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Repair and Insulating Works Using the Grouting Material "FORT" by "SNK" LLC

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Abstract: The paper deals with the technological schemes of conducting repair and insulating works using the grouting material "FORT" by "SNK" LLC. The sequence of preparing the grouting material and the main stages of work organization are presented. Using "FORT" material allows providing the insulation of water influx successfully.

1. Introduction

The water encroachment of oil layers and wellbores evolving in the conditions of water displacement is a regular and unavoidable process. The operation of separate wells and the entire deposit is complicated by the presence of bottom water that is conically drawn into the bottom-hole zone and come into the well. In this case the well water cut progresses.

Under conditions of a layered structure of producing layers their most permeable, separate and narrow intervals are exposed to prime development. Naturally, they are sources of the well water cut. Besides, water emergence in oil wells is caused by defects in design, first of all, a low-quality cement ring.

Irrespective of the reasons water emergence in the production of oil wells leads to the decrease in the oil output. There are cases when separate wells are filled up with water completely while the most part of a producing layer still remains oil-saturated. Under these conditions to ensure the fullest production of layers and the reduction in the volumes of the extracted water it is necessary to isolate the already developed and watered intervals or to improve the low-quality cement ring [1, 2].

Despite a variety of conditions of the well water cut, distinctions in a geological structure of layers and various service conditions, almost the only material currently applied when carrying out repair and insulating works is grouting cement. Low filtration characteristics and high hygroscopic behavior can refer to the main shortcomings of the grouting material. Besides, the cement stone formed by Portland cement in hostile environment and mineralized water is a subject to high corrosion reducing its durability. Alternative grouting mixtures on the binding basis don't have the majority of these shortcomings. The grouting material "FORT" has been used as such a mixture.

2. Research

In February 2016 trials of the "FORT" mixture were carried out in the wells of Western Siberia fields.

The grouting material "FORT" includes the following components: FORT-B is a mixture of inorganic binding substances, FORT-C is a regulator of setting time and FORT-P is a grouting fluid.

FORT-B represents a mixture of mineral binding substances.

FORT-C represents a mixture of inorganic and organic acid salts.

FORT-P represents a water solution of inorganic and organic acids salts and surface active substances.

When mixing all "FORT" components a stable suspension is formed that possesses the ability to harden forming a strong stone. The hardening time of the grouting material "FORT" depends on the temperature conditions and is regulated with the quantity of the entered setting time retarder. The

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optimal time for the loss of mixture mobility is from 2.0 to 4.0 hours. Full hardening is from 1 to 2 days depending on the layer temperature.

The formulation of the working mixture and the amount of chemical reagents for preparation of 1 m^3 of "FORT" is specified every time relative to specific geological field conditions of the treated well.

Preparation of the grouting material "FORT" is carried out in the following sequence:

- the design quantity of FORT-P is collected in the cement surge tank;
- FORT-C and FORT-B are entered in the mixing mode;
- the received mixture is blended for 10-15 minutes until a uniform mixture is obtained and then the mixture is pumped in.

Thus prepared composition has the density of 1500-1800 kg/m^3. The strength development time of "FORT" after pumping is from 1 to 2 days depending on the layer temperature. As a result of reaction the "stone" is formed serving as an impenetrable barrier.

During operations and implementation of the technological process on preparation and pumping "FORT" the following equipment is used:

- an equipment set is necessary for connection with the wellhead assembly;
- a cement surge tank is necessary to prepare the mixture;
- a pump unit is necessary to pump the mixture;
- an oil tank car and a loader crane are necessary to deliver chemical reagents.

To prevent the influence of the increased pressure on the production string when repair and insulating works are carried out, the technology provides for the use of additional service equipment:

- a mechanical packer;
- a packer – retainer.

The technology of repair and insulating works using the grouting material "FORT" includes preparing the mixture on the surface, pumping it in the isolation zone, waiting on cement hardening and putting the well into operation. The general organization of works includes three main stages:

1. Hydrodynamic studies are carried out in the well; their aim is to receive initial data for planning the insulating works [3].

2. A pumping design is developed and a grouting material formulation is also selected, the necessary volume of the mixture and technological parameters of pumping are calculated [4].

3. The third stage includes all types of works connected with the preparation and pumping of the grouting mixture [5].

Before repairing and insulating works the following preparatory operations are carried out:

- raising the downhole equipment;
- identifying the source of water cut or the interval of production casing leakage;
- preparing the wellbore for insulating works;
- determining the injection capacity of a well at various modes.

After arranging the process equipment and briefing the personnel on safety measures by a person in charge the following types of works are carried out:

-connecting the equipment with the wellhead assembly;

-pressure testing the delivery line for 1.5 multiple operating pressure;

-preparing and pumping the necessary volume of the "FORT" mixture according to the technical plan for carrying out the repair and insulating works.

Upon termination of waiting on mixture time the following works are performed:

- drilling and normalization of the bottomhole (if necessary);
- downhole logging;
- secondary opening of the producing horizon;
- development of a well and lowering the downhole equipment.

Technological schemes of carrying out insulating works in wells using the grouting material "FORT" are constructed by analogy to schemes of insulating works with the application of grouting Portland cement.

The grouting material "FORT" is a non-selective material. Hardening happens both in water-saturated, and in oil-saturated parts of a layer. The hardened material is insoluble both in water, and in oil. Improving the integrity of the cement ring is carried out with the help of pumping the mixture behind casing in the places of violations. Shutting separate layer is carried out by pumping the mixture in the bottom-hole zone of a layer. Irrespective of the purpose of the carried out works the wellbore and, first of all, the intervals of isolation have to be carefully washed from various deposits, products of corrosion and products of acid reactions.

The well must be filled with the well-killing fluid. At the same time, the difference in the well-killing fluid density in tubing and the annual space isn't allowed, as it can lead to the emission of the pumped mixture if tubing breaks off and is raised and it can mix with the liquid filling the well.

If the well injection capacity is greater than 20 m^3/(day·MPa), at first, the absorption intensity is reduced. The formulation of the grouting material "FORT" is specified for each new batch for the conditions of expected temperatures and pressure for a specific layer and technology. The time of the beginning of mixture hardening has to be not less than the required time for pumping it in the isolation zone. The preparation of working solutions is carried out only after the implementation of all the preparatory work performed by the well workover crew. After preparation, to control the time of hardening a sample of the mixture is selected. The well-killing fluid is used as a displacement fluid. All equipment used for preparing and pumping working solutions is thoroughly washed out with water after the use. Improving the integrity of the cement ring is carried out by pushing the mixture through the existing perforation interval. The scheme of processing is given in figure 1.

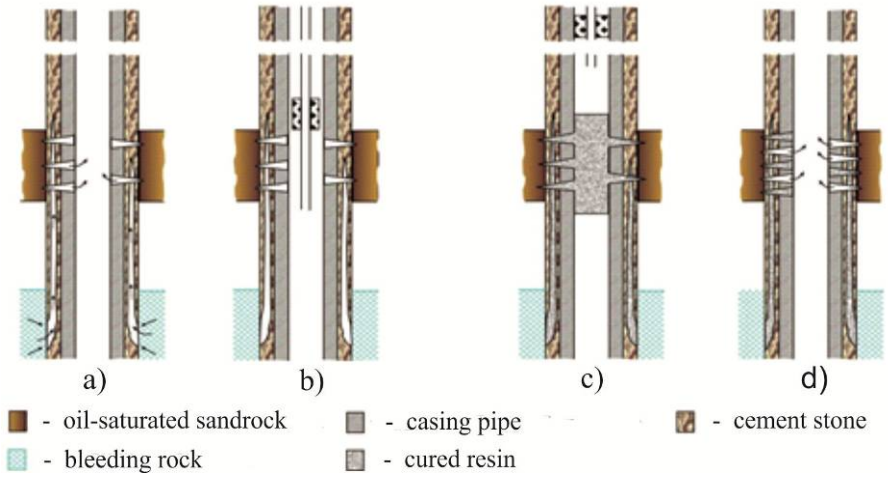


Figure 1. The process scheme of improving the integrity of the cement ring by squeezing the mixture through the existing perforation interval.

Improving the integrity of the cement ring to eliminate behind-the-casing overflows of formation fluids is carried out by a plugging under pressure method. Raising the tubing from the well and the subsequent wellbore drifting in the isolation interval is obligatory. Determining the well injection capacity is carried out in three pumping modes. If necessary, measures to increase the well injection capacity are taken (acid treatment, drainage, etc.). If the well injection capacity is greater than 20 m^3 (day·MPa), at first, the absorption intensity is reduce. When improving the integrity of the cement ring located above the producing formation, additional preparatory operations are conducted.

Depending on the size of the expected squeezing pressure [figure 1a] in the oil well tubing is lowered with or without a packer [figure 1b]. The mixture in a given volume is brought to the isolation

zone and squeezed into the well with an unfitted packer and an open annular space. Then the tubing is lifted above the possible level of the mixture in the well, a control mixture section is cut, a packer is set (if available) and the mixture is squeezed behind the casing in a set volume, the well is sealed under the pressure of 40-60% of the production casing test pressure for the required hardening and strength development time [figure 1c]. Figure 1d shows drilling of the hardened mixture "FORT".

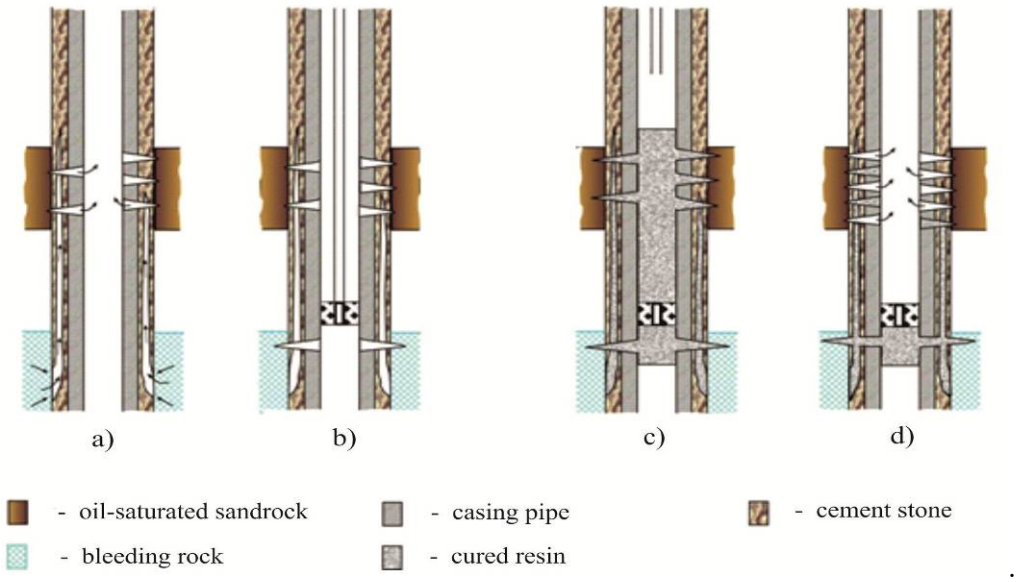


Figure 2. The process scheme of improving the integrity of the cement ring by squeezing the mixture through special holes.

To improve the cement ring [figure 2a] the string is additionally opened in a narrow interval of 0.5-0.8 meters [figure 2b]. The interval of additional opening is chosen so that between it and the interval of opening of a producing layer there was a possibility to reliably fit a packer-retainer. The packer-retainer is lowered and installed between the interval of opening of a producing layer and special holes in the string [figure 2b]. Fluid circulation is caused by forcing the pressure in the subpacker zone through breaks in a cement ring behind the string.

The design volume of the mixture is pumped via tubing through special holes behind the production string at an opened annual space. Detaching from the packer-retainer is performed and the volume of the mixture required for installing the bridge and overlappings of the perforation interval is pumped in the production string. Lifting of tubing is performed on a safe depth, backflush of tubing and sealing the wellhead is carried out at the waiting on mixture time [figure 2c]. Drilling of the hardened mixture, opening the layer and development of the wall are carried out. It is preferable to leave the interval of special holes closed with the grouting mixture column [figure 2d]. In some cases, perforation is made opposite an interbedded layer watering the well [figure 2b]. In these cases, it is advisable to create special holes in a roofing part of the watering interbedded layer, and besides filling the breaks in the cement ring, use them to create an impenetrable interbedded layer. To create an impenetrable interbedded layer the mixture is squeezed through special holes with a closed annual space and a set packer.

Figure 3 shows two general process schemes of isolating the bottom interbedded layer [figure 3, I, a] and the top interbedded layer [figure 3, II, a].

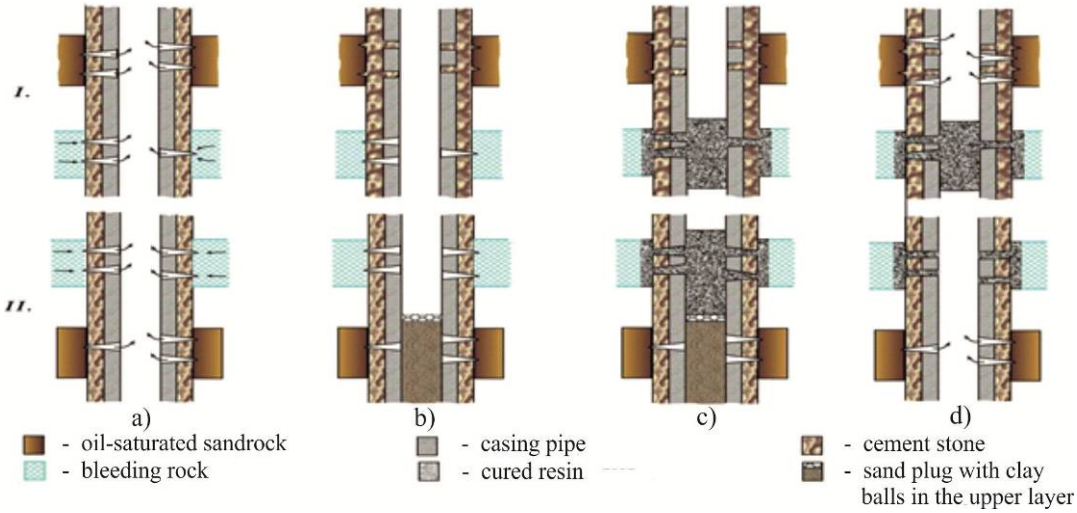


Figure 3. The process scheme of isolating the interbedded layers.

Injection of the mixture "FORT" in the perforation interval is carried out both using a technological packer in the case of shutting the overlying interval (with previous back filling of underlying interval) and using a packer-retainer when isolating the underlying interval. In the second case, a packer-retainer is set above the bottom perforation interval. The isolation zone must be carefully washed from different deposit, products of corrosion and products of acid reactions [6].

Building up the cement ring behind the uncemented casing string is made by plugging under pressure in the following cases:

- to protect the casing strings against corrosion from aggressive formation fluids;
- to eliminate or prevent the overflow of formation fluids in the uncemented annular space;
- to fill the annular space with the grouting material in the area of a casing defect or producing formations.

Pumping the grouting material into the annulus is carried out through special holes. If the well injection capacity of the absorption zone is greater than 20 m^3/(day·MPa), at first, the absorption intensity is reduced. The main method of eliminating the leakage of the casing string and annular space is grouting under pressure with the use of a technological packer of a packer-retainer. If there is a perforation interval below the unsealed casing, works are made to isolate it (a cement bridge, a bridge plug, an explosive packer). If the casing damage zone is located more than 100 m above the perforation interval, it is recommended to set up an additional cement bridge. Its capacity should be not less than 5 m at the 20 to 50 meter distance below the defect. If there are a few defects in the string successive grouting of every defect is performed from top down. Before grouting below the next defect at the 20 to 30 meter distance a dividing bridge is set up. Its capacity is not less 5 meters. If the string defect injection capacity is greater than 20 m^3/(day·MPa), a mixture with fillers is used or the absorption intensity is reduced. For the required hardening and strength development time a well is pressurized under the pressure of 40-60% of the production casing test pressure.

3. Conclusion

Thus, the grouting material "FORT" possesses sufficient hardening and setting times to get the work don;, the cement stone formed with this solution is resistant to corrosion. The use of the specified grouting material for repair and insulating works allows providing the isolation of water inflows.

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