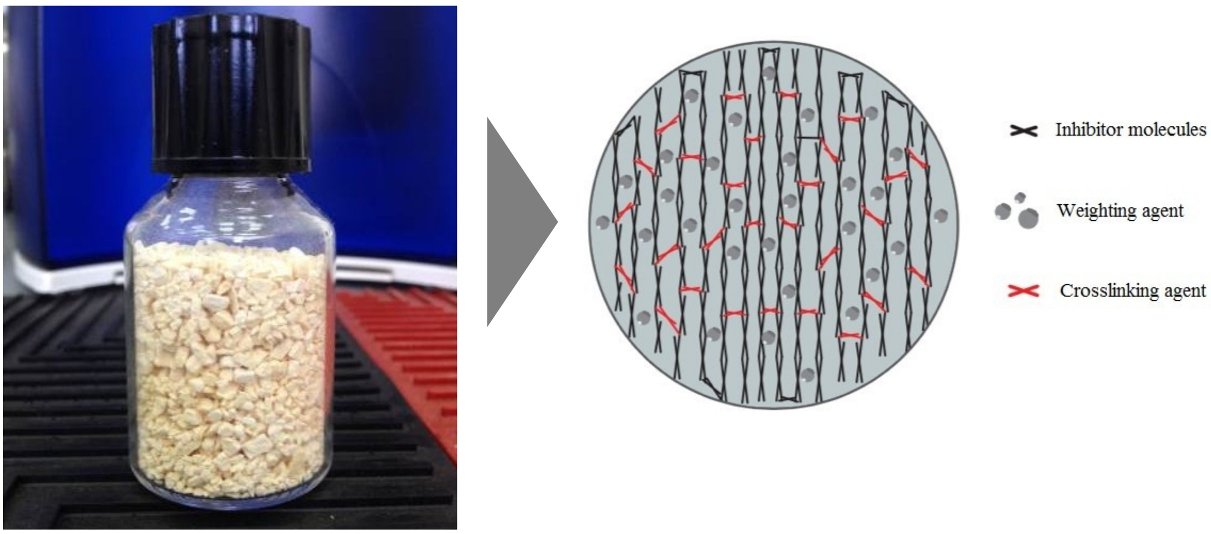

Fig.1 Encapsulated scale inhibitor of "caramel" type "Descum-2" WSC

The Descum-2 WSC encapsulated scale inhibitor is intended for use in the oil industry to prevent complications associated with the formation of mineral salts at all stages of production, transport and preparation of oil under conditions of the high salinity of production waters.

The novelty of materials and technology lies in the fact that the scale inhibitor is a microcapsule of a phosphorus-containing organic compound in preservation fluid. The uniform removal of the inhibitor is ensured by the long-time diffusion process of product molecules through the polymer membrane. The result is a uniform product removal. This reagent is relevant for autonomous deposits due to the lack of a metering device and the need for its maintenance. There is the possibility of filling both in the well container and in the sump (sedimentation zone of fluid mechanical impurities) with the possibility of adding an inhibitor as it is used up. Due to the lack of contact with methanol, the inhibitor is environmentally friendly and safe.

The technology for loading the encapsulated scaling inhibitor into the annulus in the sump is subdivided into two options: with lowered or lifted bottom-hole equipment. In the first case, the electrical submersible pump is turned off, the annular pressure is not relieved. The calculated amount of reagent is loaded into a prepared and tested for leaks technological vessel for feeding the inhibitor into the annulus and filled with Dewaxol WSC process liquid or water. The hatch of the technological vessel is closed, the tightness is checked, the valve is gradually opened by equalizing the pressure of the annular space of the well and the technological vessel, and a pause is maintained for 20 minutes. The process annular valve closes, and the pressure in the process vessel is aligned with atmospheric. After the loading operation, maintain a technological pause for 24 hours to prevent a wedge of an electrical submersible pump.

In the second option, with the bottom-hole equipment lifted, the estimated amount of granular scaling inhibitor is poured into the pipe space. The encapsulated scaling inhibitor is being pushed with process water using a CA-320 type aggregate in a volume (10 m^3) necessary to move the inhibitor to the well sump, but not allowing the well to be killed.

The candidate wells under consideration, which were subjected to this treatment, had the following application criteria for this technology, presented by the manufacturer of this scale inhibitor: mechanized well stock (rod well pump, electrical submersible pump, submersible cavity pumps), the flow rate of which does not exceed 150 m^3/day for liquids with a water cut to 90%, vertical wellbore (no horizontally directed wells), no sidetracks at the well, open wellbore (no packers), sump volume is at least 200 litres (using the borehole container removes the restriction), the height of the dynamic level of the annulus of the well is at least 250 meters, the pressure in the annulus is not more than 15 atmospheres. In particular, if the volume of sump does not provide for the adding of an inhibitor in the full set volume, then backfilling is carried out for a shorter period of protection, in a conditionally calculated volume, also with a lower value [2].

If the above indicators recommended by the manufacturer go beyond the established requirements, it is necessary to make an individual calculation of the reagent volume and the treatment period with the maximum possible productivity. The annulus should allow free passage of the granular scale inhibitor and process fluid to the sump.

The key predicted factors for the effectiveness of the use of the encapsulated inhibitor are the absence of bottom-hole equipment failures due to “salt deposition” and an increase turnaround interval. When evaluating the effectiveness of the reagent, the presence of a scale inhibitor in the formation water is important when analyzing its residual content (average value for a month is at least 2 mg/dm^3).

After 12 months of exploiting the encapsulated scale inhibitor Descum-2 WSC ensured the stable operation of downhole equipment during the test period at the “X” field, there were no failures of downhole equipment due to "scaling".

The effectiveness of the encapsulated products use was also confirmed during pilot tests. In 2015, a test was carried out with an effective result of encapsulated Scimol WSC corrosion inhibitor and Descum-2 WSC scale inhibitor placed in a container at Lukoil AIK CJSC. In 2017, Gazprom Dobycha Orenburg conducted a test with a positive result of the encapsulated Scale Inhibitor Descum-2 WSC with placement in a sump [4].

At the moment, encapsulated products demonstrate rather high technological efficiency of use at oil production facilities, a little experience of the application shows that there is a prerequisite for more perfect technological efficiency and economic profitability of using solid reagents in the near future.

References

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