APPLICATION OF MULTI-STAGE HYDRAULIC FRACTURING COMPLETION SYSTEMS WITHOUT THE USE OF PACKERS TO ISOLATE INTERVALS

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The article dwells on a new well completion technology for multi-stage hydraulic fracturing that does not require packers to isolate intervals. The method is based on using continuous cementing with hydraulic fracturing intervals isolated with a cement sheath. Bench tests and field trials have been conducted at five wells in Western Siberia. The advantages of the method have been shown, such as a shorter well construction cycle, minimized risks of cross-flows, the possibility to use in case of increased cavernosity, and no need for millout operations.

In the course of oil and gas well operation, the permeability of the formation's bottom-hole zone deteriorates due to the accumulation of paraffin, resinous, and clay and salt deposits. To address this problem and achieve a higher flow rate, various formation stimulation methods are used. Among them, the most common one is multi-stage hydraulic fracturing (MSF). Traditionally, MSF completion systems require setting packers to isolate intervals; however, this leads to a more complex design and higher capital costs. Packers have elastomer seals that are often mentioned in professional literature as vulnerable barriers (risk of degradation when exposed to temperature/environment, extrusion, incomplete fit, etc.), which is directly associated with leakages and loss of production. Numerous packer assemblies create local "hard" inclusions and areas of increased contact, which results in a higher load during the passage of curved borehole sections/horizons. In the course of RIH operations, packers may be responsible for more frequent local drags and a greater number of jamming cases. By reducing their number, operators can reduce the number of potential leak spots and make the liner RIH operations easier.

With this in mind, Tatprom-Holding Group has come up with an alternative method based on continuous cementing.

As known from up-to-date experience, cement sheath plays the role of a key barrier ensuring zonal insulation, supporting casing, and extending the borehole life. Given properly performed cementing design and quality control, this helps reduce the risk of cross-flows between zones and annular spaces.

THE CORE OF THE METHOD

The philosophy underlying the method assumes that hydraulic fracturing intervals are isolated by the cement sheath. This allows:

- creating a continuous barrier that isolates the zones;
- preventing fluid cross-flows;
- achieving higher reliability and efficiency of field development.

Respective equipment was developed to implement the method:

- a modified "ball-and-baffle" system (Fig. 1);
- a new cementing collar with anti-adhesive coating (Fig. 2);
- wiper plugs that are used for thorough cleaning of residual cement (Fig. 3).

TRIALS

A series of bench tests were performed at the premises of NChTZ LLC to verify the equipment operability. The results showed full compliance with the declared technical specifications and customer requirements.

Fig.1 Modified "ball-and-baffle" system

After that, the method was put into practice at five wells in Western Siberia (with a liner diameter of 102 mm). All RIH and cementing jobs were completed as designed, and the ports were activated at the design pressure levels (see the table). The set of plugs successfully reached the landing collar and locked.

Since there are no equipment elements requiring millout, the well's time-to-first-production was reduced with zero reaming costs.

RESULTS AND DISCUSSION

High-quality isolation of intervals was achieved at all five wells due to the use of the cement sheath.

Multi-stage hydraulic fracturing modes

Well No.	Hydraulic port opening pressure, MPa	Proppant quantity, · 10^4kg	Opening pressure of the 2nd port, MPa	Proppant quantity, · 10^4kg	Opening pressure of the 3d port, MPa	Proppant quantity, · 10^4kg	Opening pressure of the 4th port, MPa	Proppant quantity, · 10^4kg	Opening pressure of the 5th port, MPa	Proppant quantity, · 10^4kg
1	41.0	6	48.6	6	64.2	6	43.0	6	50	6
2	31.0	7	32.0	7	37.0	7	54.0	7	–	–
3	35.0	–	39.0	13	57.0	13	29.0	13	–	–
4	51.8	9	35.0	9	36.9	9	–	–	–	–
5	42.0	5	55.1	18	38.0	18	48.7	18	–	–

The planned flow rates were achieved as designed.

Since no equipment elements requiring millout were used, the well's time-to-first-production was reduced with lower reaming costs.

The method revealed an additional advantage, i.e. the possibility of setting hydraulic frac sleeves in zones with a high cavernosity ratio, in which the use of packers would pose difficulties.

LIMITATIONS OF THE APPLICATION

The key factor of successful implementation is the control over cementing parameters. It is recommended to use normal-density cement (1.90 g/cm3).

Lightweight mortars are undesirable due to the risk of unwanted crack formation in the respective interval.

CONCLUSION

The proposed well completion method with the use of MSF completion systems without interval-isolating packers has demonstrated high efficiency and reliability.

By implementing the method, the following can be achieved:

- a shorter time of the well construction cycle;
- lower production costs;
- higher profit margins of projects;
- broader application of hydraulic fracturing at fields with challenging geology.

Thus, the continuous cementing method can be considered as a promising direction for the development of EOR methods applied to hard-to-recover reserves.

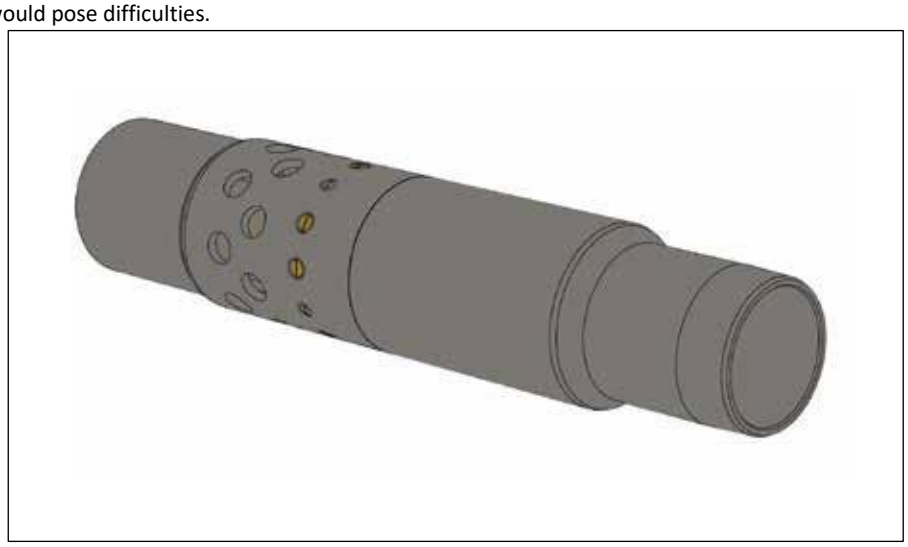

Fig. 2. A new cementing collar with anti-adhesive coating

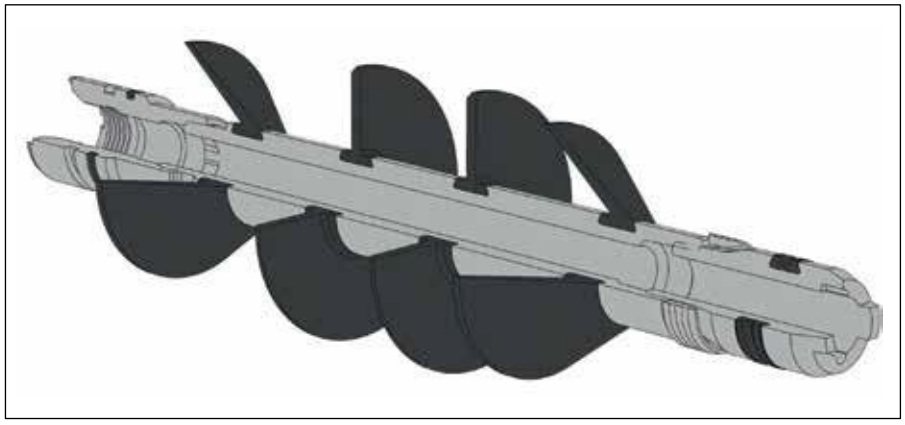

Fig. 3. Wiper plugs that are used for thorough cleaning of residual cement