Successful Application of a Specialized Drill-In Fluid in Horizontal Niagaran Reef Wells in the Michigan Basin

Technical case study | Saber Drilling Fluids | Disolv-Seal® technology

A proactive reservoir drill-in fluid engineered with Disolv-Seal® provided effective lost-circulation control throughout the horizontal reservoir intervals of Consumers Energy's Ray 511 and Ray 510 wells. The system enabled both wells to maintain circulation and reach planned total depth while minimizing formation damage and preserving post-cleanup hydrocarbon deliverability

Geological and Operational Context

The Niagaran pinnacle reef trend is a mature Silurian carbonate petroleum play with a substantial exploration and production history in the Michigan Basin. Exploration for northern Michigan Niagaran reefs dominated petroleum activity in the state from 1969 through 1987. By the end of 1986, cumulative production from the northern reefs had reached approximately 268 million bbl of oil and 1.4 Tcf of natural gas (Gill 1994).

Niagaran reef reservoirs are characterized by considerable geological and petrophysical heterogeneity. Reef development varied in response to depositional setting, relative sea-level change, facies distribution, and subsequent diagenesis (Ritter and Grammer 2018). Within the northern reef trend, the principal reservoir rock consists of porous and permeable dolomite containing intercrystalline pores, separate vugs, and touching vugs. The relationship between porosity and permeability varies substantially among these pore systems, making reservoir behavior difficult to predict from bulk porosity alone (Suhaimi 2016). The Niagaran reef plays are also recognized as important components of the broader Michigan Basin petroleum system (Charpentier 1988).

These reservoir characteristics can create significant drilling-fluid-management challenges. Saber Drilling Fluids' experience in the play has shown that highly porous and vuggy intervals can accept substantial volumes of fluid after exposure to the wellbore. Loss of returns can interrupt drilling, impair effective cuttings transport, complicate hydraulics management, and increase the time required to reach planned total depth.

For horizontal wells, these risks become more consequential as the length of exposed reservoir increases. Conventional lost-circulation strategies often respond to losses after they occur through the addition of lost-circulation material or separate remediation treatments. On a recent two-well Michigan Basin pad, Saber implemented a proactive reservoir drill-in-fluid design intended to reduce fluid losses as the producing interval was drilled.

Fluid-System Design

The reservoir drill-in fluid incorporated Saber Drilling Fluids' proprietary Disolv-Seal® technology as a temporary formation-sealing component. The system was designed to bridge irregular pore throats and vug openings as they were exposed, thereby forming a removable barrier between the circulating fluid and the reservoir.

The design focused on maintaining circulation through the planned reservoir interval, limiting whole-fluid and filtrate invasion, supporting effective hole cleaning and manageable drilling hydraulics, reducing dependence on reactive lost-circulation treatments, and preserving hydrocarbon deliverability following cleanup and completion.

Disolv-Seal® was incorporated into the active fluid system rather than deployed only after significant losses had developed. This allowed the sealing material to circulate continuously across newly exposed reservoir surfaces. As the fluid contacted porous and vuggy dolomite, the bridging package was intended to create a temporary filter cake across fluid-entry pathways.

The fluid was managed to balance sealing performance, circulation, wellbore condition, and reservoir protection. Because the sealing system was designed to be temporary and removable, it could be addressed during the planned cleanup and completion sequence.

Field Application and Results

The fluid system was used while drilling the horizontal reservoir intervals of both wells on the pad. Circulation was maintained through the target sections, and both wells were drilled to their planned total depths.

Maintaining returns allowed drilling to continue through the planned reservoir exposure without curtailing the laterals because of uncontrolled fluid losses. The proactive sealing approach also reduced the operational disruption associated with repeatedly stopping drilling to treat losses after their onset.

The field response was consistent with effective temporary bridging of the exposed pore and vug system. This conclusion is based on observed circulation behavior and the ability to continue drilling through the reservoir, rather than on direct observation of the sealing structure downhole.

Following drilling, the temporary sealing system was addressed through the planned cleanup and completion process. The wells subsequently demonstrated hydrocarbon deliverability. This result indicates that the temporary sealing treatment did not prevent production after cleanup; it should not be interpreted as proof that formation damage was eliminated entirely or that all original reservoir permeability was restored.

Operational Significance

The two-well application demonstrates that a properly engineered reservoir drill-in fluid can reduce the operational exposure associated with drilling heterogeneous, porous, and vuggy Niagaran reef carbonates.

The results are specific to the conditions encountered on this pad and should not be treated as universal performance data for every Niagaran reef well. Reef geometry, pore distribution, permeability, pressure, fluid properties, well trajectory, and completion design can vary considerably between locations.

Nevertheless, the project establishes a practical design basis for comparable wells. By approaching fluid loss as a condition to be managed proactively rather than solely as an event to be treated after it occurs, operators may be able to maintain circulation, reach planned total depth, and increase reservoir contact without depending exclusively on reactive lost-circulation treatments.

Conclusion

Niagaran reef reservoirs combine meaningful hydrocarbon potential with complex carbonate pore systems that can create substantial drilling-fluid losses. On this two-well pad, a specialized drill-in fluid incorporating Disolv-Seal® maintained circulation through the planned reservoir intervals and enabled both wells to reach total depth.

The application demonstrates the potential value of proactive, temporary formation sealing in mature carbonate reservoirs. For wells encountering similar porous and vuggy conditions, the technology provides an alternative to accepting severe fluid losses or relying entirely on remedial lost-circulation treatments after

losses have developed. Treatment design should remain specific to the geology, drilling program, reservoir conditions, and completion objectives of each well.

References

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