New life for Oklahoma's North Burbank field

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CO_2 EOR opens new chapter for an historic field.

What does football have in common with CO_2 EOR? Both are all about contact. "A good friend of mine summed it up really well – he likened the process to a contact sport," said Scott Wehner, vice president of EOR operations for Chaparral Energy. "If you can contact the hydrocarbons and keep in contact with them, you're going to get recovery. And the longer you are in contact, the better the recovery."

The Oklahoma City-based company is no rookie when it comes to EOR projects.

In June Chaparral began injecting CO_2 into its mature oil field of the North Burbank Unit (NBU) located in northeastern Oklahoma. Representing the largest of eight operated COEOR projects for the company, its capital investment into the NBU to date is nearly US $250 million, according to a press release. The NBU project is a key element in the company's CO_2 EOR program and solidifies its position as the third largest CO_2 EOR operator in the US based on the number of projects under way.

The initial phase of the project involved the installation of a CO_2 capture and compression facility at a fertilizer plant in Coffeyville, Kan.; the laying of a CO_2 pipeline; the construction of field infrastructure facilities for the injection of CO_2 into the reservoir; and complementary infrastructure to gather the produced fluids and CO_2. A facility also was constructed to recycle produced CO_2 back to the reservoir. Over the projected 30-year lifespan of the project, the company estimates the total capex will eventually approach $1.4 billion. Covering more than 23,000 acres, the NBU is the single largest producing unit in the state of Oklahoma. The company expects to recover an additional 88 MMbbl of oil from the NBU, which already has produced more than 319 MMbbl of oil since its discovery.

Field challenges

Drilled in 1920 by Marland Oil Co., the Bertha Hickman #1 well was the first to produce oil from the Burbank field. The initial discovery produced 150 b/d from the Burbank sand at a depth of 899 m to 915 m (2,949 ft to 3,001 ft). Later that year Roxana Petroleum Co. brought in another well at 3,450 b/d in the same general area. The field had its highest production from 1920 through 1924 with 20 MMbbl to 31 MMbbl of oil annually, according to the Oklahoma Historical Society's website.

"This reservoir has been through big swings in its life. It went through primary production from 1920 to 1950," Wehner said. "Actually, prior to 1950 there was some production that you could consider secondary because there was some natural gas injection into the field. There was not a market for the gas at the time, but
it was a good product to use for pressure maintenance."

Waterflooding of the reservoir began in 1950 by Phillips Petroleum Co.

"Primary production blew the reservoir down to somewhere in the 150-psi to 200-psi range from the initial

reservoir pressure, so it was quite depleted," he said. "Over a 10-plus-year period Phillips expanded from the south to the north and fully implemented waterflooding throughout the entire project into the early '60s." Reservoir pressure over ensuing decades depleted again, to somewhere in the 800-psi to 900-psi range, he said.

"Chaparral ultimately ended up with the project and saw the early need for raising the pressure to miscible conditions prior to CO_2 injection," he said. "Laboratory studies showed that we needed to reach 1,700 psi to achieve miscibility."

Achieving miscibility

Before work could begin on bringing the reservoir pressure back up, extensive construction of facilities and infrastructure had to be completed. Starting in 2010, the company began the permitting and construction

process. The field is located in Osage County, where approvals and permitting do not go through the state but through the federal Environmental Protection Agency (EPA) and the Osage Nation.

"The permitting process started two-and-a-half years ago, and we worked very closely with the EPA to educate them as to what we were going to do," he said. "It was a new process that had not been permitted before through the agency."

While the permitting process was under way, the company set to work remediating the old wellbores in the field.

"At one time, the unit had almost 2,900 wellbores. To get the project online, we remediated close to 250 well-bores and redrilled about 30 wells," Wehner said. "Phase I started in a northern area, which held the highest number of remaining wellbores, so we haven't had to redrill quite so many."

With permits secured and wellbores brought up to date, the company set to work.

"We started building the reservoir pressure from 900 psi at a steady rate, achieving miscible pressure in our Phase I area in April of this year, and we have maintained it since we started CO_2 injection through a material

balance reservoir management of the operation," he said. "But it took us approximately two years to fully get that pressure up to that level. We reached it a couple months ahead of our target."

To do this, the company had to revamp all of the water distribution and production gathering systems in the field, he said. "We also installed the CO_2 distribution system. Effectively, we've got an entirely new system in an old, historic field."

In addition to new gathering and distribution systems, the company installed a 109-m (68-mile) long 8-in. pipeline from the CVR Partners' Fertilizer Plant in Coffeyville to the NBU.

"We capture the anthropogenic CO_2 at the stack, bring it from 1 psi, and run it through blowers, which brings it up to about 15 psi to 20 psi. The COthen goes through four stages of compression. Between the third and fourth stage we dehydrate the gas, and once we come out of the fourth stage we're in the 1,300-psi to 1,400-psi range.

"The CO_2 is then run through horizontal CO_2 pumps because it's at a supercritical state, and it is more efficient to pump than continue compressing. Once we get the pressure into the 2,000-psi range, we send it

down the pipeline to the field," Wehner said.

The pipeline began operation earlier in June and has the capacity to move up to 1.7 MMcm/d (60 MMcf/d) of captured CO_2.

Next steps

According to Wehner, everyone involved with the project is looking forward to the month of November. "We

have projected initial response to be in the fourth quarter of this year. Typically, if you get an early response –

assuming that your engineering is all done correctly – that suggests that you might experience poorer ultimate

recovery. If it's more of a delayed response, then you will have more time to contact the oil and potentially get better ultimate recovery. It would be great if this thing responds in November of this year because that means we have done all of our engineering right."