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

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Abstract

A significant work program has been implemented 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 includes 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 has nearly doubled, while gas production and nitrogen content of produced gas have both decreased. Nitrogen recycle within the pilot area has increased to 23% in recent months, but this is still far below the 58% recycle prior to initiation of the project.

Two additional wells – EBU 65-2 and EBU 67-2 – were brought on line during this reporting period. EBU 65-2 was successfully sidetracked after encountering thin pay on the edge of the reservoir, and is awaiting conversion to nitrogen injection service. The early performance of EBU 67-2 has been as predicted.

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Introduction

A significant work program has been implemented in the East Binger Unit (“EBU”) miscible nitrogen injection project in an effort to reduce gas cycling and economically increase ultimate oil recovery. The majority of this work was completed during Budget Period 2, but two additional new wells were added in this reporting period. Data gathering and project monitoring continue for the pilot area in which this work was conducted.

Executive Summary

A significant work program has been implemented 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 includes 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 has nearly doubled, while gas production and nitrogen content of produced gas have both decreased. Although nitrogen recycle within the pilot area has increased to 23% in recent months, it is still far below the 58% recycle prior to initiation of the project.

Two additional wells – EBU 65-2 and EBU 67-2 – were brought on line during this reporting period. EBU 65-2 was successfully sidetracked after encountering thin pay on the edge of the reservoir, and is awaiting conversion to nitrogen injection service. Results at EBU 67-2 have been as predicted.

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

Monitoring of new well and overall pilot area performance continues. Figure 1 shows the well work implemented during the project. Overall, for the third quarter of 2004, pilot area production averaged 518 bopd, a net increase of about 250 bopd over the projected current rate without development. Production from new wells added 309 bopd but was offset by the loss of

60 bopd from wells converted to injection. See Figures 2 (all wells in pilot area), 3 (pre-existing wells), and 4 (new wells).

As shown in Figure 2, the reduction in gas cycling continues to be significant. Total nitrogen produced from the pilot area has declined from 2.3 MMscf/d (4.15 MMscf/d total gas with a nitrogen content of 56%) to 1.6 MMscf/d (3.61 MMscf/d total gas with a nitrogen content of 45%). Over the same time period, total nitrogen injection has increased from 4.0 MMscf/d to 7.0 MMscf/d. As shown in the table below, this represents a total change in gas recycle from 58% prior to development to 23% today. These figures will continue to change and stabilize as rate impacts from new wells and recent conversions level off. Benefits to this 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)	4.15	56	2.3	4.0	58
Third Quarter 2004	3.61	45	1.6	7.0	23

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 Budget Period 2. Overall, the three vertical wells (44-3, 46-3, and 74G-2) have performed on par with the two horizontal wells (63-2H and 64-3H). Figure 6 shows the averages of these wells. Although the horizontal well produces more than the vertical well on average, the increased production is not sufficient to justify the higher cost, as a horizontal well costs over twice the cost of a vertical well.

Perhaps most encouraging with all of the new wells are the low GORs and nitrogen contents in produced gas. As shown in Figure 7, nitrogen contents in the produced gas of all of the new wells is far below the field average of about 70%. Two of the wells – 44-3 and 46-3 – have been on production for less than one year, so long-term trends are still difficult to predict accurately, but the relative lack of nitrogen at the infill well locations indicates poor areal sweep. Trends at 64-3H and 74G-2 suggest it could be years before the nitrogen contents in the produced gas of these wells approach the current field average.

Gas sampling also continues at other pilot area wells. Data collected is presented in Figure 7. The most significant changes have occurred at EBU 36-1, due to impacts from EBU 37-3H. After 37-3H was brought on production in late 2001, the nitrogen content at 36-1 dropped from 65% to less than 50%. Since 37-3H was converted to injection service in October 2003, the nitrogen content has risen higher than its prior level. This was expected, and is consistent with the interpretation that the predominant flow direction is east-west.

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.

Task 1.3.7 – Drill New Wells

Two new vertical wells were drilled. EBU 65-2, the location of which is shown in Figure 1, was drilled to complete the development of the area south of horizontal well EBU 64-3H, while EBU 67-2 was drilled just outside the original pilot area to test the expansion of the understanding gained so far to a new area.

EBU 67-2 was completed in late June. Although the sand thickness was somewhat less than predicted (64' versus 80' prognosed), the well has been performing as expected. Oil rate performance has been similar to that of EBU 44-3 (see Figure 5), but the well's GOR is higher (about 10 Mcf/bbl) than the wells drilled in Budget Period 2, yielding more NGL recovery.

The first major unexpected geologic finding occurred with the drilling of EBU 65-2. The well was expected to encounter 45' to 50' of net pay, but hit only 9'. Figure 8 shows what was expected and what was encountered. Prior to the drilling of EBU 65-2, the reservoir was believed to be essentially one sand body, similar to the "channel sandstone" shown in Figure 8, but with the edge to the southwest of EBU 75-1. The sand was expected to thicken to the northeast from EBU 75-1. Instead, 65-2 encountered a pay section very similar to that of EBU 75-1. It appears that the reservoir consists of at least two sand bodies, a lower channel sandstone overlain by a blanket sandstone. The original wellbore of EBU 65-2 appears to have been drilled at the edge of the channel sandstone. EBU 65-2 was sidetracked to the northeast approximately 800', as shown in Figure 1, and encountered 45' of net pay (corrected to true vertical thickness).

The production performance of EBU 65-2 has been poor: the well produced less than 20 bopd after the first two months. The reservoir pressure in the area has been drawn down by the production from EBU 64-3H and EBU 74-2. EBU 74-2 was previously slated for conversion to injection service, as discussed in prior Technical Reports (most recently Report 15121R16 for 1Q 2004). However, at its new (sidetracked) location, EBU 65-2 is better situated for injection than is EBU 74-2, as it can support the production from both EBU 64-3H and EBU 74-2. The conversion of EBU 65-2 has been permitted and is awaiting repair of the air separation unit (ASU) at the Nitrogen Management Facility. A heat exchanger in the ASU failed in early November, limiting the availability of nitrogen for injection.

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 has nearly doubled, while gas production and nitrogen content of produced gas have both decreased. Although nitrogen recycle within the pilot area has increased slightly, to 23%, it is still far below the 58% recycle prior to initiation of the project.

Two additional wells – EBU 65-2 and EBU 67-2 – have been drilled and completed. EBU 65-2 was successfully sidetracked after encountering thin pay on the edge of the reservoir, and is awaiting conversion to nitrogen injection service. The early performance of EBU 67-2 has been as predicted.

References

There are no references for this report.

Figure 1. Wellwork implemented in the Project is highlighted in red; the Pilot Area is indicated by the blue polygon.

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 horizontal and vertical wells drilled in Budget Period 2.

Figure 6. Comparison of average production data for horizontal and vertical wells drilled in Budget Period 2.

East Binger Unit Pilot Area Nitrogen Content in Produced Gas Pilot Area Sample Data											
<u>Well</u>	<u>December</u> <u>2001</u>	<u>3rd Qtr</u> <u>2002</u>	<u>4th Qtr</u> <u>2002</u>	<u>1st Qtr</u> <u>2003</u>	<u>2nd Qtr</u> <u>2003</u>	<u>3rd Qtr</u> <u>2003</u>	<u>4th Qtr</u> <u>2003</u>	<u>1st Qtr</u> <u>2004</u>	<u>2nd Qtr</u> <u>2004</u>	<u>3rd Qtr</u> <u>2004</u>	
35-2	58%	-	61%	-	63%	67%	63%	-	66%	-	
36-1	65%	50%	49%	46%	47%	44%	45%	50%	58%	70%	
36-2	25%	-	29%	-	20%	-	18%	-	22%	-	
37-2	83%	77%	79%	80%	79%	80%	81%	81%	83%	84%	
43-1	9%	10%	-	7%	-	6%	-	4%	4%	12%	
44-1	69%	67%	67%	68%	71%	66%	68%	67%	69%	65%	
44-3	-	-	-	-	-	-	-	4%	3%	3%	
45-2	56%	58%	-	57%	59%	60%	61%	62%	64%	64%	
46-2	62%	-	-	68%	64%	61%	62%	64%	62%	62%	
46-3	-	-	-	-	-	-	-	-	2%	3%	
48-1	83%	83%	84%	84%	85%	86%	87%	87%	87%	87%	
57-2	37%	41%	39%	41%	45%	47%	40%	37%	39%	40%	
58-2	8%	5%	-	6%	5%	29%	-	12%	6%	6%	
59-2	44%	-	-	48%	45%	43%	39%	45%	48%	49%	
61-1	56%	-	-	-	56%	-	59%	-	63%	61%	
63-2H	-	-	-	-	-	16%	19%	22%	20%	19%	
64-3H	-	23%	18%	17%	16%	23%	25%	36%	36%	30%	
65-2	-	-	-	-	-	-	-	-	-	25%	
73-1	13%	21%	-	21%	-	21%	-	19%	-	24%	
74G-2	-	-	-	6 - 10%	10%	10%	10%	19%	16%	16%	

Figure 7. Pilot Area gas sample data.

Figure 8. Diagram of the geology expected and encountered with the drilling of EBU 65-2.