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Openhole Multistage Frac Systems Offer Economic Advantages

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Operators have looked to increase production through cost-effective completion methods such as horizontal, multi-stage fracturing in unconventional reservoirs. Recent completions in unconventional reservoirs have been designed to increase the effective surface area of the well to maximize reservoir contact. The two primary methods of horizontal drilling and multistage fracturing – cemented liner plug-and-perf and open hole multistage (OHMS) systems – have accomplished this. Both systems have the same goal of increasing access to the reservoir through the induction of fractures along the entire length of the horizontal wellbore, but they differ significantly from an operational perspective.

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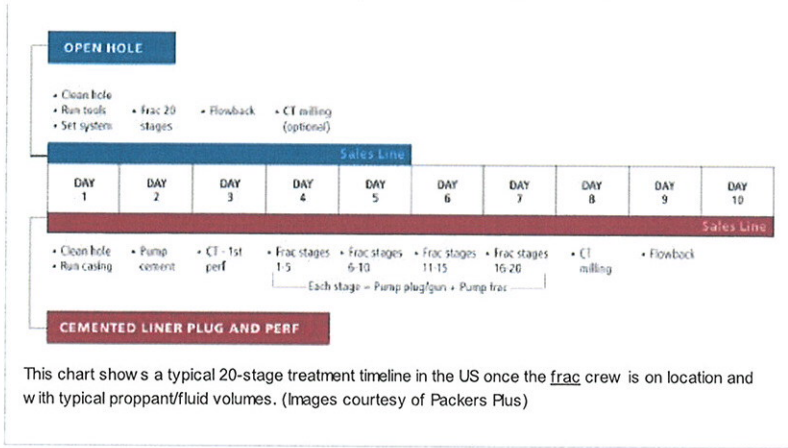
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The state of the industry

Plug-and-perf involves cementing production casing in the horizontal wellbore and then using perforating guns to create access to the formation for hydraulic stimulation. After the first stage is stimulated, a bridge plug is pumped down via wireline or conveyed by coiled tubing (CT) and set uphole of the perforations. In this way, the cement provides a mechanical diversion in the annulus, and the bridge plugs provide mechanical diversion in the casing. The perforating and fracturing combination is repeated for each stimulation stage in the horizontal wellbore. After all of the stages have been completed, CT is used to drill out the bridge plugs so the well can be put on production.

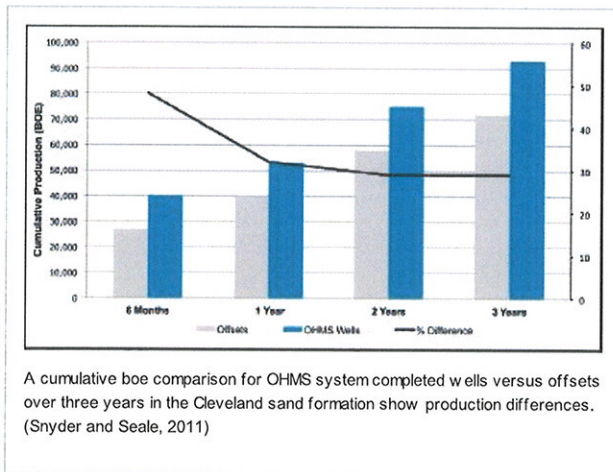
OHMS, or ball-drop, systems were pioneered in 2001 by Packers Plus Energy Services. The goal was to increase the efficiency of multi-stage fracturing by decreasing fracture treatment time and overall costs. These improvements created a system that was much more repeatable and reliable than previous methods. OHMS systems use hydraulically set mechanical packers to isolate sections of the wellbore. These packers seal against the wellbore, isolating the stages for the life of the well.

The OHMS system is run in hole on either a drilling rig or service rig, and the tools are spaced out on the production liner. Once the system reaches total depth, the packers are set, and the drilling or workover rig can be moved to a different location. These systems have fracture ports that create openings between packers. The fracture port tools are opened either hydraulically (at a specific pressure) or by dropping size-specific actuation balls into the system to shift the sleeve and expose the port to the reservoir. The balls create internal isolation from stage to stage as the stimulation process moves from toe to heel in the wellbore. Once stimulation of all stages is complete, the well can be flowed back immediately and production brought online.



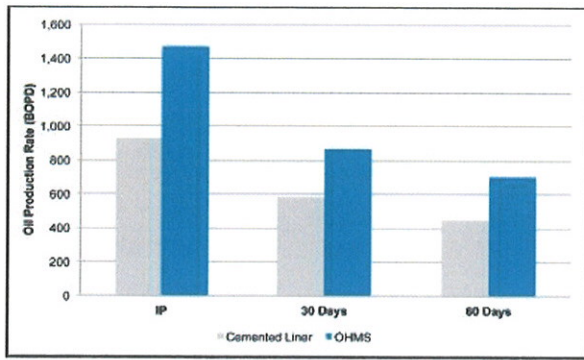
System comparison

Plug-and-perf operations have many operational issues associated with multiple wire-line and/or CT trips in and out of the wellbore to convey the perforating guns, bridge plugs, and other fracturing equipment required for each stimulation stage. This process also suffers from long delays, which result in increased costs and inefficient use of time. And production can be negatively affected due to the cement closing off the wellbore to many natural fractures and fissures that would otherwise contribute to overall production. Safety risks also are present in these highly labor-intensive operations.



The speed at which the stimulation treatments can be placed, the reduction of fluid loading on the reservoir, and under-displacement are key benefits of OHMS. The primary advantage of OHMS systems is that all of the fracture treatments can be performed in a single, continuous pumping operation without the need for CT or wireline. The OHMS approach takes considerably less time than the plug-and-perf method, resulting not only in cost savings but also allowing more efficient use of limited frac crews. In addition, this lowers risks to health and safety, as less time is spent performing high-risk operations such as the use of perforating guns, working around high-pressure lines at the wellhead, and wire-line tripping.

When OHMS system stimulation is complete, the well can be turned over immediately to production or testing. Because the well can be flowed back directly after stimulation, fracture fluids are in contact with the reservoir for significantly less time, thus mitigating induced damage to the reservoir.



Initial production, 30-day and 60-day average daily production rates for wells completed with cemented liners or OHMS systems in the Bakken formation. (Snyder and Seale, 2011)

Another feature of OHMS systems is that less fracturing fluid is used. This is because in the plug-and-perf method, bridge plugs need to be pumped down the casing, which requires the wellbore to be flushed clean of all proppant to avoid getting the plug stuck before it reaches the desired setting depth. This reduction in fluid can add up to significant cost savings. For example, in the Bakken an extra 200 bbl is used per stage to pump down plugs. For a 14-stage completion, the average cost for water using OHMS is US \$40,000, saving 15% or \$6,000 per job. The cumulative effect of these savings taken over the course of a sustained drilling program can have a significant impact on the rate of return of the project.

There are benefits to both approaches, but OHMS provides an opportunity for operators to increase on-site efficiency as well as long-term production and economics.

References available