OPTIMIZING WELL COMPLETION EQUIPMENT

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Companies have turned towards well completion systems that do not require millout. What's the know how? What are the results?

A significant challenge in completing wells for subsequent multi-stage hydraulic fracturing, as well as wells with screen completions or collar cementing completions is posed by the need to mill out pump-down plugs, cementing collar components, junk catchers, catching baffles, non-dissolvable frac baffles and frac balls, as well as knock-off caps on well screens. The millout job is performed by a workover crew with the use of a slim-hole rig with milling tools and low-power downhole motors. The millout process takes between 40 and 72 hours, and in some cases even longer, which extends the well's time-to-first-production.

To address this issue, the industry is now turning towards well completion technologies that utilize tools with dissolvable internal components and elements.

Among the pioneer technologies incorporating dissolvable components was collar cementing, used in a combined casing string (Combined Production String, see Figure 1). The completion equipment includes a 178-mm stage cementing collar, a 178-mm junk catcher with dissolvable components, and a set of pump-down plugs.

Operators widely implement this system in Western Siberian fields. After the completion equipment is run in hole, a workover crew arrives at the wellhead 15–20 days later to perform the reaming job to subsequently run the frac plug (stinger) and proceed with multi-stage fracturing. The time required to mill out the interval, in which soluble tool elements were set, is only about 30 minutes, compared to 40 hours, if a standard completion is used. No dissolution by-products, component fragments, or rubber cuttings were detected. The BHA was run in hole freely during the millout operation, and no tight spots or overpulls were recorded (see Figure 2). The key advantage of this technology is that there is no need for additional RIH/POOH operations to mill out catching baffles and plugs after the WOC (Wait-On-Cement) period. Consequently, it saves rig time for the drilling crew, while ensuring predictable dissolution (the components are manufactured from the same material as used for dissolvable frac balls).

The next technology involving soluble components is the soluble activation dart system (see Figure 3).

The multistage hydraulic fracturing (MSF) activation dart is an innovative solution enabling effective activation of the target frac sleeve. The dart is pumped down to the frac sleeve simultaneously with pumping the previous stage fluid or immediately prior to conducting multi-stage hydraulic fracturing operations. Each frac activation dart has a unique activating mechanism that is actuated exclusively when contacting a target frac sleeve having a suitable profile. After that, the activation dart clings to the frac sleeve and deploys, creating an axial thrust that opens the frac sleeve for the next stage of hydraulic fracturing.

An activation dart is part of an equal-bore frac sleeve assembly, which enables achieving an optimal equal-bore liner completion cross-section without the need to mill out catching baffles. The activation darts are produced from custom-selected dissolvable materials that are suitable for downhole conditions and the requirements set by the client. Activation darts do not require additional millout jobs in the well after hydraulic fracturing, therefore there is no need to run coiled tubing systems and a wireline in the hole. This simplifies the process of bringing the well into production while reducing the costs associated with flow initiation.

The combined production string technology has the following characteristics and advantages:
Dissolvable materials: no need for subsequent millout operations in the well.
No need for CT or wireline: lower operational costs and simpler fracturing jobs.
Custom-selected materials optimally tailored to specific well conditions (pressure, temperature, fluid composition).
Equal-bore completion assembly: smoother passage of a liner completion during well interventions and workover operations.

Figure 1. Combined Production String

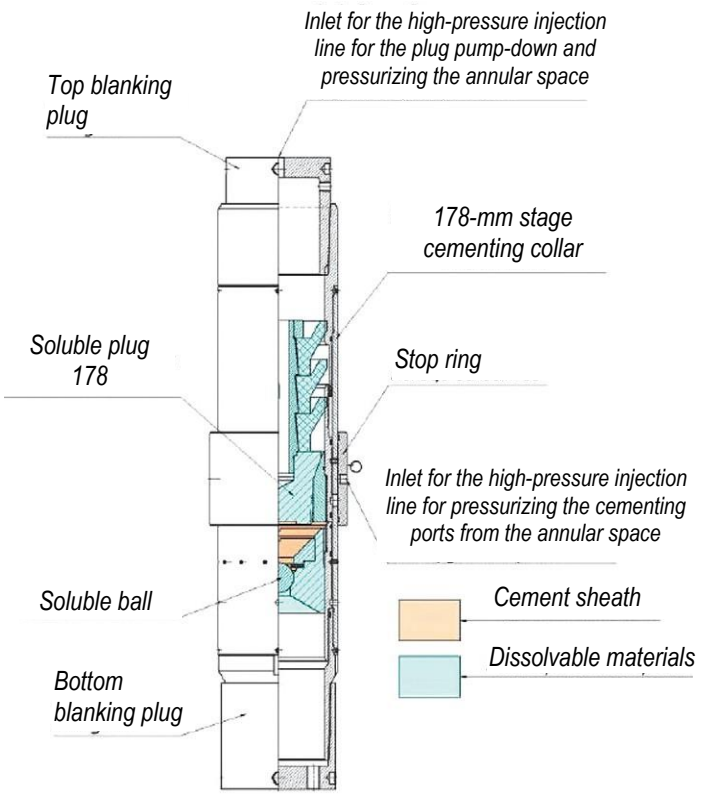

Figure 2. Equipment with dissolvable internal components

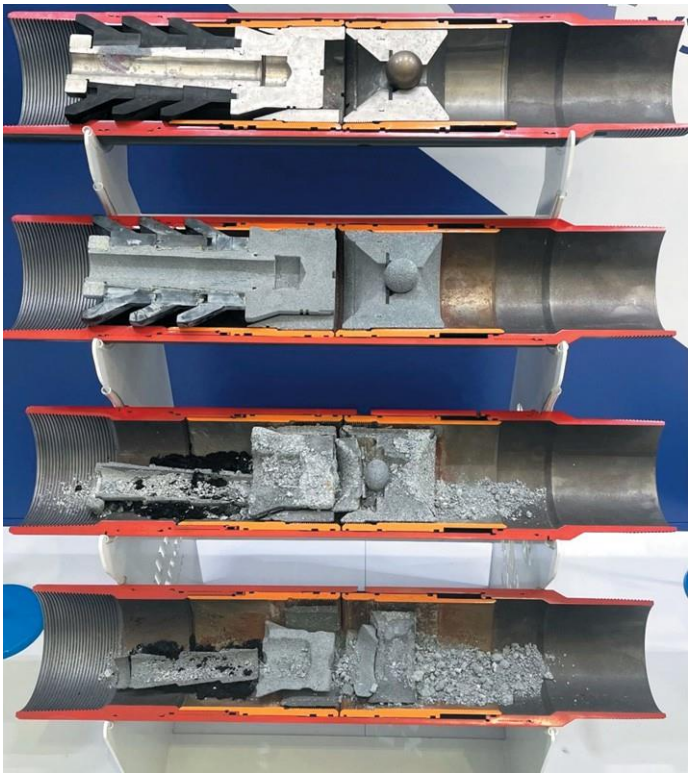

Figure 3. Frac Activation Dart

Unlimited number of stages: enables MSF operations with virtually any number of stages.
Accelerated dissolution is achieved by injecting acid, if required.

By now, this equipment has been successfully field-tested in an oil well operated by PJSC Rosneft. The completion with activation dart-driven frac sleeves fully proved its operational reliability in field conditions. The dart dissolution time was within 10 days (the actual time till well flowback). The dissolution time for the dissolvable activation dart, specified by TatProm-Holding Group, was at least 8 days. The equipment activation, hydraulic fracturing, and millout operations were carried out as per design. When reaming the interval, where the completion elements were set, no dissolution by-products, component fragments, or rubber cuttings were detected.

In the context of the development of modern full-bore completion systems, frac sleeves with dissolvable ball catching baffles are currently being tested. This solution is at the final stages of development, with factory acceptance tests underway. This technology and equipment will enable completing wells and performing multi-stage fracturing utilizing the conventional method, i.e. by dropping frac balls of various sizes. However, milling out the ball catching baffles to make the liner equal-bore will not be required, as the baffles, manufactured from a long-dissolvable material, will dissolve after a pre-set time (from 40 days and beyond).

The challenge faced when implementing such a technology is the need to have precise data on the frac job dates for each well, since there may be a significant time gap between the running the completion assembly and HF operations on remote fields. In such a case, the "ball-and-baffle" system integrity in the frac sleeve could be lost, which would make further operations impossible. This technology is scheduled for serial production in the near future.

To finalize the overview of reservoir stimulation technologies, here is some information regarding screen completions.
When running screens in long horizontal sections of the pay zone, circulating is often required to run the completion assembly to target depth without trouble. In this case, screens with pre-installed plugs must be used to prevent the circulating fluid from escaping through the uppermost perforations. After the liner hanger is run and the hanger is set, a workover crew arrives at the well to mill out the screen (knock off the plugs) by running a junk mill. If sealing plugs used in the screen are made from a dissolvable material, there is no need for such a millout job. However, numerous factors and nuances must be considered when implementing this technology. Dissolvable materials have a very soft structure, so some of the plugs may fall out in the course of the manufacturing and installation or fail to hold pressure during the initial screen pressure testing. Consequently, a new plug design, different from the designs commonly used earlier, must be employed. Therefore, changes are required to both the screen installation method and pressure testing procedures. Furthermore, as noted earlier, close attention must be paid to screen storage conditions and running schedules, as the dissolvable material is sensitive to humidity. Prolonged storage in humid environments or exposure to humid conditions can result in impaired functionality of the dissolvable plugs.

Despite all the complexities associated with dissolvable materials, their application in completion tools helps significantly reduce the well's time-to-first-production and substantially save the operator's physical and financial resources during the flow initiation phase.