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Advanced Reservoir Characterization and Horizontal Laterals
in a Class I Reservoir – East Binger (Marchand) Unit”**

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Principal Author/Investigator: **Joe Sinner**

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Contractor Name & Address: **Binger Operations, LLC
P. O. Box 2850
Cody, Wyoming 82414**

DOE Project Manager: **Chandra Nautiyal, National Petroleum Technology Office**

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Abstract

A significant work program was implemented from 2002 to 2005 in the East Binger Unit (“EBU”) miscible nitrogen injection project in an effort to reduce gas cycling and economically increase ultimate oil recovery. This work included the drilling of new wells, both horizontal and vertical, as well as pattern realignment through producer-to-injector conversions.

Monitoring of overall performance of the pilot area continues. Response to the various projects continues to be very favorable. Injection into the pilot area, despite being limited at times by problems in the Air Separation Unit of the Nitrogen Management Facility, has increased an average of 60% over levels prior to the project. Meanwhile, gas production and nitrogen content of produced gas have both decreased. After decreasing to 20-25% early in the project, nitrogen recycle (produced nitrogen volume divided by injected nitrogen volume) within the pilot area has risen to about 40%, still far below the 72% prior to initiation of the project.

Poor areal sweep efficiency appears to be the primary cause of nitrogen cycling. Seven vertical and three horizontal wells have been drilled in the pilot area throughout the project, and most have had initial produced gas oil ratios and gas nitrogen contents significantly below the field averages. Given similar reservoir conditions of net thickness and gas sweep, vertical wells are performing nearly as well as horizontal wells. Additional vertical well drilling was completed in 2005 following the success of wells drilled from 2002 through 2004.

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Quarterly Technical Progress Report – 1st Quarter 2006

Introduction

The DOE-sponsored project in the East Binger Unit (“EBU”) miscible nitrogen injection project is progressing toward its conclusion. A significant work program was implemented from 2002 to 2005 in an effort to reduce gas cycling and economically increase ultimate oil recovery. Horizontal and vertical infill wells were drilled and existing producers were converted to injection. Overall project results have been encouraging, with reductions in nitrogen production and cycling, and fluid flow in the reservoir is better understood. In general, horizontal wells have been disappointing relative to their vertical counterparts. The project is now in Phase 3, the monitoring phase of the program. Due to successes with infill drilling in Phase 2, additional drilling was done in Phase 3. Data gathering will continue throughout this Budget Period.

Executive Summary

A significant work program was implemented from 2002 to 2005 in the East Binger Unit (“EBU”) miscible nitrogen injection project in an effort to reduce gas cycling and economically increase ultimate oil recovery. This work included the drilling of new wells, both horizontal and vertical, as well as pattern realignment through producer-to-injector conversions.

Monitoring of overall performance of the pilot area continues. Response to the various projects continues to be very favorable. Injection into the pilot area, despite being limited at times by problems in the Air Separation Unit of the Nitrogen Management Facility, has increased an average of 60% over levels prior to the project. Meanwhile, gas production and nitrogen content of produced gas have both decreased. After decreasing to 20-25% early in the project, nitrogen recycle (produced nitrogen volume divided by injected nitrogen volume) within the pilot area has risen to about 40%, still far below the 72% prior to initiation of the project.

Poor areal sweep efficiency appears to be the primary cause of nitrogen cycling. Seven vertical and three horizontal wells have been drilled in the pilot area throughout the project, and most have had initial produced gas oil ratios and gas nitrogen contents significantly below the field averages. Given similar reservoir conditions of net thickness and gas sweep, vertical wells are performing nearly as well as horizontal wells. Additional vertical well drilling was completed in 2005 following the success of wells drilled from 2002 through 2004.

Experimental

There were no experimental methods used in the work completed during this reporting period.

Results and Discussion

The following is a detailed review of the work conducted in this reporting period.

Task 1.3.1 – Continue Monitoring Program

Binger Operations, LLC (“BOL”) continues to monitor new well and overall pilot area performance. Figure 1 shows the well work implemented during the project. For the first quarter of 2006, pilot area production averaged 451 bopd, a net increase of 204 bopd over the projected current rate without development. Production from new wells added 250 bopd but was offset by the loss of 46 bopd from wells converted to injection. See Figures 2 (all wells in pilot area), 3 (pre-existing wells), and 4 (new wells). It can be observed in Figure 4 that some of the new wells, such as #BU 64-3H, are now showing injection response rate increases.

Gas cycling is increasing but is still well below pre-development levels, as shown in Figure 2. Injection has been at normal levels for about one year now, following extensive problems with the Air Separation Unit (“ASU”) of the Gas Plant from November 2004 through February 2005. Compared to pre-project levels, total nitrogen produced from the pilot area has declined from 2.9 MMscf/d (4.2 MMscf/d total gas with a nitrogen content of 69%) to 2.5 MMscf/d (3.8 MMscf/d total gas with a nitrogen content of 66%). Over the same time period, total nitrogen injection has increased from 4 MMscf/d to about 6.4 MMscf/d. As shown in the table below, this represents a total change in gas recycle from 72% prior to development to 40% in the first quarter. Gas production and gas nitrogen content will continue rise; the overall impact of the work program will continue to be monitored as the flood progresses.

Pilot Area Gas Recycle

	[A] Total Gas Production Rate (MMscf/d)	[B] Percent Nitrogen (%)	[C] = [A]*[B] Nitrogen Production Rate (MMscf/d)	[D] Nitrogen Injection Rate (MMscf/d)	[C] / [D] Percent Recycle (%)
Pre-Development Baseline (1H 2001)	4.2	69	2.9	4.0	72
Second Quarter 2004	3.4	53	1.8	6.2	29
Third Quarter 2004	3.6	54	1.9	7.0	28
Fourth Quarter 2004	3.7	56	2.1	5.1 *	40
First Quarter 2005	3.4	58	2.0	4.4 *	46
Second Quarter 2005	3.7	60	2.2	6.8	33
Third Quarter 2005	4.3	62	2.6	6.1	43
Fourth Quarter 2005	4.2	64	2.7	6.4	42
First Quarter 2006	3.8	66	2.5	6.4	40

* Plant problems limited the supply of nitrogen for injection from November 2004 through February 2005.

A secondary aspect of Pilot Area performance monitoring is the comparison of the performances of horizontal wells to vertical wells. Figure 5 is a plot of the rate performances of the new wells drilled in the project, excluding EBU 37-3H, the horizontal well drilled in Budget Period 1, and EBU 43-2 and EBU 60-2, two recently completed vertical wells. As previously reported, these three wells were drilled in areas with much higher gas saturation. EBU 37G-3H and EBU 43-2 have been converted to injection, and EBU 60-2 is awaiting conversion.

Comparisons of wells in similar reservoir environments (thickness and gas saturation) show that vertical wells have performed nearly as well as the horizontal wells. Figure 6 shows the averages of the following horizontal and vertical wells:

<u>Well</u>	<u>Net Pay</u>	<u>Average GOR & %N2 @ 6 - 9 Months (reflect gas saturation)</u>	<u>Average GOR & %N2 @ 15 - 18 Months (reflect gas saturation)</u>
<i>Horizontal</i>			
EBU 63-2H	70' - 75'	4.3 Mcf/bbl & 21%	4.9 Mcf/bbl & 24%
EBU 64-3H	55' - 60'	5.6 Mcf/bbl & 17%	3.9 Mcf/bbl & 29%
<i>Average Horizontal</i>	<i>65'</i>	<i>5.0 Mcf/bbl & 19%</i>	<i>4.4 Mcf/bbl & 27%</i>
<i>Vertical</i>			
EBU 44-3	66'	2.4 Mcf/bbl & 3%	2.9 Mcf/bbl & 4%
EBU 46-3	80'	1.6 Mcf/bbl & 3%	1.3 Mcf/bbl & 4%
EBU 47-2	69'	5.9 Mcf/bbl & 54%	Not there yet
EBU 67-2	62'	11.6 Mcf/bbl & 50%	15.9 Mcf/bbl & 52%
EBU 74-2	45'	1.6 Mcf/bbl & 10%	1.7 Mcf/bbl & 17%
<i>Average Vertical</i>	<i>63'</i>	<i>4.6 Mcf/bbl & 24%</i>	<i>5.5 Mcf/bbl & 19%</i>

Most of the new wells have low GORs and nitrogen contents in produced gas, as indicated above and shown in Figure 7. The relative lack of nitrogen at the infill well locations indicates poor areal sweep – EBU 60-2 being a significant exception to this. For most new wells, current trends of nitrogen content data suggest it will be years before the nitrogen contents in their produced gas approach the current field average.

Monitoring of pilot area performance will continue throughout the project.

Task 1.3.3 – Technology Transfer Activities – Continue Updating Web Site

Additional technical progress reports have been posted on the project web site, www.eastbingerunit.com. A review of the project was presented to the Big Horn Section of the Society of Petroleum Engineers in Cody, Wyoming on May 4, 2006.

Conclusion

Monitoring of overall performance of the pilot area continues. Response to the various projects continues to be very favorable. Injection into the pilot area, despite being limited at times by problems in the Air Separation Unit of the Nitrogen Management Facility, has increased 60% over levels prior to the project. Meanwhile, gas production and nitrogen content of produced gas have both decreased. Nitrogen recycle within the pilot area decreased from 72% prior to initiation of the project to about 25% before rising back to a current rate of 40%.

It appears from the production data of new infill wells that poor areal sweep efficiency is the primary factor causing nitrogen cycling and limiting oil recovery. Most new infill wells have had initial produced gas oil ratios and gas nitrogen contents significantly below the field averages. Seven vertical and three horizontal wells have been drilled in the pilot area throughout the project.

References

There are no references for this report.

Figure 1. Map of the central portion of the East Binger Unit. The Pilot Area is indicated by the blue polygon. Well work implemented in the Project is highlighted in red; wells 43-2, 47-2, and 60-2 were drilled in 2005.

Figure 2. Production data for all wells in the pilot area.

Figure 3. Production data for wells in the pilot area that existed before DOE Project development.

Figure 4. Production data for new wells in the pilot area.

Figure 5. Comparison of production data for recent horizontal and vertical wells in or near the Pilot Area. Horizontal wells are designated with an “H” in their names.

Figure 6. Comparison of average production data for two horizontal and six vertical wells in or near the Pilot Area.

East Binger Unit Pilot Area Nitrogen Content in Produced Gas Pilot Area Sample Data																
	4th Qtr 2001	3rd Qtr 2002	4th Qtr 2002	1st Qtr 2003	2nd Qtr 2003	3rd Qtr 2003	4th Qtr 2003	1st Qtr 2004	2nd Qtr 2004	3rd Qtr 2004	4th Qtr 2004	1st Qtr 2005	2nd Qtr 2005	3rd Qtr 2005	4th Qtr 2005	1st Qtr 2005
Well																
35-2	58%	-	61%	-	63%	67%	63%	-	66%	-	67%	-	70%	-	-	68%
36-1	65%	50%	49%	46%	47%	44%	45%	50%	58%	70%	74%	77%	80%	86%	-	82%
36-2	25%	-	29%	-	20%	-	18%	-	22%	-	18%	-	20%	-	-	23%
37-2	83%	77%	79%	80%	79%	80%	81%	81%	83%	84%	83%	83%	85%	85%	-	85%
43-1	9%	10%	-	7%	-	6%	-	4%	4%	12%	11%	20%	27%	31%	-	33%
44-1	69%	67%	67%	68%	71%	66%	68%	67%	69%	65%	66%	73%	68%	67%	-	70%
45-2	56%	58%	-	57%	59%	60%	61%	62%	64%	64%	65%	64%	67%	67%	-	69%
46-2	62%	-	-	68%	64%	61%	62%	64%	62%	62%	61%	63%	66%	66%	-	69%
48-1	83%	83%	84%	84%	85%	86%	87%	87%	87%	87%	87%	87%	87%	86%	-	86%
57-2	37%	41%	39%	41%	45%	47%	40%	37%	39%	40%	43%	45%	45%	48%	-	51%
58-2	8%	5%	-	6%	5%	-	-	12%	6%	6%	17%	5%	5%	-	-	6%
59-2	44%	-	-	48%	45%	43%	39%	45%	48%	49%	52%	54%	55%	53%	-	56%
61-1	56%	-	-	-	56%	-	59%	-	63%	61%	-	60%	-	63%	-	63%
73-1	13%	21%	-	21%	-	21%	-	19%	-	24%	-	18%	-	11%	-	11%
Avg	48%	46%	58%	48%	53%	53%	57%	48%	52%	52%	54%	54%	56%	60%	-	55%
43-2	-	-	-	-	-	-	-	-	-	-	-	-	-	91%	93%	-
44-3	-	-	-	-	-	-	-	4%	3%	3%	3%	4%	4%	4%	-	5%
46-3	-	-	-	-	-	-	-	-	2%	3%	4%	4%	-	5%	-	4%
47-2	-	-	-	-	-	-	-	-	-	-	-	-	-	42%	54%	54%
60-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	91%	94%
63-2H	-	-	-	-	-	16%	19%	22%	20%	19%	23%	26%	20%	18%	-	29%
64-3H	-	23%	18%	17%	16%	23%	25%	36%	36%	30%	43%	45%	-	52%	-	18%
65-2	-	-	-	-	-	-	-	-	-	25%	22%	CTI	-	-	-	-
74-2	-	-	-	8%	10%	10%	10%	19%	16%	16%	18%	24%	25%	28%	-	33%
Avg	-	23%	18%	13%	13%	16%	18%	20%	15%	16%	19%	21%	16%	34%	-	34%

Figure 7. Pilot Area gas sample data – percent nitrogen in produced gas. New wells are shown in blue at the bottom of the table. Limited data was obtained in the fourth quarter of 2005 due to a sampling problem.