

Preliminary Evaluation of Carbon Dioxide-Enhanced Oil Recovery (CO₂-EOR) In Kansas Oilfields Oluwole Okunromade, Jennifer Hollenbach, Yevhen Holubnyak and Edward Peltier

Abstract

The successful use of carbon dioxide as a tertiary recovery mechanism has grown rapidly in the oil industry to combat global warming. Many mature oilfields in Kansas are currently in the late stage of water injection, making them good candidates for CO_2 -EOR. However, several assessments need to be carried out to determine their suitability for this technology. The Kansas Geological Survey (KGS) online database contains a compilation of geologic and engineering resources required for the evaluation of oilfields in Kansas. This database contains well data, secondary recovery and pressure maintenance records, which is the foundation for majority of this work. This study provides a preliminary assessment and identification of oilfields in Kansas with the potential for CO₂-EOR, applying cutoff parameters such as reservoir depth, oil gravity, cumulative oil production and CO_2 miscibility. From an initial selection of 505 fields, 107 oilfields are good candidates for CO_2 -EOR. 24 fields are grouped under Tier 1 because they are suitable for miscible CO_2 -EOR. 48 fields are classified as Tier 2 (i.e. reservoirs pressures slightly less than estimated MMP) and 34 fields are classified as Tier 3 (i.e. immiscible CO_2 -EOR candidates). All selected fields are ranked based on production data to lay the groundwork for further screening and limitations.

Objective

- Identify fields with the potential of CO_2 utilization using specific screening criteria.
- Perform geochemical analysis for selected potential fields.

Database

Kansas Geological Survey

• Waterflood Records between 1964 to 1981 <u>Reason</u>: (1) Advanced stage of waterflood or

- aquifer encroachment.
- (2) No prior tertiary oil recovery that can cause complex miscibility with CO_2 .
- Approx. 2,800 fields.
- Lithology of production/injection zones
- Field depth, oil gravity (API) & viscosity
- Production and water injection volumes
- Drill Stem Test (DST) & Well logs

- Min. condition for supercritical CO_2 :
- 87.8°F (31.04°C) and 1071psia (7.39MPa)
- Assume pressure gradient of 0.433 psia/ft
- Min. depth able to retain $CO_2 = 2,473$ ft
- In Kansas, production depth ranged from 1,700 - 6,200ft
- Oil gravity ranged from 20 to 60°API (indicating slightly heavy to extra-light crude or condensates).
- A min. depth of 2,400 ft was chosen to include as many fields as possible.
- Minimum oil gravity of 22° API

											Location	Acres	in project		os gaiseborq lix	e	Oil proc	losing wells (19	77)	West at
Project uni-	Own	tor.	Ty	pe and project nam			Lease name				5 – T – R	Fred	Abd.	Name	Depth,	Thick.,	Active	In- active Deilled	Abd	been con-
RUSSELL COUNTY (Conf	.)																			
							W133 - 1				4 140 100	40			2050	00				
10923 No Gorham	Leb	en Oil Corp.) Mills A			Mills A				4-138-13W	160		Lans	3050	90	5		-	Yes
17573 Gorham	R.P Okm	an Oil Co	ns (- /w	Vaughn	11		Vaughn k	(rug			17-148-148	90	ŏ	Lane	31.80	8	4	2 0	ŏ	res
12345 No Gorham	Phi	llins Petroleum	Co (W) Carroll			Carroll	ar 48			18-14S-14W	70	ŏ	LKC	3100	50	4	ĩŏ	ŏ	Yes
Yes Gorham	Roy	Vonfeldt	(W	ó			Dumler U	nit			11-14S-15W	160	40	KC			2	2 -	ō	
15950 No Gorham	Ter	ra Resources, Ind	c. (D) Reinhard	dt		Reinhard	t "D"			19-14S-14W	30	100	LKC	3055	18	3	0 0	0	
4098 Gorham	Tex	aco Inc.	(7) D.Brande	enburg		D.Brander	nburg			20-14S-14W	160		Lans	3100		1	0 0	0	Yes
9974 Hall Gurne	y AB	011 Co., Inc.*	(P)	n		Carl Dum	ler	4- 808		16-14S-13W	160		Tark	2370	10	1		-	Yes
6968 Hall Gurne	y Ame	rican Petrofina f Texas*	Co. (*) Tarkio (Unit		Rein "I	"В", Ке F"	in "C"		20-14S-13W 20-14S-13₩	210	v	Tark	2315	10	Ð	э 0	0	res
9395 Hall Gurne	y Ame	rican Petrofina	Co. (W) J.Blehm			J.Blehm	-			11-14S-14W	160	0	Tark	2380	10	3	0 0	0	Yes
9516 Hall Gurne	y Ame	rican Petrofina f Texas*	Co. (¥) Rein			G.Rein H.Rein				17-148-13W 19-148-13W	320	120	Tark	2410	10	3	60	0	Yes
14923 Hall Gurne	y Ane	rican Petrofina	Co. (D) Kuhnle			G.Rein Kuhnle				20-14S-13W 4-15S-12W	80	0	LKC	2953	28	2	0 0	0	Yes
4549 No. Holl Come	0	f Texas* ward Drilling C	ю. /п) Holl "A	-		Holl "A"				22-145-14W	60	40	LKC	3000	22	8	0 0	0	Yes
7165 No Hall Gurne	ry AYL NY AVI	ward Drilling C	0. (P) Herbel	"B"		Herbel "	в"			26-148-14W	80	0	LKC	2924	20	3	ŏ ŏ	õ	Yes
7167 No Hall Gurn	y Ayl	ward Drilling C	o. (P) J.Boxber	rger		J.Boxber	ger			26-14S-14W	70	20	LKC	2292	18	4	0 0	ō	Yes
7946 No Hall Gurne	y Ayl	ward Drilling C	o. (P) Holl "A'			Holl "A"	-			22-14S-14W	10	50	Tark	2425	22	1	0 0	0	Yes
7950 No Hall Gurne	y Ayl	ward Drilling C	o. (P) Holl "B'			Holl "B"				22-14S-14W	140	20	LKC	2950	22	9	0 0	0	Yes
8293 No Hall Gurn	y Ayl	ward Drilling C	0. (P	P) H.A.Fink	k		H.A.Fink Holl "	B" #13			15-148-14W 22-148-14W	10		Lans	3000	22	1	0 0	0	Yes
9425 No Hall Gurn	y Ayl	ward Drilling C	o. (D) Anschut:	z		Anschutz				21-14S-14W	140	20	LKC	3127	20	6	1 0	0	Yes
13157 No Hall Gurne	y Ayl	ward Drilling C	o. (P	P) Holl "C'			Holl "C"	_			21-14S-14W	80	60	LKC	3027	60	4	0 0	0	Yes
15814 No Hall Gurn	ey Car	1 W.Boxberger	(1)) Boxberg	er B		Boxberge:	rВ			14-14S-14W	160	0	LKC	3000	10	2	0 0	0	Yes
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_		Water		nation.			V.41 + V.1			NI	Talastes	Production and inject	tion statistics (I	bbik)	01	han and	and the state			
Injection W	ella	head bbl/ -	Injec	bea-water data	This	Date,	Primary	Primary	API V	inc.,	Cum	Total OIL recevered in	on project PR		VAL DECEMENTES	by custoces	Com			
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MMP Estimates

- MMP is the minimum pressure at which CO₂ will mix with reservoir oil to form a single phase.
- Cronquist correlation (Mungan, 1981)
- Miscible region > 3800 ft
- Near miscibility 3000< ft < 3800
- Immiscible region 2400< ft < 3000



Reservoir Pressure & MMP by Depth

Candidate Fields										
			Cumulative Prod.		Depth	Oil Gravity	Reservoir	Ave. Reservoir	Est. MMP	
Site #	County	Field	(bbl)	Formation	(ft)	(API)	Pressure (psi)	Temp. (°C)	(psi)	
1	Kingman	Spivey-Grabs-Basil	70,647,222	Mississippian/ Viola	4400	37	1,724	136	1,683	
2	Ellsworth	Stoltenberg	55,556,387	Simpson/ Arbuckle	3333	37	1,427	86	1,086	
3	Graham	Cooper	29,303,560	Arbuckle	3740	35	1,973	115	1,505	
4	Sumner	Wellington	20,746,849	Mississippian	3650	42	2,188	130	1,452	
5	Rooks	Barry	20,149,580	Arbuckle	3200	35	1,702	98	1,277	
6	Sedgwick	Gladys	18,431,104	Simpson	3600	42	1,473	117	1,312	
7	Seward-Stevens	Cutter	7,745,971	Morrowan/ Mississippian	5200	40	2,478	155	1,770	
8	Clark	Harper Ranch	5,084,194	Lansing-Kansas City/Morrowan	5450	36	1,933	127	1,606	
9	Seward	Evalyn-Condit	4,656,650	Chesterian/ Marmaton	6236	42	1,550	125	1,396	
10	Rooks	Dorr	4,656,615	Lansing-Kansas City	3445	39	1,209	97	1,168	





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cture Engineering at University of Kansas. "This material is based upon work supported by the Department of Energy under Award Number DE-FE0031623, Midcontinent Stacked Storage Hub." Disclaimer: "This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof."





CO₂ Storage Capacity

age Capacity = $\rho CO_2 * \Theta * A * H * So* E / 2200$

 CO_2 sequestration capacity (metric tons), ρCO_2 is Density of CO_2 under reservoir conditions , Θ is Porosity (%), A is Area (ft²), H is Reservoir thickness (ft), So is Oil saturation (%) and 2200 rsion from lbs to metric tons.

				CO ₂ Storage Capacity (Metric tons)			
	Field	Oil Gravity (API)	Area (acre)	- P10	P90		
l	Spivey-Grabs-Basil	37	11750	13,949,620	69,748,098		
	Wellington	42	5600	1,851,511	9,257,554		
Stevens	Cutter	40	5440	1,930,552	9,652,759		
	Plainville	34	6240	9,522,330	47,611,650		
	Seydell	40	1680	555,453	2,777,266		
		• • • • • •					

I CO₂ stored in all 5 fields is approximately between 27 – 139 million metric tons

On-going Work

orm geochemical analysis using PHREEQC simulator.

y changes in produced water composition prior to and after CO_2 injection.

Late the effect of CO_2 addition to mineralization.

Acknowledgements

oject is supported by Kansas Geological Survey and Department of Civil, Environmental and

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