Optimizing Reservoir Oil Displacement and CO_2 storage on the Texas Farnsworth Unit CMTC-486252-MS

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Presentation Outline

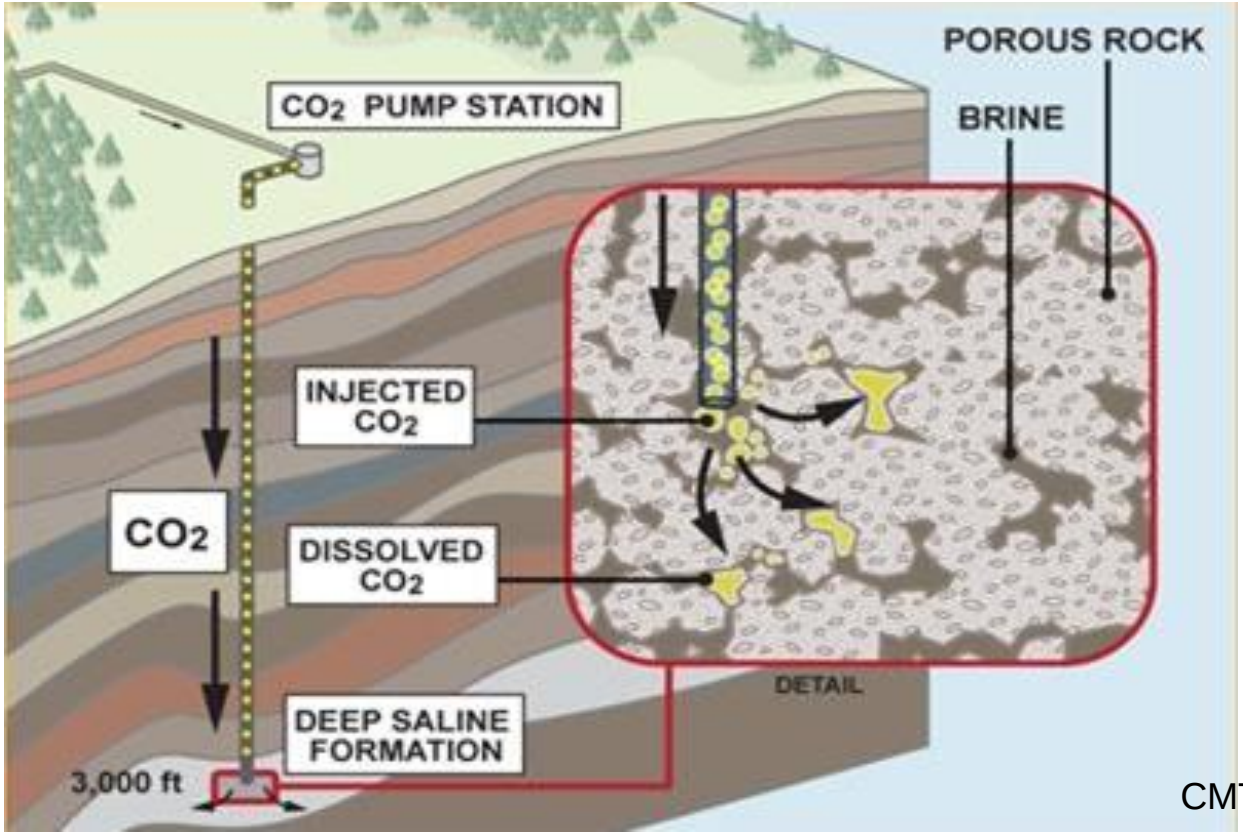
- Introduction
- Background
- Experimental Set-up
- Theories and Principles [CO_2 storage]
- Results [CO_2 storage]
- Discussion [CO_2 storage]



Presentation Outline

- Theories and Principles [WAG & SWAG]
- Results [WAG & SWAG]
- Discussion [WAG & SWAG]
- Conclusions
- Recommendations

INTRODUCTION



INTRODUCTION

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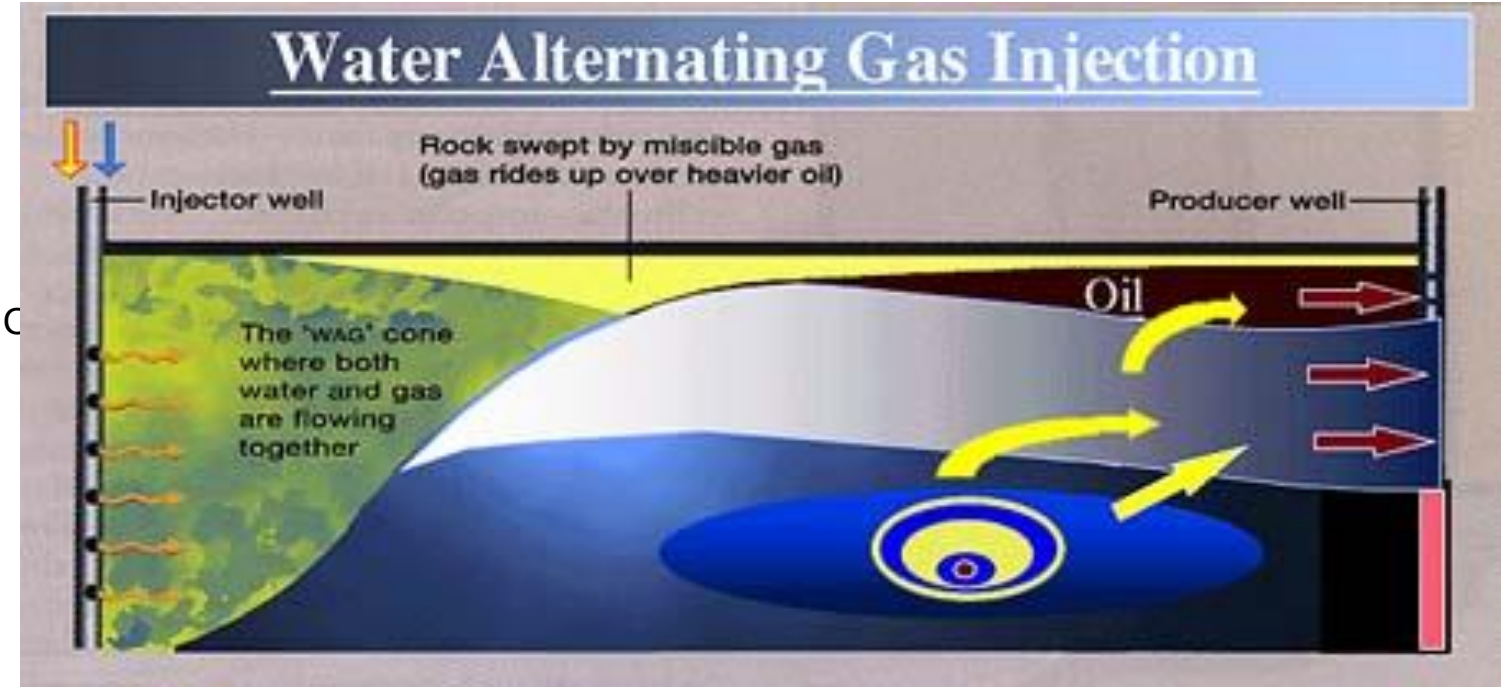




BACKGROUND

Why measure displacement of brine and CO_2?

*CO_2 injection into Saline Aquifers is the future of carbon capture and storage (CCS)

*It has been shown that brine salinity change can affect the recovery rate in a waterflood, thus does it have an effect in CO_2 displacement?

*FWU salinity has had a significant decrease over time with the waterflooding using low salinity water as injectant.



BACKGROUND

*WAG is widely used in field applications.

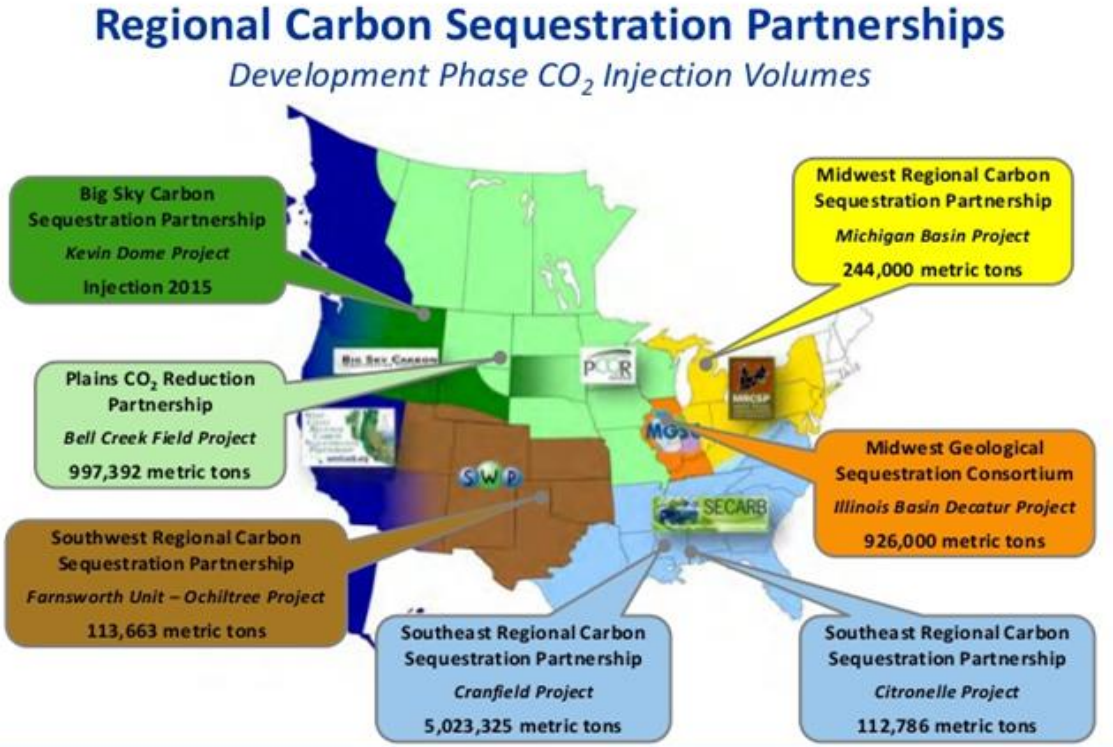
*SWAG has not been used in field applications.

*Worth knowing the effect of injection fluid dynamics of recovery factor.

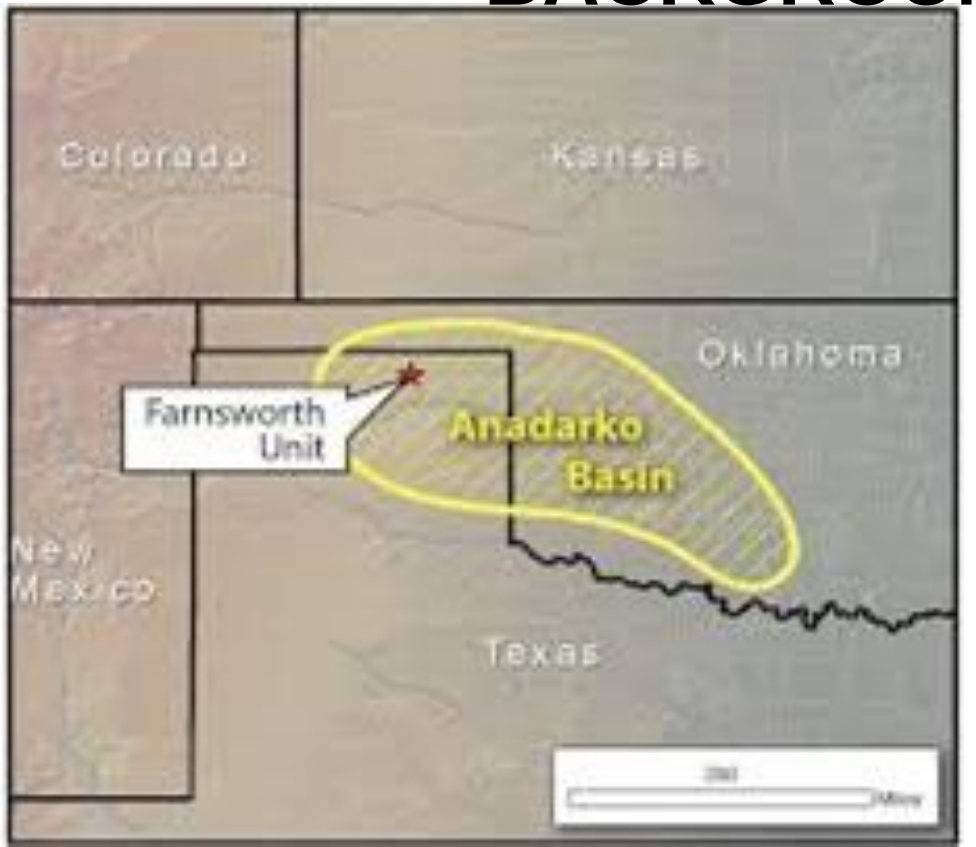
*PH difference between produced water and injection fluid.

*Observe the risk of simultaneous injection of fluid.

BACKGROUND


Regional Carbon Sequestration Partnerships
Development Phase CO_2 Injection Volumes
Big Sky Carbon Sequestration Partnership
Kevin Dome Project
Injection 2015
Plains CO_2 Reduction Partnership
Bell Creek Field Project
997,392 metric tons
Southwest Regional Carbon Sequestration Partnership
Farnsworth Unit – Ochiltree Project
113,663 metric tons
Midwest Regional Carbon Sequestration Partnership
Michigan Basin Project
244,000 metric tons
Midwest Geological Sequestration Consortium
Illinois Basin Decatur Project
926,000 metric tons
Southeast Regional Carbon Sequestration Partnership
Cranfield Project
5,023,325 metric tons
Southeast Regional Carbon Sequestration Partnership
Citronelle Project
112,786 metric tons
Injection volumes updated as of September 2014
NETL

BACKGROUND



Farnsworth Unit (FWU)

Texas Panhandle

Discovered: 1950's

Waterflood started: 1964

CO_2 flood started: December 2010

Theories and Principles [CO2 Storage]

*Absolute permeability in rock with single fluid, Darcy's law:

$$q = \frac{k\,A\,\Delta p}{\mu\,L}$$

*Relative permeability determine with two or more fluid:

$$k_r = \frac{(q * \mu)_j * L}{A * (dp)_j * k_{abs}}$$

*Brine Saturation ratio of bri $S_W = \frac{V_{bp}}{PV}$ in rock:



Theories and Principles [CO_2 Storage]

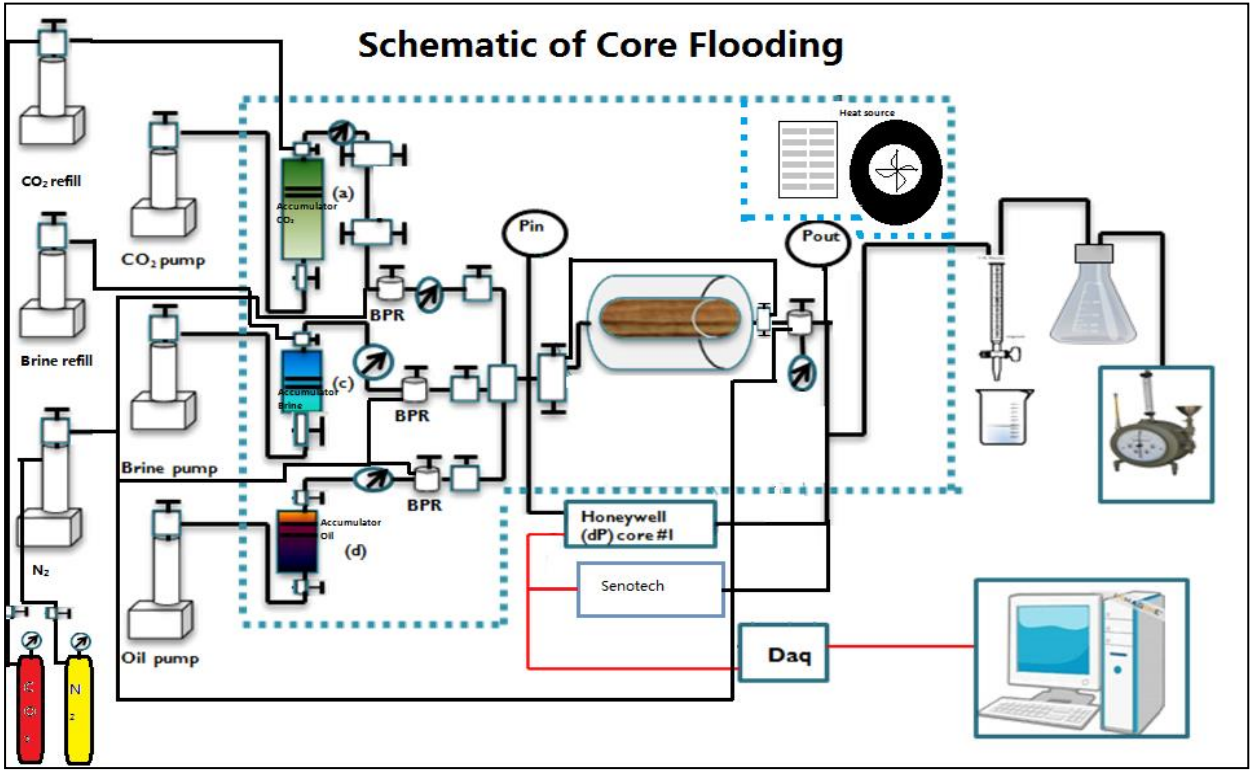
•Drainage > non-wetting fluid displaces wetting fluid.

*Imbibition > wetting fluid displaces non-wetting fluid.

*Fluids present are brine and CO_2

*Brine wetting phase and CO_2 non-wetting phase.

Experiemental Setup





EXPERIMENTAL SET-UP

* Physical properties and dimensions of core used in this study.

CORE (7- 13-15)		Units
Length	17.52	Cm
Diameter	3.77	Cm
Pore Volume	24.48	Cm^3
Porosity	12.48	%
Peameabilty	48.39	md



EXPERIMENTAL SET-UP(CO2 Storage)

Injections Fluids Used :

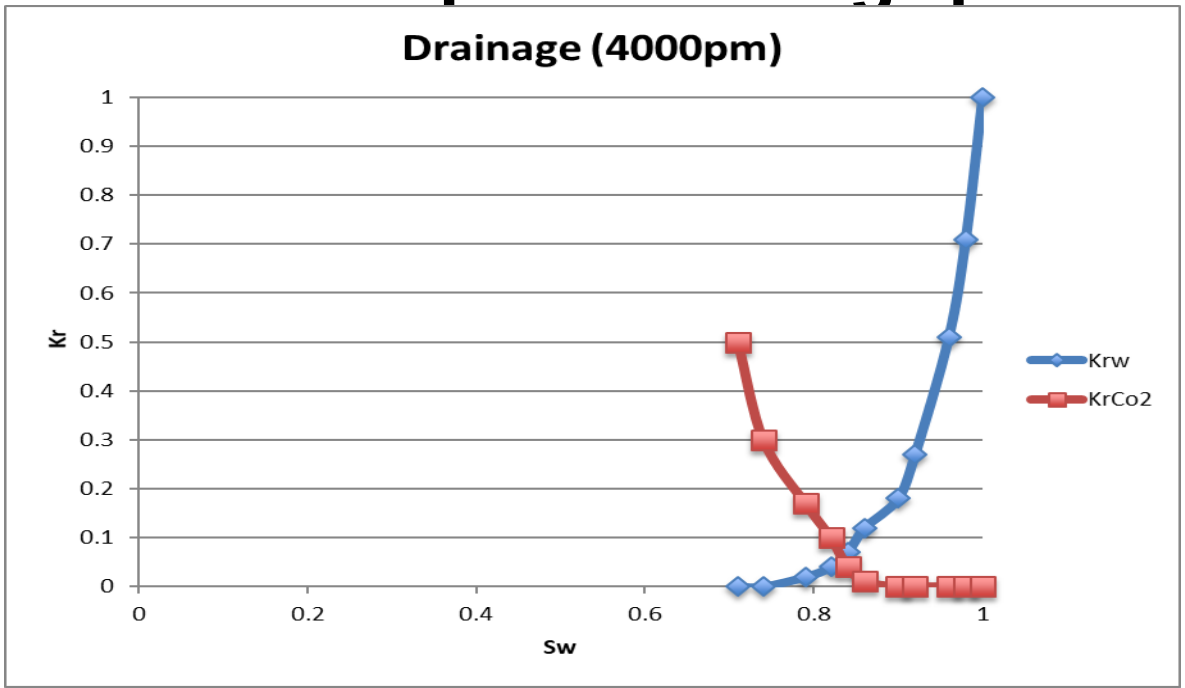
*Supercritical CO_2

*Brine(4000ppm)Farnsworth unit

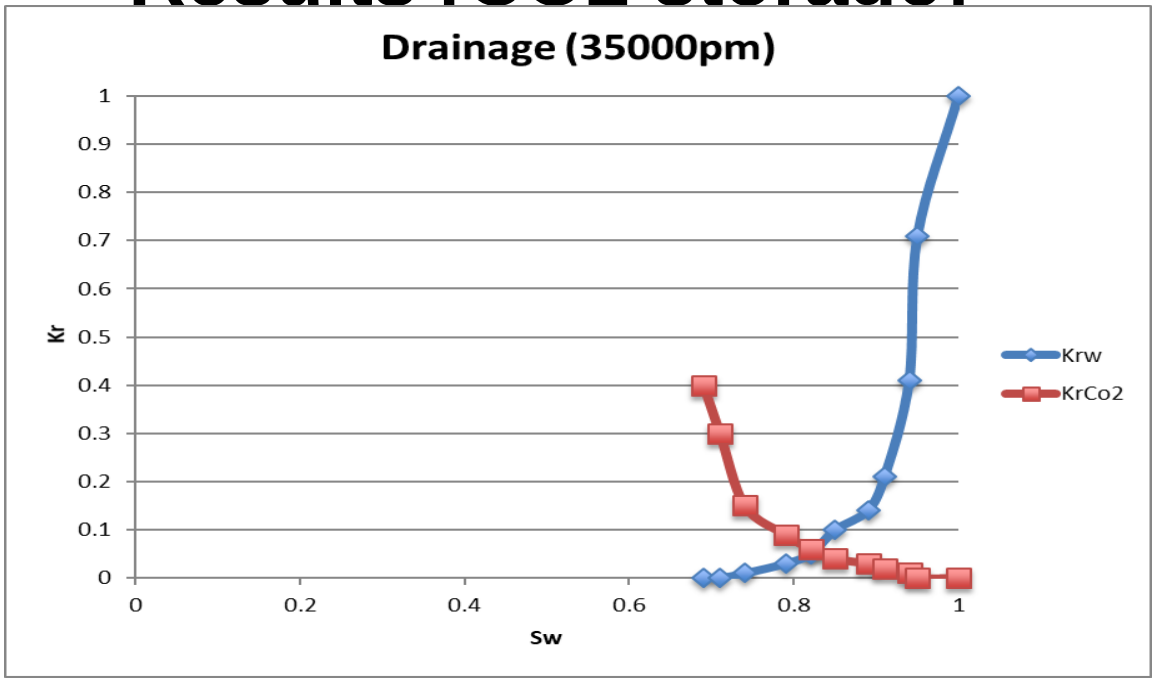
*Brine(35000ppm)Sea Water

All tests performed at reservoir conditions of 168°F and 4400 psi

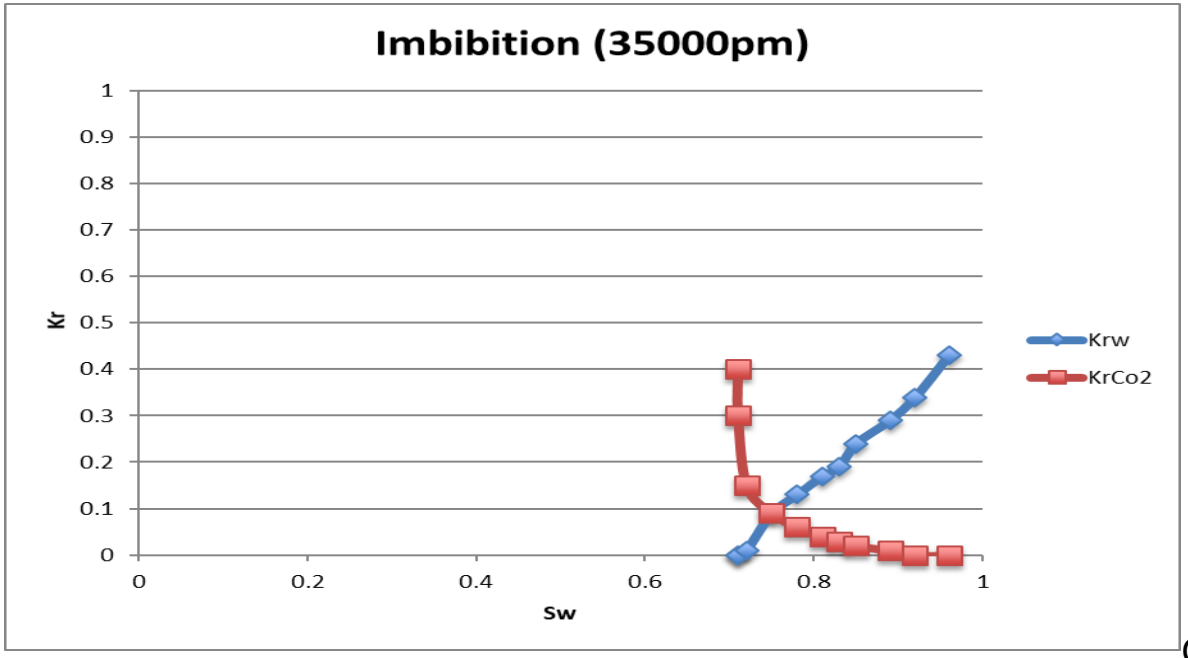
Results [CO2 storage]



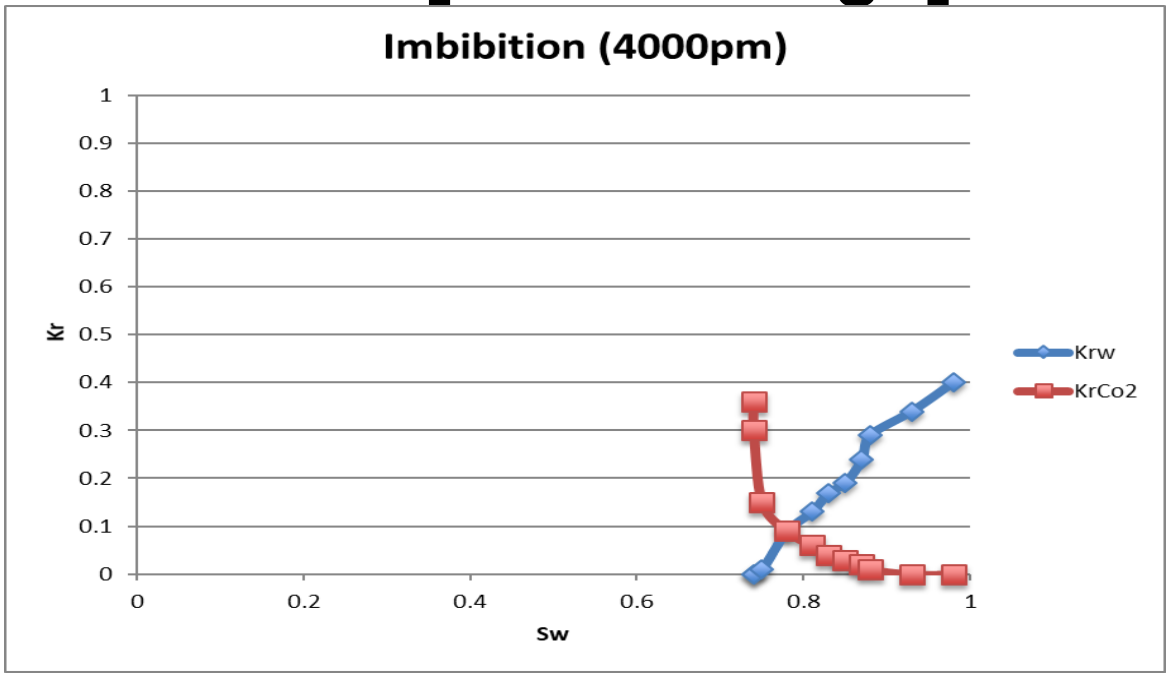
Results [CO2 storage]



Results [CO2 storage]



Results [CO2 storage]





Results [CO_2 storage]

End point values for gas and water saturations

Relative Permeability	Sw	Sg	Vol. of CO2 Stored(mL)
Drainage with 4000ppm	0.68	0.32	7.8336
Drainage with 35000ppm	0.69	0.31	7.5888
Imbibition with 4000ppm	0.74	0.26	6.3648
Imbibition with 35000ppm	0.73	0.27	6.6096



Discussion [CO_2 storage]

* Brine salinity of the aquifer had little or no effect on CO_2 storage in the cores tested under the conditions studied.

*Higher CO_2 storage was achieved during drainage, though significant storage remained after brine injection that followed the CO_2 injection.



Theories and Principles [WAG & SWAG]

*WAG is when water and gas are injected alternately for better sweep efficiency

*SWAG is when water and gas are injected simultaneously for better sweep efficiency

*Recovery Factor is ratio of recoverable oil to estimated oil in place.



Theories and Principles [WAG & SWAG]

*Gas Cut is the ratio of gas produced to the volume of total fluids produced.

*Residual oil saturation is fraction of pore volume occupied by oil at the end of oil displacement.

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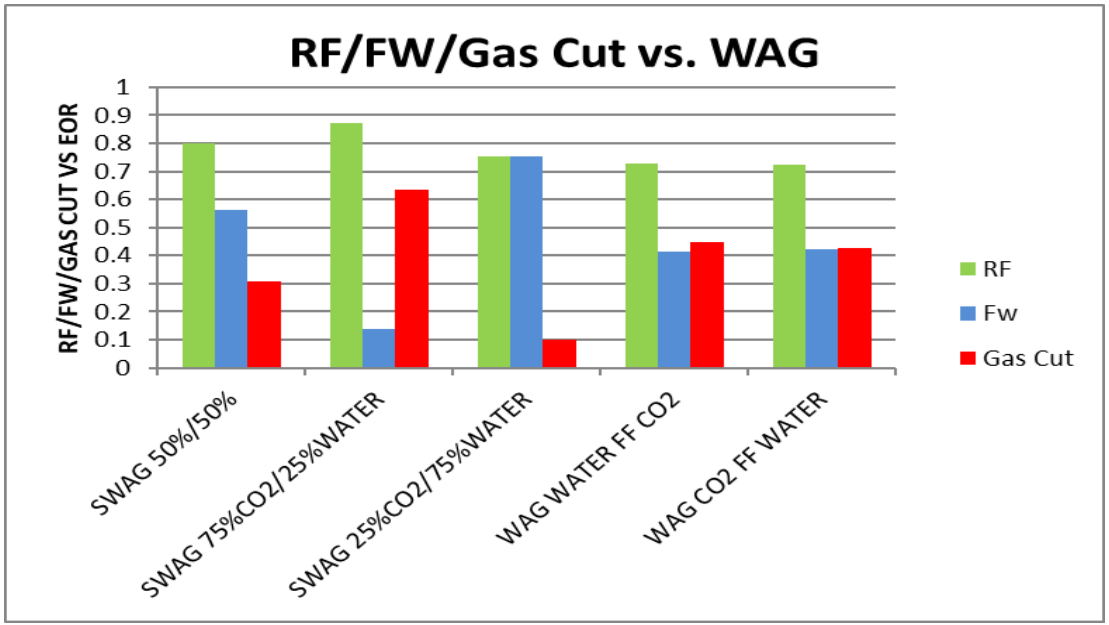
Results [WAG & SWAG]

WATER AND ALTERNATING GAS	RF	FW	Gas Cut
SWAG 50%/50%	0.80	0.56	0.31
SWAG 75%CO_2/25%WATER	0.87	0.14	0.63
SWAG 25%CO_2/75%WATER	0.75	0.75	0.10
WAG WATER FF CO_2	0.73	0.42	0.45
WAG CO_2 FF WATER	0.73	0.42	0.43

Results [WAG & SWAG]





Discussion [WAG & SWAG]

*WAG with 75% CO_2 and 25% recorded highest oil recovery

*WAG with 25% CO_2 and 75% recorded the least oil recovery

*WAG with 50%CO_2 and 50% water recorded a sizable recovery factor.



Conclusions

*The salinity of aquifer does not have an effect on its ability to store CO_2.

*Drainage which the practical method of storing records the best results.

*SWAG is an effective EOR method.

*pH of injection fluids were lower the pH of produced water.



Recommendations

*Studies should be conducted on field application of SWAG

*Research into making CO_2 a stronger wetting agent should done to Aid sequestration.