QUARTERLY TECHNICAL PROGRESS REPORT
FOR THE PERIOD ENDING JUNE 30, 2001

TITLE: FIELD DEMONSTRATION OF CARBON DIOXIDE MISCIBLE FLOODING IN THE LANSING-KANSAS CITY FORMATION, CENTRAL KANSAS

DOE Contract No. DE-AC26-00BC15124

Contractor:	University of Kansas Center for Research, Inc. 2385 Irving Hill Road Lawrence, KS 66044
DOE Program:	Class II Revisited - Field Demonstrations
Award Date:	March 8, 2000
Total Project Budget:	$5,388,683
DOE Cost Amount:	$1,892,094
Program Period:	March 8, 2000 – March 8, 2006 (BP1 03/00-06/01, BP2 06/01-03/05, BP3 03/05-03/06)
Reporting Period:	April 1, 2001 – June 30, 2001
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ABSTRACT:

Progress is reported for the period from April 1, 2001 to June 30, 2001. Assessment of the demonstration site has defined many aspects of the reservoir. However, uncertainty in reservoir permeability distribution and residual oil saturation is sufficiently great that assuring viability of the project warrants further reservoir characterization. Economic and recovery analysis of the Colliver lease, based on the existing reservoir model, indicates that a lease pattern of 60-acres provides the oil production revenues and CO_2 usage needed for the demonstration to be economically viable for MV Energy LLC and ICM Inc.

VIP compositional simulation run #T61 for a CO_2 WAG (Water-Alternating Gas) flood predicts that oil recovery from a 60-acre (24.3 ha) pilot area is approximately 100,000-116,000 bbls (15,900-18,400 m^3), within the DOE demonstration period, and requires estimated CO_2 volumes injected ranging from 765 MMcf to 843 MMcf (million cubic feet, 21.6–23.8*10^6 m^3).

Additional reservoir characterization for a larger pilot requires modifications to the original plan involving extension of Budget Period 1 and the reorganization of well remediation and testing activities. Presented economics for a 60-acre (24.3 ha) pattern show that modifications to the original project plan, maintaining program industry match rates, require increased financial commitment by MV Energy LLC, the U.S. Department of Energy, and a new partner, ICM Incorporated, and decreased commitment by Kinder-Morgan CO_2 Company LLP in the present L-KC demonstration. Total cost of the modified project is $7,469,292 compared with $5,388,064 in the original project.

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INTRODUCTION

Objectives - The objective of this Class II Revisited project is to demonstrate the viability of carbon dioxide miscible flooding in the Lansing-Kansas City formation on the Central Kansas Uplift and to obtain data concerning reservoir properties, flood performance, and operating costs and methods to aid operators in future floods. The project addresses the producibility problem that these Class II shallow-shelf carbonate reservoirs have been depleted by effective waterflooding leaving significant trapped oil reserves. The objective is to be addressed by performing a CO_2 miscible flood in a 40-acre (16.2 ha) pilot in a representative oomoldic limestone reservoir in the Hall-Gurney Field, Russell County, Kansas. At the demonstration site, the Kansas team will characterize the reservoir geologic and engineering properties, model the flood using reservoir simulation, design and construct facilities and remediate existing wells, implement the planned flood, and monitor the flood process. The results of this project will be disseminated through various technology transfer activities.

Project Task Overview -

Activities in Budget Period 1 (03/00-03/01) involve reservoir characterization, modeling, and assessment:

- Task 1.1- Acquisition and consolidation of data into a web-based accessible database
- Task 1.2 - Geologic, petrophysical, and engineering reservoir characterization at the proposed demonstration site to understand the reservoir system
- Task 1.3 - Develop descriptive and numerical models of the reservoir
- Task 1.4 - Multiphase numerical flow simulation of oil recovery and prediction of the optimum location for a new injector well based on the numerical reservoir model
- Task 2.1 - Drilling, sponge coring, logging and testing a new CO2 injection well to obtain better reservoir data
- Task 2.2 - Measurement of residual oil and advanced rock properties for improved reservoir characterization and to address decisions concerning the resource base
- Task 3.1 - Advanced flow simulation based on the data provided by the improved characterization
- Task 3.2 - Assessment of the condition of existing wellbores, and evaluation of the economics of carbon dioxide flooding based on the improved reservoir characterization, advanced flow simulation, and engineering analyses
- Task 4.1 – Review of Budget Period 1 activities and assessment of flood implementation

Activities in Budget Period 2 (03/01-03/05) involve implementation and monitoring of the flood:

- Task 5.1 - Remediate all wells in the flood pattern
- Task 5.2 - Re-pressure the pilot area by water injection
- Task 5.3 - Construct surface facilities
- Task 5.4 - Implement CO_2 flood operations
- Task 5.5 - Analyze CO_2 flooding progress - carbon dioxide injection will be terminated at the end of Budget Period 2 and the project will be converted to continuous water injection.

Activities in Budget Period 3 (03/05-03/06) will involve post-CO2 flood monitoring:

- Task 6.1 – Collection and analysis of post-CO2 production and injection data

Activities that occur over all budget periods include:

- Task 7.0 – Management of geologic, engineering, and operations activities
- Task 8.0 – Technology transfer and fulfillment of reporting requirements

EXECUTIVE SUMMARY:

Progress is reported for the period from April 1, 2001 to June 30, 2001. Assessment of the demonstration site has defined many aspects of the reservoir. However, uncertainty in reservoir permeability distribution and residual oil saturation is sufficiently great that assuring viability of the project warrants further reservoir characterization. Economic and recovery analysis of the Colliver lease, based on the existing reservoir model, indicates that a lease pattern of 60-acres provides the oil production revenues and CO_2 usage needed for the demonstration to be economically viable for MV Energy LLC and ICM Inc.

VIP compositional simulation run #T61 for a CO_2 WAG (Water-Alternating Gas) flood predicts that oil recovery from a 60-acre (24.3 ha) pilot area is approximately 100,000-116,000 bbls (15,900-18,400 m^3), within the DOE demonstration period, and requires estimated CO_2 volumes injected ranging from 765 MMcf to 843 MMcf (million cubic feet, 21.6–23.8*10^6 m^3).

Additional reservoir characterization for a larger pilot requires modifications to the original plan involving extension of Budget Period 1 and the reorganization of well remediation and testing activities. Presented economics for a 60-acre (24.3 ha) pattern show that modifications to the original project plan, maintaining program industry match rates, require increased financial commitment by MV Energy LLC, the U.S. Department of Energy, and a new partner, ICM Incorporated, and decreased commitment by Kinder-Morgan CO_2 Company LLP in the present L-KC demonstration. Total cost of the modified project is $7,469,292 compared with $5,388,064 in the original project.

RESULTS AND DISCUSSION:

TASK 3.1 RESERVOIR SIMULATION

The *VIP* reservoir simulation model utilized for predicting CO_2 oil recovery was refined to provide a better history match in the region of the Colliver #7 well and the western Colliver lease. The new model (Model # S171) history match for the Colliver lease provides a closer match of the estimated lease oil production history and rates than previous models (Fig. 1). As with the previous models, differences between model and estimated rates of production during the pilot waterflood from 1958 to late 1962 are believed to result from either: 1) a different contribution of oil from the L-KC “G” zone than estimated, or 2) reservoir properties in the pilot flood area, and particularly around the Colliver #7 well, that are significantly different than other areas of the lease. Model refinements improved the history match but predicted recovery is still highly sensitive to uncertainty in reservoir properties in the western Colliver lease region in the region around the Colliver #7 well. Modeling of lease repressurization and CO2 flood confinement indicates that repressurization should require less than three months and that fewer wells may be required for pressure control and containment. This conclusion requires confirmation from simulations that will be performed after additional wells are

remediated and tested to determine local reservoir properties.

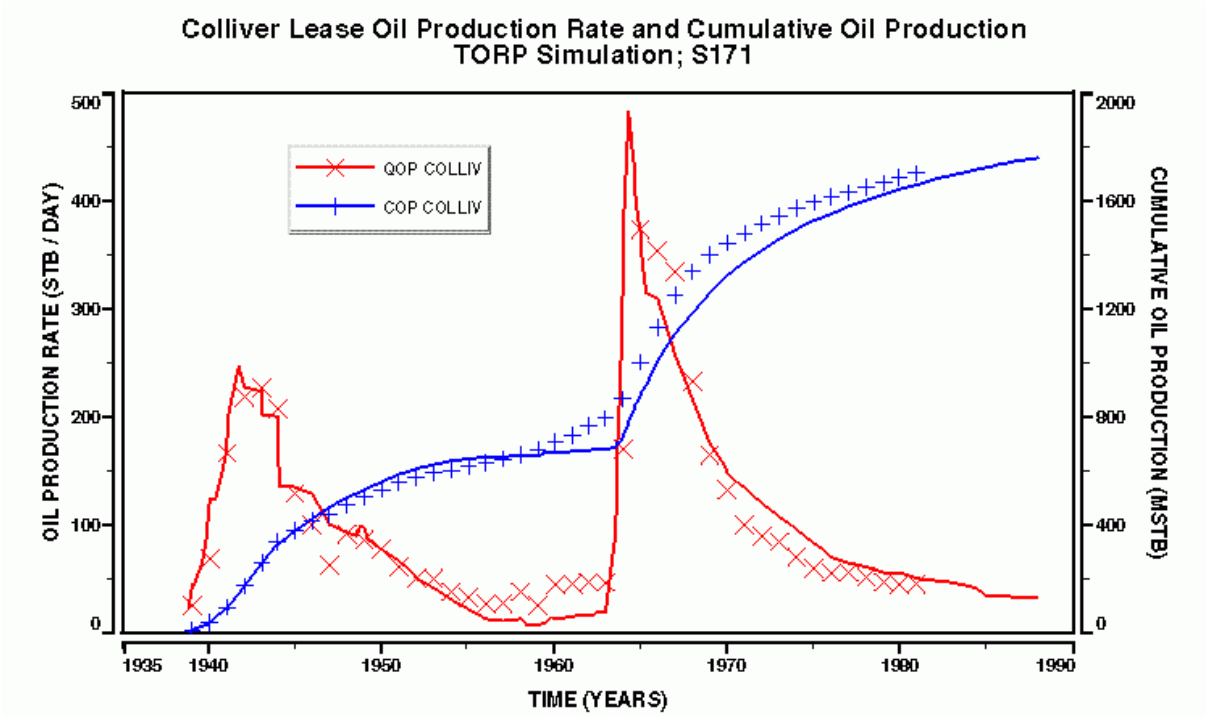


Figure 1. Comparison of model and estimated Colliver lease oil production rates and cumulative production for TORP simulation model S171.

For input to modeling of CO_2 flooding, reservoir simulator model #S171 was used to model oil saturation distribution in the Colliver lease at the end of waterflood. Previous analysis indicated that the 60-acre pattern provided an economically viable pilot. *VIP* compositional simulation run #T61 for a CO_2 WAG (Water-Alternating Gas) flood predicts that oil recovery from the 60-acre pilot area (fig. 2) is approximately 116,000 bbls (18,400 m^3) within the DOE demonstration period. This recovery was compared with general volumetric recovery efficiency models based on West Texas floods. Oil recoveries using general West Texas models are estimated to be approximately 95,000-97,000 bbls (15,100-15,400 m^3). Estimated CO2 volumes injected range from 765 MMcf to 843 MMcf (million cubic feet, 21.6–23.8*10^6 m^3).

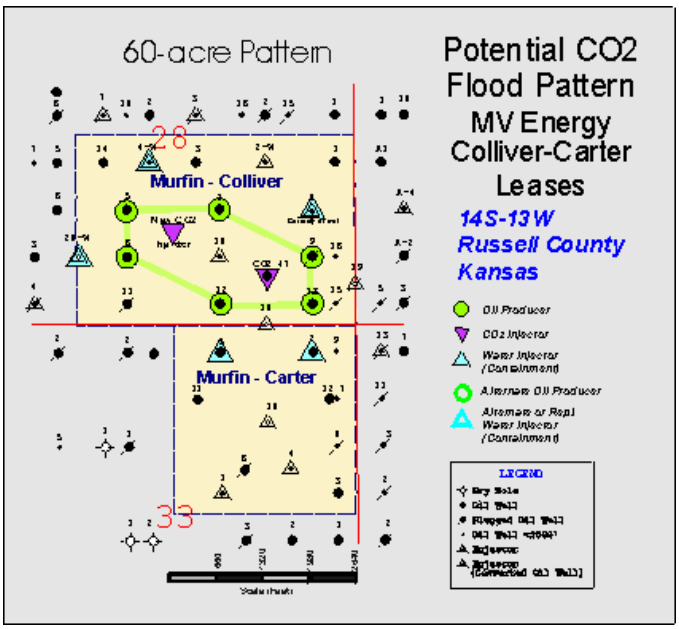


Figure 2. 60-acre (24.3 ha) CO_2 flood pattern for demonstration site.

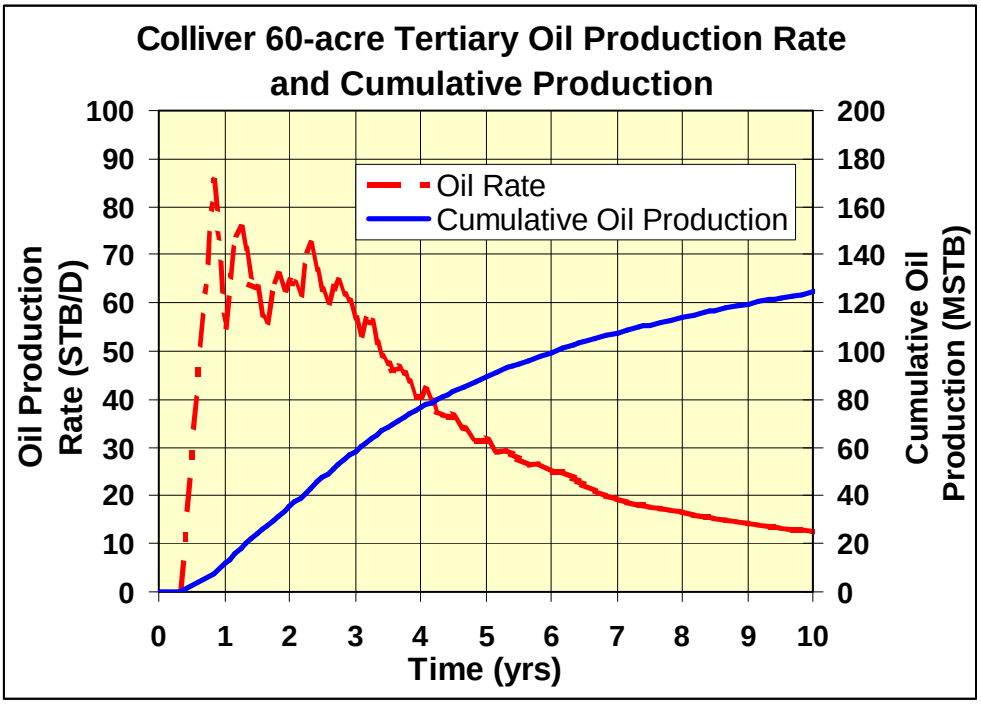


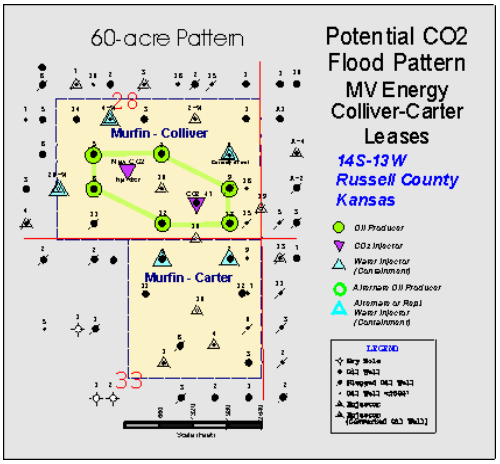
Figure 3. Simulation Run T61 prediction of oil recovery for 60-acre (24.3 ha) pattern.

TASK 3.2 ECONOMIC AND RECOVERY ANALYSIS OF PILOT

Economic and recovery analysis of the Colliver lease, based on the existing reservoir model, indicates that a lease pattern of 60-acres (24.3 ha) provides the oil production revenues and CO_2 usage needed for the demonstration to be economically viable for MV Energy LLC and ICM Inc. Smaller patterns have too high a lease capital cost for the oil income returned and require less CO2, limiting the income to ICM Inc. to offset CO_2 capture and delivery capital and operating expenses. Economics for a 60-acre (24.3 ha) pattern are presented in Tables 1 through 3. Table 1 shows a summary of the original project economics and revised project economics for a 60-acre (24.3 ha) pattern. Modifications to the original project plan require increased financial commitment by MV Energy LLC, the U.S. Department of Energy, and a new partner, ICM Incorporated, and decreased commitment by Kinder-Morgan CO_2 Company LLP in the present L-KC demonstration. All modified activities and tasks would maintain the existing required industry match of 55% in Budget Period 1, 65% in Budget Period 2, and 90% in Budget Period 3. Carbon dioxide supplied by the ICM ethanol facility would be valued such that the total cost of CO_2 delivered to the demonstration site would not exceed the \$3.00/Mcf (\$0.106/m^3) cost of supplying CO_2 from Guymon, OK. Total cost of the modified project is \$7,469,292 compared with \$5,388,064 in the original project.

Table 1- Budget Summary for Revised Kansas CO2 Flood Project

	Original Project	Modified Project
Flood Performance		
Acres	40	60
Total CO2 Injected (mcf)	843	850
WAG Years	3.7	6
Post CO2 WF years (DOE)	1	1
Post CO2 WF years (post DOE)		1
Oil Produced (Commercial Life)	75,300	96,700
Capital		
Drill & Equip #1 CO2 I &Plug Line Well (Task	236180	$341,750
Rework and upgrade wells (old Task 5.1 /Tas	$474,500	$706,244
Drill & Equip CO2 I-2 (Task 2.1)	$0	$175,000
Surface facilities (Task 5.3)	$322,575	$308,315
Drill and Equip Water Supply Well (Task 2.3)	$35,000	$35,000
Subtotal	$1,068,255	$1,566,309
Flood Operations		
Repressure Reservoir (Task 2.3&Task 5.2)	$16,377	$31,487
CO2 Slug, WAG + Admin (Task 5.4)	$734,231	$1,188,570
Post waterflood (Task 5.4)	$100,858	$129,484
CO2 Purchased by operator (Task 5.4)	$0	$212,500
Subtotal	$851,466	$1,562,041
CO2 Supply		
Compressors or Liquifaction Equipment Lease		$547,600
8 mile pipeline		$530,000
CO2 compression (fuel & ops)		$484,500
Value of CO2 contributed	$1,608,900	$775,400
Recycled CO2	$414,045	$0
Subtotal	$2,022,945	$2,337,500
Research, Data, Tech Transfer, Admin.		
KU Research, Data Collection & Tech Transf	$1,446,018	$1,829,887
Outside Consulting & Adm.	0	$173,477
Subtotal	$1,446,018	$2,003,363
PROJECT TOTAL EXPENSES	**$5,388,684**	**$7,469,213**
Revenue Sources		
DOE ($Cap $LOE)	$676,261	$1,176,405
DOE ($CO2)	$708,031	$892,500
DOE (Research, Data, Tech Transfer)	$507,802	$655,959
Murfin ($Cap $LOE)	$830,259	$1,840,639
Murfin (net $CO2)	$0	$138,125
Kinder-Morgan In-kind CO2	$268,150	$476,000
Kinder-Morgan Cash	$1,359,858	$46,657
ICM ($Cap $Lease $Ops)	$0	$457,100
ICM In-kind CO2	$0	$511,900
KUCR In-kind	$938,323	$1,173,927
State Of KS DOC	$100,000	$100,000
PROJECT TOTAL REVENUES	**$5,388,684**	**$7,469,213**
DOE Total	$1,892,094	$2,724,865
DOE Incremental over Original Project	$0	$832,771



MURFIN COST ESTIMATES & VARIABLES	
Capital Costs	
Characterization activities	$105,570
BP-1 Rework and upgrade wells	$529,635
BP-1 WIW Surface Facilities	$94,645
Drill & Equip CO2 I-2	$175,000
BP-2 Prepare wells	$81,964
BP-2 WI Surface Facilities	$308,315
Drill and Equip Water Supply Well	$35,000
	$1,330,129
Lease Operations	
CO2 Oil	1,200
Post CO2 Oil	1,200
Water Inj	800
CO2 Injector	1,200
WSW	1,000
CO2 Purchase	$0.25
Lost Oil Revenue	($50,000)
Oil Price	$20.00
EOR Tax Credit	10%
ICM COST ESTIMATES AND Variables	
Pipeline	$530,000
(Not budgetted) Purchase Compression	*$350,000*
Dehydration	$30,000
Install Compress & Dehy	$100,000
Compressor lease costs/yr	$69,600
Power	$0.18
Compress ops	$0.26
Pipeline ops	$0.13
	$0.57
MV Purchase Price CO2 from ICM	$0.25
EOR Tax Credit	0%
CO2 Required MMCF	850
FACTOR	**100.0%**
Kinder-Morgan	
Spot Value at Bravo Dome	$0.60
Relative Value for 800/900 mmcf	$0.56

TABLE 2 - GENERAL ECOMOMICS FOR MV ENERGY

(These calculations use average numbers and may differ slightly from budget worksheets)

DATE 05/01

Color Code	***Input Cell***
	Input elsewhere
	Calculated
	mportant

60-Acre Pattern

Colliver-Carter CO2 Pilot

Date: **DATE: 05/01**

$20.00 **per Barrel**

Working Interest	100.00%	**Probability:**	***100%*** **100% Model Output**
N.R.I.	87.50%		***0%*** **82% Model Output**
			0% **111% Model Output**
Price:	$ 20.00		
Tax Rate:	0.00% Year 1-3 0.00%		

Year	Prod	Price	Net Oper Revenues	Sev & Adv Taxes	Net Well Oper Expenses	CO2 Costs	Pre-Op Cap Costs	Surf Fac Cap Costs	EOR Tax Credit	Cash Flow BFIT	PVP @ 10%	PV Factor 10%
Initial	Pre-flood repressuring				18,688		445,613	219,655	68,396	(665,560)	(665,560)	1.00000
1	2,562	$20.00	44,835	0	145,603	37,213		0	18,282	(119,699)	(108,817)	0.90909
2	10,698	$20.00	187,215	0	145,603	20,313		0	16,592	37,891	31,315	0.82645
3	23,006	$20.00	402,605	0	145,603	19,988		0	16,559	253,573	190,512	0.75131
4	23,201	$20.00	406,018	0	145,603	19,988		0	16,559	256,986	175,524	0.68301
5	16,428	$20.00	287,490	0	145,603	19,988		0	16,559	138,458	85,971	0.62092
6	10,863	$20.00	190,103	0	145,603	20,638		0	16,624	40,486	22,853	0.56447
7	6,506	$20.00	113,855	0	84,326	0		0	8,433	37,962	19,481	0.51316
8	3,422	$20.00	59,885	0	93,696	0		0	9,370	(24,441)	(11,402)	0.46651
9	0	$20.00	0	0	0	0		0	0	0	0	0.42410
10	0	$20.00	0	0	0	0		0	0	0	0	0.38554
	96,686		1,692,006	0	1,070,328	138,128	445,613	219,655		(44,344)	(260,123)	

Capital Cost/ NetBbl	**$ 7.08**	**I.R.R.**	**-1.55%**
Operations/Net Bbl	**$11.39**	**Profit**	**(44,344)**
CO2 Cost/Net Bbl	**$1.47**	**Profit/Capital**	**-7%**
Total/Net Bbl	**$19.94**	**Net Ult. Reserves**	**84,600**

Possible Outcome		Probability	Cash Flow BFIT	Risk-weighted Cash Flow	PVP @ 10%
100%	**Model Output**	100.00%	(44,344)	(44,344)	(260,123)
60-Acre CO2 Demo					
Flander's Mid PPV					
82%	**Model Output**	0.00%	(348,877)	0	(466,644)
60-Acre CO2 Demo					
Flander's Mid PPV					
111%	**Model Output**	0.00%	141,770	0	(133,902)
60-Acre CO2 Demo					
Flander's Mid PPV					
Expected Value		100.00%		(44,344)	

Oil Production (Flander's)		
	% of Projected	
Optimistic	82%	
Pessimistic	111%	
Risk Wieghting	1	1 = No 2 = Yes
	Risk	**% Prod**
Scenario 1	60%	100%
Scenario 2	20%	82%
Scenario 3	20%	111%

CO2 costs $/mcf	$0.25
EOR Tax Credit	10%
Lost Oil Revenue	($50,000)
(from plugged zones)	

$LOE	**Avg Monthly/Well**	
CO2 Oil	1,600	6 mos repressure

Capital		**DOE**	**Operator**	**DOE**	**Operator**	
BP-1characterization	$105,570	45%	55%	$47,507	$58,064	
BP-1 Rework and upgrade we	$529,636	45%	55%	$238,336	$291,300	
BP-1 WI Surface Fac	$94,645	45%	55%	$42,590	$52,055	
Drill & Equip CO2 I-2	$175,000	45%	55%	$78,750	$96,250	
Drill and Equip Water SW	$35,000	45%	55%	$15,750	$19,250	
BP-2 Rework and upgrade we	$81,964	35%	65%	$28,687	$53,277	
BP-2 All Other Surface Fac	$308,315	35%	65%	$107,910	$200,405	
	$1,330,130			$559,530	$770,601	$1,330,131
Lease Operating Expense						
BP-1	$16,251	45%	55%	$7,313	$8,938	
BP-2	$1,359,024	35%	65%	$475,658	$883,366	

TABLE 3 - GENERAL CO2 Supply Economics, Hall-Gurney Miscible flood project

DATE: 05/01

(These calculations use average numbers and may differ slightly from budget worksheets)

60-Acre Demonstration

Color Code (for most): Input Cell; Input elsewhere; Calculated; Important

Assumes ICM recovers 35% DOE match on capital, operations and CO2 in-kind contribution

ICM delivers CO2 to site at injection pressure for pilot project
ICM is able to sell commercial CO2 after pilot

Max Rate (mcfpd): 626 (Calculate)

CO2 useage for pilot 60Acre Pattern	CO2	% of projected	Projected
Year 1	228,634	100.0%	228,634
2	124,515		124,515
3	123,450		123,450
4	123,450		123,450
5	123,450		123,450
6	126,501		126,501
7	0	Avg Rate	0
CO2 total mcf	850,000	378	(Calculate)
Value of CO2	$0.912		
DOE Match	35%		
Price for purchase of CO2 from ICM	$0.250	$431 per ton	
CO2 Income	$212,500		
CO2$ Target	$3.000		

			Tons/day
Injection Rate-Pilot Period, mcfd	RATE	378 mcfpd	22
Injection Rate-Commercial Period, mcfd		1000 mcfpd	58

Original operating expense from FloCO2 = $0.1805/mcf
Original power costs, $0.26/mcf from ICM

Purchase Compression	$0
Dehydration	$30,000
Install Compression & Dehydration	$100,000
Compressor annual lease costs	$69,600
Power Costs, $/mcf	$0.18
Compressor Ops $/mcf	$0.26
Pipeline Ops $/mcf	$0.13
Total operating Costs, $/mcf	$0.57

Purchase or Lease Compression

Kinder-Morgan CO2 $/mcf	$0.560	3" Pipeline	$530,000
EOR Tax Credit	0%	2" Pipeline	$500,000
CO2 Revenue ($/mcf)		ICM invest in larger diameter	$30,000
MV Energy Purchase	$0.250		
Commercial sales	$1.00		

Year	Pipeline Investment	Compressor Investment	Compressor Lease Option	Operating Costs	Income (DOE match $Cap & CO2)	Income (DOE match $LEASE & $OPER)	Investment Tax Credit (Applied in next year)	Kinder-Morgan CO2 Contribution	Income from CO2 Sales	Net Cash Flow BFIT	Cum Net Cash Flow BFIT
0	(530,000)	(130,000)			231,000	0	0			-429,000	-429,000
1			(69,600)	(130,321)	72,980	69,972	0	128,035	57,159	128,225	-300,775
2			(69,600)	(70,974)	39,745	49,201	0	69,728	31,129	49,229	-251,546
3			(69,600)	(70,367)	39,405	48,988	0	69,132	30,863	48,421	-203,125
4			(69,600)	(70,367)	39,405	48,988	0	69,132	30,863	48,421	-154,704
5			(69,600)	(70,367)	39,405	48,988	0	69,132	30,863	48,421	-106,283
6			(69,600)	(72,106)	40,379	49,597	0	70,841	31,625	50,736	-55,547
7			0	0	0	0	0	0	0	0	-55,547
Buy-out compression*		(250,000)		(208,050)	0	0	0	0	365,000	-93,050	-296,175
				(208,050)	0	0	0	0	365,000	156,950	-139,225
				(208,050)	0	0	0	0	365,000	156,950	17,725
				(208,050)	0	0	0	0	365,000	156,950	174,675
				(208,050)	0	0	0	0	365,000	156,950	331,625
				(208,050)	0	0	0	0	365,000	156,950	488,575
				(208,050)	0	0	0	0	365,000	156,950	645,525
								476,000	Total	793,103	
									IRR	15%	

Buy-out lease on 1 MMCFD compression for $250,000

RISK WEIGHTED ECONOMICS for ICM

	Scenario 1 Success	Scenario 2 Failure	Risk Weighted
Success Rate	50%	50%	
	Net Cash Flow BFIT	Net Cash Flow BFIT	Net Cash Flow BFIT
	-214,500	-214,500	-429,000
	64,113	64,113	128,226
	24,615	24,615	49,230
	24,211	24,211	48,422
	24,211	24,211	48,422
	24,211	24,211	48,422
	25,368	25,368	50,736
	0	0	0
	-46,525		-46,525
	78,475		78,475
	78,475		78,475
	78,475		78,475
	78,475		78,475
	78,475		78,475
	78,475		78,475
Total	396,554	-27,771	368,783
IRR	15%	-4%	10%

ICM Revenues	"Cost"/mcf		Net ICM Costs		
DOE match $CO2	$0.91	271,320	In-kind $CO2	503,880	
DOE match $CAP		231,000	$Cap	429,000	
DOE match $Lease		146,160	$Lease	271,440	
DOE match $OPER		169,576	818,056 $Oper	314,926	
Investment Tax Credit Net $Cap $Lease $Oper		0	K-M CO2	(476,000)	539,366 (Out of pocket)
CO2 Sales during pilot ($/mcf)	$0.25	212,502	Less CO2 Sales	212,502	
		1,030,558		1,255,748	
ICM Loss if project fails at end of pilot		($55,547)	(Less salvage-DOE share of salvage)		

Potential ICM Loss			
Total cost$	-1,562,102	-539,366	Out of pocket
DOE Income	818,053	271,319	DOE CO2 match
K-M CO2	476,000		
CO2 Income	$212,500	$212,500	
Invsttax credit	0	0	Invst tax credit
	($55,549)	($55,547)	

CO2 Costs to manifold	
$Capital	660,000
Compression	494,502
Equip Lease	417,600
CO2 value	775,200
CO2 Sales	$212,500
	$2,549,802
Per mcf	$3.00
Per ton	$51.69
CO2 Compress & Transport	$1.838
Total CO2 Value	$1.162
	$3.00

TASK 7.0 PROJECT MANAGEMENT

Following meetings in April, May, and June, a revised plan for the project was finalized and submitted to the DOE for approval. A brief discussion of rationale for the revised plan and aspects of the plan are provided below.

Assessment of the demonstration site, performed under Budget Period 1 activities, has defined many aspects of the reservoir. However, uncertainty in reservoir permeability distribution and residual oil saturation is sufficiently great that assuring viability of the project warrants further reservoir characterization. This characterization requires modifications to the original plan involving extension of Budget Period 1 and the reorganization of well remediation and testing activities as discussed below. The LKC demonstration project was based on the assumption that Lansing-Kansas City reservoirs in Central Kansas had sufficient CO_2-recoverable oil resource to support a pipeline. Our assessment of potential recovery from these reservoirs indicates that there is not enough recoverable oil from Lansing-Kansas City reservoirs to alone support the pipeline assuming an oil price of \$20/bbl (\$125.78/m^3), a CO_2 cost of \$1/Mcf (\$0.0353/m^3), and a pipeline amortization of 10-years. Resource assessment indicates that sufficient oil resources exist in the Arbuckle to support an 8-inch pipeline. Because the Arbuckle represents the prime resource base for a pipeline, Kinder-Morgan CO_2 Company, LP, a major partner in the project, has decided to focus most of its support on an Arbuckle demonstration project but is also willing to provide a lower level of support to the Lansing-Kansas City demonstration than proposed in the original plan. This change in support level has required that the L-KC demonstration project be modified from the original project plan.

Our analysis of the L-KC demonstration site indicates that an economically viable and risk-balanced CO2 flood with modified Kinder-Morgan support requires a larger pilot project, additional reservoir characterization and testing, additional DOE matching support, and participation of ICM Incorporated (ICM) to supply CO2 from the ethanol plant under construction in Russell, Kansas.

In general, the following significant modifications to the original Statement of Work are proposed:

1. Extend the length of Budget Period 1 from 3/7/01 to 3/7/02(1 year)
2. Move remediation and testing of selected wells and initial repressurization from Budget Period 2 to Budget Period 1
3. Drill a second CO_2 injection well
4. Extend reservoir characterization, simulation and economic analysis to provide a basis for continuation of the project into Budget Period 2
5. Add ICM to the contract as a supplier of carbon dioxide from the ethanol plant under construction in Russell, Kansas
6. Extend the length of Budget Period 2 from 3/7/02 to 3/7/07 to permit carbon dioxide flooding of a larger area than originally proposed.

7. Move Budget Period 3 activities from 3/7/05-3/7/06 to 3/7/07-3/7/08.

Three organizational meeting were held in this quarter.

A meeting was held on April 15, 2001 at the offices of the USDOE NPTO in Tulsa, OK the following personnel were present: MV Energy) Larry Jack; TORP) Paul Willhite; KGS) Alan Byrnes; Kinder-Morgan) Don Schnacke; DOE) William Lawson, Dexter Sutterfield, Dan Ferguson, Rhonda Lindsey; ICM) Paul Cantrell, Eric Mork. Topics covered included: economics of various patterns, project shortfalls, review of partner financial positions.

A meeting was held on May 8, 2001 at Murfin Drilling Company in Wichita, KS, the following personnel were present: MV Energy) James Daniels, Larry Jack; TORP) Paul Willhite, Don Green, Richard Pancake; KGS) Alan Byrnes, Martin Dubois; Kinder-Morgan) Don Schnacke, Russell Martin (phone), William Flanders (phone); ICM) Paul Cantrell, Eric Mork. Topics covered included: project shortfalls and summary of partner financial positions. A general project plan and partner financial positions were established and the decision to submit to the DOE a revised project plan with request for additional funding agreed upon.

A meeting was held on June 26, 2001 with the Kansas Corporation Commission at the offices of TORP at the University of Kansas. The following personnel were present: MV Energy) James Daniels, Larry Jack; TORP) Paul Willhite, Don Green, Richard Pancake, Rajesh Kunjithaya; KGS) Alan Byrnes, Martin Dubois; Kinder-Morgan) Don Schnacke, William Flanders (phone); ICM) Eric Mork; KCC) Maurice Korphage, Dave Williams, Alan Snider. Topics covered included: Overview of lease production history and future CO2 flood design, pressure containment, wellbore integrity, operating pressures, venting, and upcoming temporarily abandoned well considerations. An afternoon meeting with Kent Pennybaker of River City Engineering and Kenneth Ludwig of Mid-America Consultants, Inc. dealt with surface facilities design and instrumentation.

TASK 8.0 TECHNOLOGY TRANSFER

Two technology transfer activity were performed in this quarter:

1) A poster was presented at the 2001 American Association of Petroleum Geologists Annual meeting, June 3-6, Denver, CO, by Martin K. Dubois, Alan P. Byrnes, and W. Lynn Watney

"Field Development and Renewed Reservoir Characterization for CO2 Flooding of the Hall-Gurney Field, Central Kansas"

Primary and secondary production phases of the seventy-year old Hall-Gurney Field are near completion, however a third development phase could be spurred by a U.S. Department of Energy sponsored Class II carbon dioxide miscible

flood demonstration project. The CO2 target reservoirs, Pennsylvanian Lansing-Kansas City (L-KC) Groups, have yielded 90 MMBO of the 152 MMBO cumulative production in the multi-pay field. Primary production, begun in1931, was followed by extensive waterflooding in the 50's and 60's. Waterfloods reached their economic limits in the 70's and 80's but bi-passed oil represents a significant resource for CO_2 miscible flooding, a third development phase.

Reservoir rocks were deposited as coarse-grained ooid sands in shallowing upward fourth order sequences and concentrated on bathymetric highs on the broad Kansas shelf. Subaerial exposure and meteoric water percolation caused ooid dissolution and resulted in oomoldic grainstones. Modern wireline logs and core data from a recently drilled CO2 injection well validate early general reservoir models based on data typical of mid-century development, but also show previously unrecognized reservoir complexity. Detailed reservoir characterization of the 12-18 foot CO_2 target zone at the demonstration site indicates the presence of up to three stacked, shallowing-upward cycles contained within a single higher-order shallowing-upward sequence accompanied by vertically increasing porosity and permeability.

In Kansas the L-KC has produced 1.2 billion BO primarily from oomoldic grainstones in 3,500 fields. This case study of a mature field entering its third development phase provides insight into oomoldic limestone reservoirs both in Kansas and worldwide.

2) On June 15, 2001 presentations were given to Kansas state legislators and other state government personnel in Russell, KS as part of the Kansas Geological Survey Annual Field Trip. Presentations concerning the CO_2 project were given by Martin K. Dubois (KU), James Daniels (Murfin Drilling Company), Dave Vander Griend (ICM, Inc.), and Daniel Ferguson (USDOE).

CONCLUSIONS

Uncertainty in reservoir permeability distribution and residual oil saturation is sufficiently great that assuring viability of the project warrants further reservoir characterization, which requires modification of the existing project by extension of Budget Period 1. Economic analysis indicates that a larger pilot that the original plan is needed for the project to be economically viable for MV Energy LLC and ICM Inc. A modified plan has been developed and submitted to DOE for approval involving a total cost of the modified project of $7,469,292 compared with $5,388,064 in the original project. Based on current knowledge of the reservoir, the modified project will provide the needed additional reservoir data and an economically viable plan for implementation of the demonstration project.