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Unraveling the Bakken's EOR complexity

With a well test underway, one independent energy company works to decipher the Bakken's EOR secrets.

Jennifer Presley, Executive Editor

The Bakken Shale that spreads approximately 520,000 sq km (200,000 sq miles) beneath Montana and North Dakota holds an estimated 7.6 Bbbl of undiscovered, technically recoverable oil, according to the U.S. Geological Survey. It is but a fraction of the total 167 Bbbl of original oil in place that the North Dakota Department of Natural Resources estimated in 2008.

With decline rates as high as 70% over the first three years of production and a primary recovery rate of about 7.5% of original oil in place, finding ways to recover more oil using EOR techniques in the maturing unconventional play is key.

Widespread interest has lead to numerous R&D efforts, with reservoir modeling and testing in a laboratory setting serving as the critical first step with testing of promising theories in the field the next step.

Building on the many years of experience it built in its Permian Basin EOR operations, Hess Corp. began an EOR R&D project in 2015 in the Bakken Shale. In 2016 the company drilled a gas injection and a production well targeting the Middle Bakken at Ross Field in Mountrail County, N.D., in the company's Red Sky acreage as part of the project.

E&P recently spoke to Dougie McMichael, director of Bakken well factory planning and execution, at Hess Corp. about the company's EOR efforts.

_E&P_: What are the primary challenges of EOR in the Bakken Shale?

McMichael: The team has identified three major challenges that will affect the success of the project. First, [the challenge is] whether the injectant fluid-rock interaction will yield incremental production—will EOR work in the Bakken? Secondly, conformance of the injected fluid to create optimized contact with the oil with the least amount of injectant needed in the reservoir [is a challenge]. Finally, how to control the injectant on a drilling spacing unit and/or work with offset operators to maximize the recovery [is another challenge].

Dougie McMichael

_E&P_: How do these challenges compare to other unconventional resource plays?

McMichael: EOR has yet to find wide application in unconventional resource plays, but it does appear that several companies are looking at it seriously. Most are handling their information confidentially, as you can imagine for a technique that might have a competitive advantage, so we don't know for sure how the challenges in the Bakken compare with other plays.

Our best assessment is based on publicly available information, which suggests the challenges are similar. For example, it will be important to have completions that enable gas to be injected efficiently, and it will be important to find areas where the formation is able to contain injected gas. We will also need to have access to infrastructure to supply, inject and then process the gas being used for the EOR scheme.

_E&P_: How has Hess applied its Permian Basin EOR expertise in the Bakken?

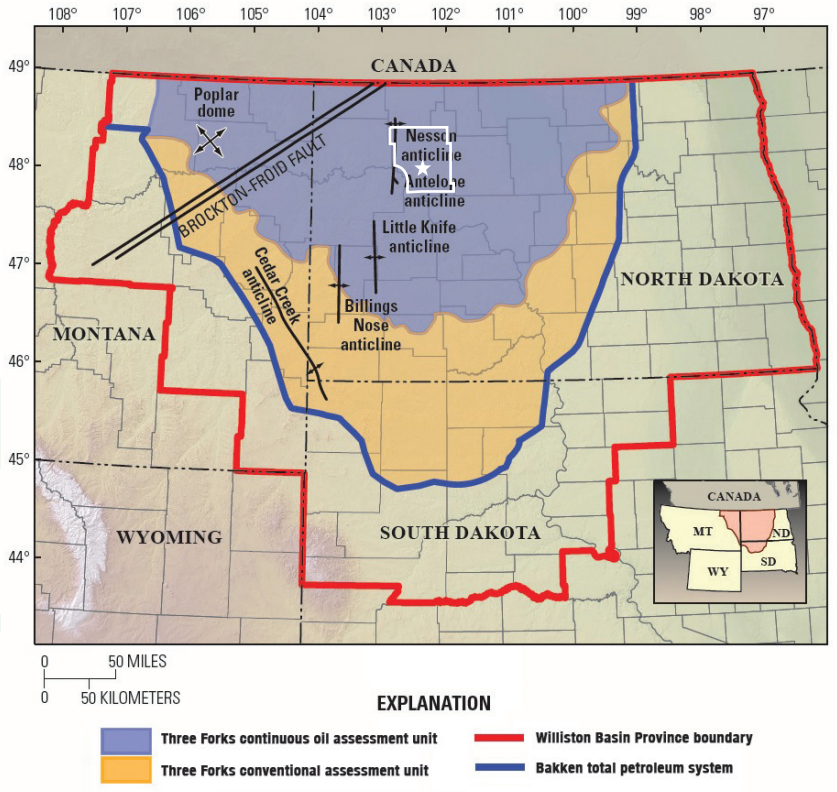
McMichael: Hess had many years of EOR experience in the Permian, where we operated a CO_2 injection scheme. The Permian assets were divested by Hess in mid-2017, but we managed to retain knowledge and skills from that work. In particular, the type of skills the company has as a result of our work in the Permian include reservoir modeling of EOR schemes and designing lab studies to support and optimize the CO_2 injection. Bakken Formation characteristics are quite different to Hess' former Permian development, so we are working on some issues for EOR application in the Bakken Formation that are different from the Permian.

_E&P_: EOR requires a formation that can accommodate the pressuring up of the reservoir and can contain the gas long enough for it to soak into the formation. The Bakken Shale is a highly fractured, complex formation with a dense rock matrix. How will the gas penetrate the nearly impenetrable rock?

McMichael: You are correct that we need the formation to contain the injected gas long enough to contact oil-bearing rock and increase the displacement of oil from the rock. It also is the case that the Bakken Formation is complex with a dense rock matrix.

The formation is variable across the basin, however, and Hess has a large acreage position. We can look at the characteristics of the rock across the formation to decide on where we think the application has the best chance of success.

We think the gas will migrate through the formation and contact oil-bearing rock using the same flow paths that are used for production. That includes hydraulic fractures that we initiate during well completion, natural fractures in the rock and the rock matrix. We know the formation produces oil, lots of oil, so we have high confidence we can get gas in, providing we have sufficient pressure to inject.



Mountrail County, N.D., is indicated by a white star and outline on this map of the Bakken and Three Forks formations within the Williston Basin of North Dakota, Montana and South Dakota. (Source: U.S. Geological Survey)

***E&P*: How is the gas floating the oil molecules out of the microscopic pores, into the fractures and then to the surface?**

McMichael: We believe there are a few possible mechanisms at play. Our current thinking is that potential mechanisms include oil and gas mixing, which results in the volume of oil swelling and then expelled out of the pore space, into the fracture and then produced.

There also is potential for oil to vaporize into the gas phase and then flow into the fracture and recondensate back to oil downstream of the fracture. We don't know for sure the relative impact of each and there are other mechanisms that would be at play. We are actively trying to improve our understanding of the specific processes that are leading to increased oil recovery through lab work and other studies.

***E&P*: How was the testing site selected?**

McMichael: Parameters for selection were established and various areas evaluated. Among the factors that underpinned the selection of Red Sky was an assessment of the reservoir fluids that were suitable for an EOR test, and there were no significant horizontal well development activities in this area of the field during the time frame of the planned test. This allowed for a controlled test environment for this part of the project.

***E&P*: It has been said that to successfully apply EOR in an unconventional resource play like the Bakken that it will take an 'unconventional' approach. Are you finding this to be true? How far 'out of the box' is Hess' approach to solving the Bakken EOR puzzle?**

McMichael: Interesting statement and it has its merit. I would say we are on the edge of the box, the general theories are the same for EOR in conventional and unconventional—improve sweep area/matrix contact and improve recovery.

Our approach has been to understand how EOR works in an unconventional play, identify the key factors for improved recovery, capture differences between play types and apply lean methodologies to problem solve to reach a solution.

I also would add that with technology that is still in a testing phase in our industry (unconventional EOR) we must also be willing to learn from other operators. We also feel that there will be variance from play to play that has to be understood and adjustments made to be successful. E&P