OPTIMIZATION OF A PARTIALLY DEPLETED LOW TRANSMISSIBILITY OIL RESERVOIR VIA CYCLIC/CONTINUOUS MISCIBLE CO_2 FLOOD

ABSTRACT

In this very insightful project, two eager to learn Petroleum Engineering students explore a topic related to Miscible CO_2 Enhanced Oil Recovery by using different flooding schemes, including continuous flooding and cyclic injection over a 10-year timeframe. The project works to determine which method is more efficent in optimizing the chosen formation, located in northwestern Alberta.

PROBLEM STATEMENT

Is continuous pure miscible CO_2 flooding more efficient than pure cyclic CO_2 miscible injection?

OBJECTIVES

- Determine most efficient injection method to optimize selected reservoir.
- Determine how each method impacts the flow rates of the selected formation.
- Determine how each method impacts the economic return of the project.

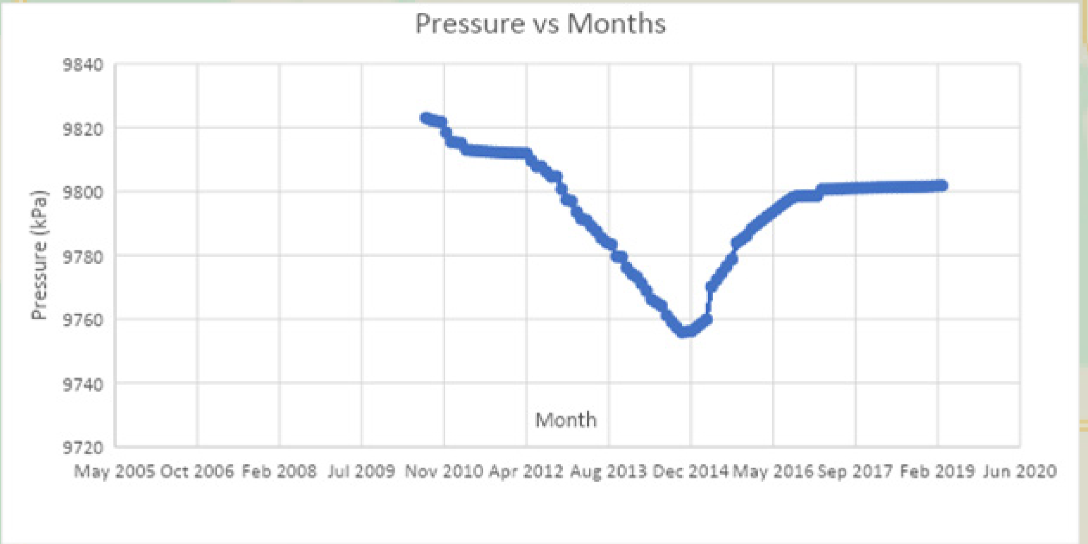
Montney Reservoir	
Depth	1040 m
API	28
Temperature	39°C
Thickness	45 m
Porosity	13%
Permeability	20 mD in HZ direction
OOIP	32,205,600 STB
Solution Gas Oil Ratio	26,290 SCF/STB
Production to date	543,204 STB

MATERIAL BALANCE

The following assumptions were made to complete the Material Balance and Pressure Depletion Calculation:

- Pressure changes 10 kPa per month on top of the change in pressure calculated from Material Balance, which is 0.1% of initial pressure.
- The Waterflood adds 35 kPa in pressure per month, on top of the volume added from Balance, based on slow flow increase from wells indicating that this was about 0.3% of initial pressure.

Shown below is the plot of Pressure Depletion per month as withdrawal volume out.



PROJECT LOCATION

Hamlet of Guy, Alberta

AKNOWLEDGEMENTS

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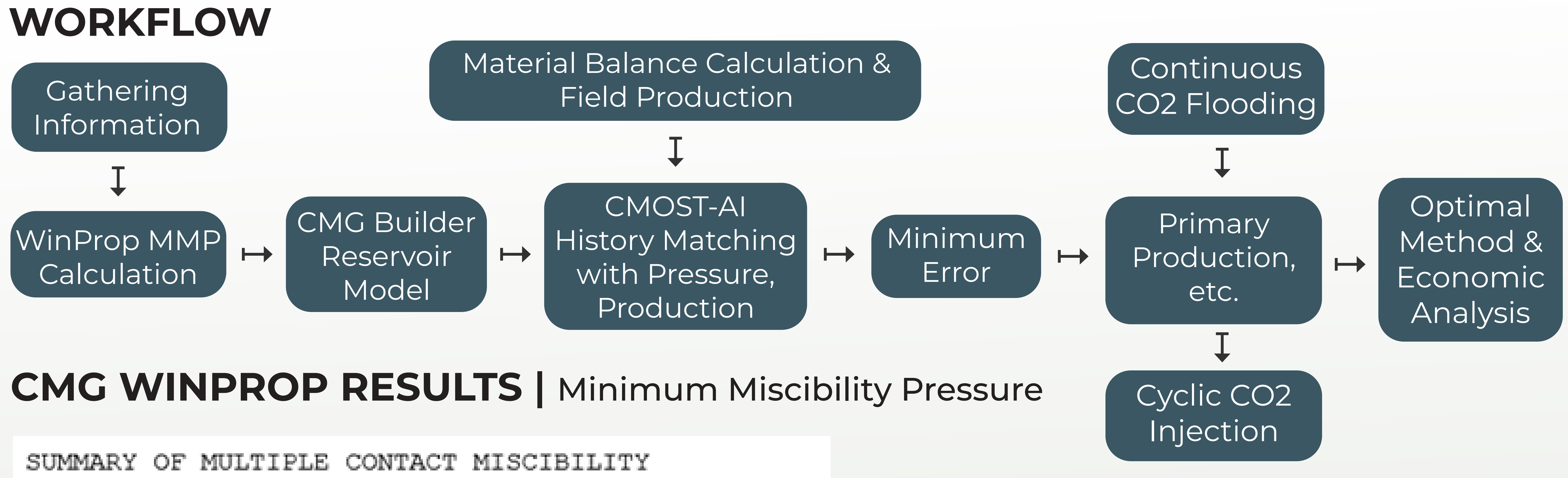
University of Regina

WORKFLOW



CMG WINPROP RESULTS | Minimum Miscibility Pressure

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SUMMARY OF MULTIPLE CONTACT MISCIBILITY
CALCULATIONS AT TEMPERATURE =       38.000 deg C

MULTIPLE CONTACT MISCIBILITY ACHIEVED
AT PRESSURE =  0.95820E+04    kPa
MAKE UP GAS          MOLE FRACTION =   0.00000E+00
BY BACKWARD CONTACTS - CONDENSING GAS DRIVE
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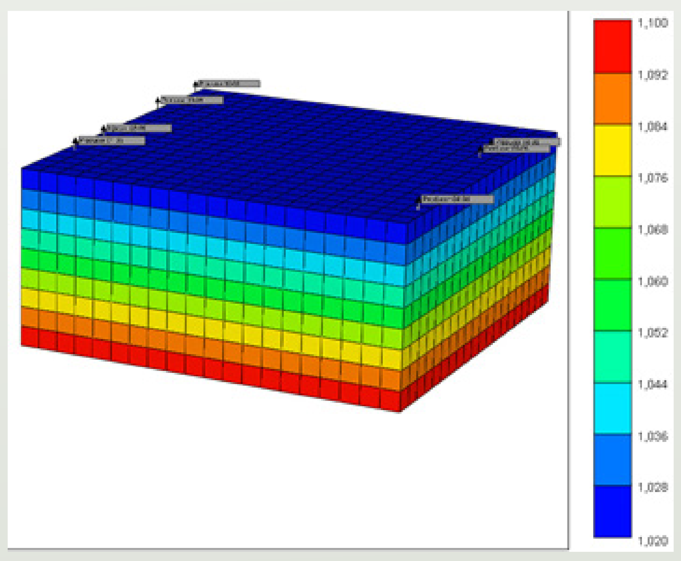
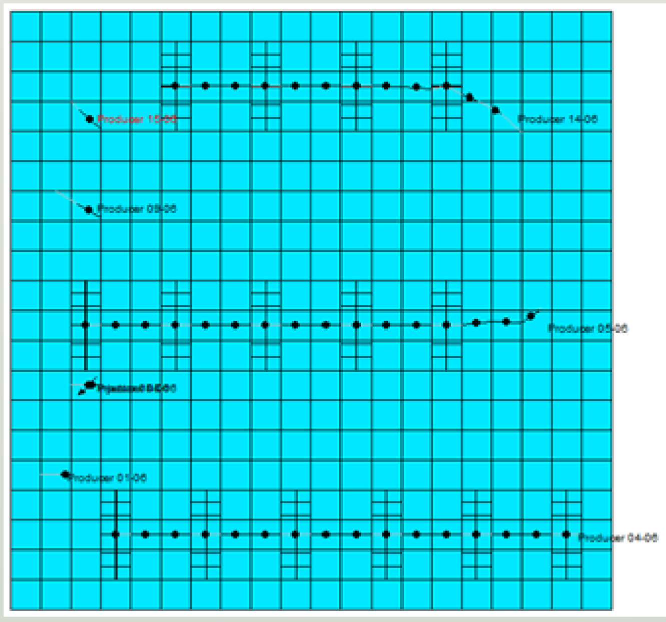
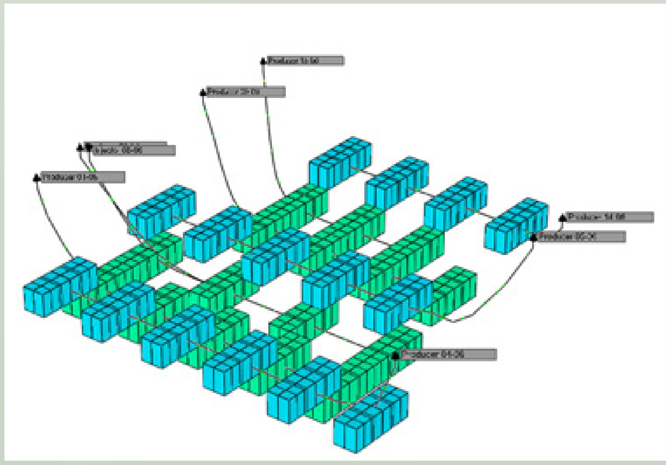
CMG BUILDER RESULTS

Model & Fractures

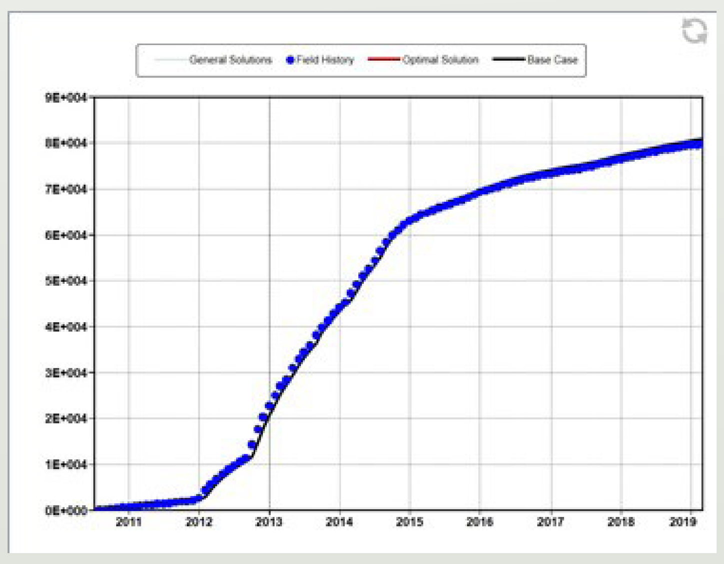


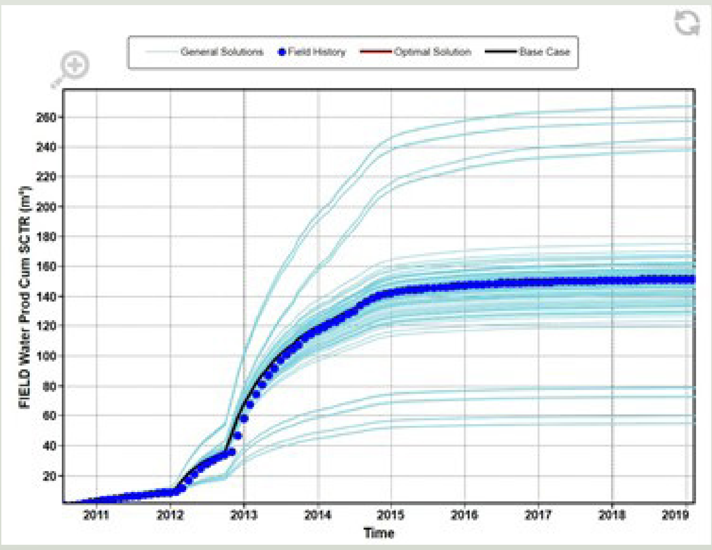


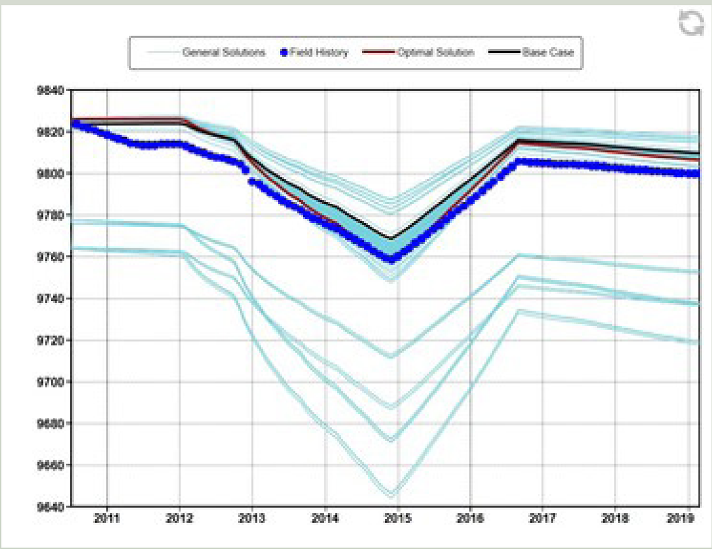


CMOST RESULTS

Oil, Water & Pressure Matching



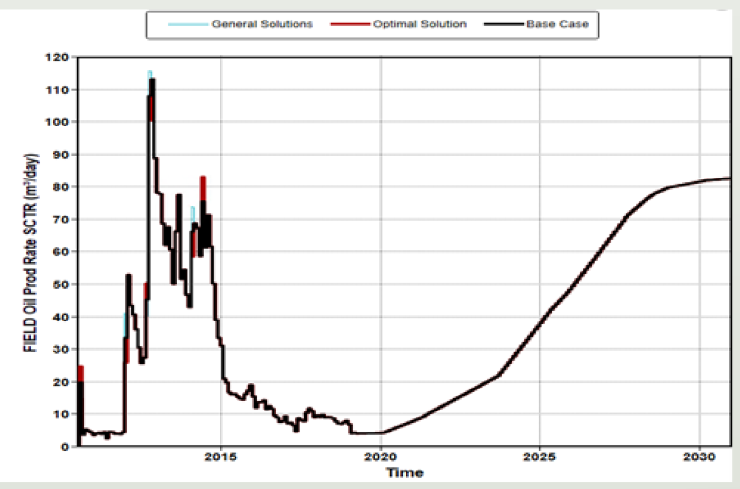


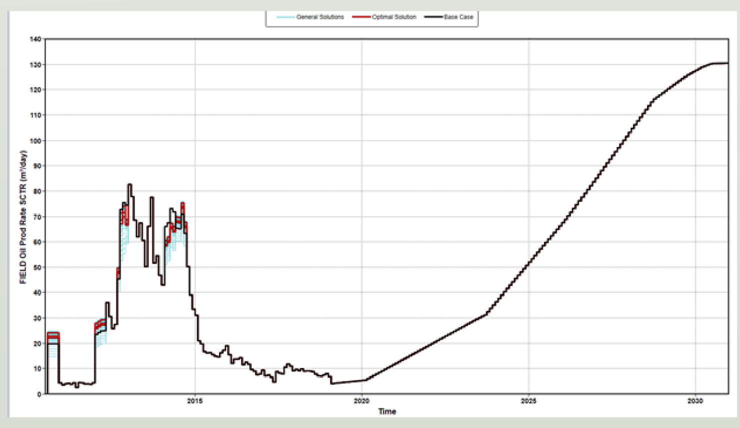


CMOST RESULTS

Continuous & Cyclic Methods

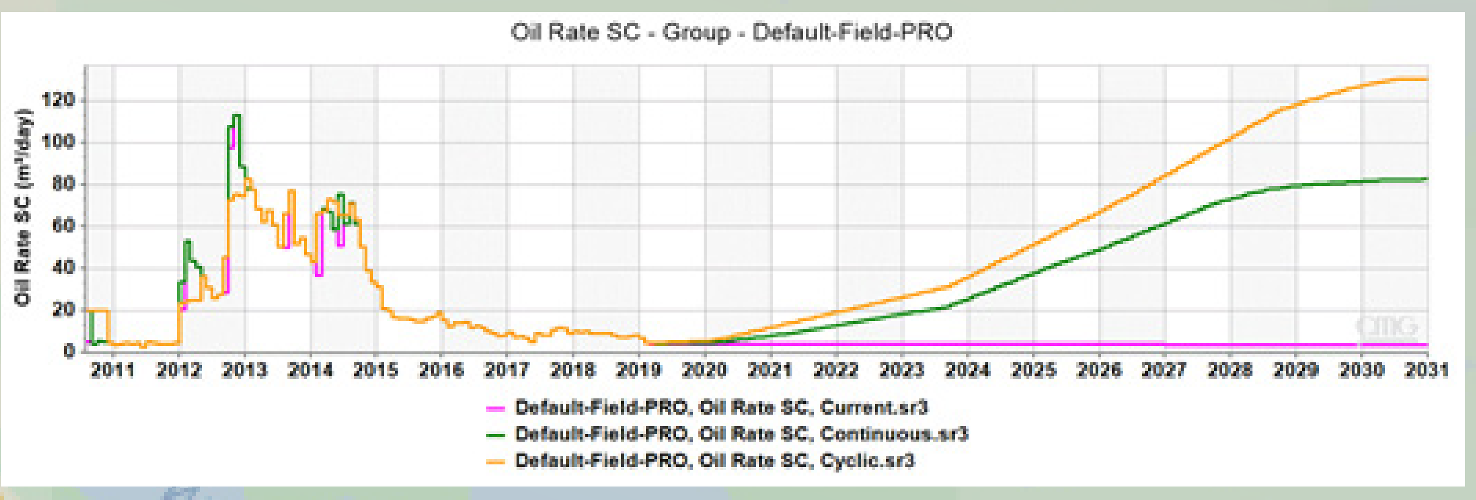
Oil Forecasting





COMPARISON OF METHODS

Current, Cyclic & Continuous



CONCLUSION

Based on these plots, the team has concluded that the most efficient method to optimize this reservoir is cyclic injection. This method also proves to be the most economically viable option under both $30/bbl and $65/bbl based on the economic analysis conducted. The team also recommends an opportunity for CO_2 storage in this reservoir once it becomes not economically viable to produce oil, due to low flow rates.

FINANCIAL SUMMARY

With Pipeline				
	Cyclic Injection at $30/bbl	Cyclic Injection at $65/bbl	Continuous Flooding at $30/bbl	Continuous Flooding at $65/bbl
Payout	over 10 years	8.3 years	longer than 10 years	9.9 years
Netback ($/bbl)	2.04	19	2.29	14.5
Recovery Factor	7%	7%	4.50%	4.50%
ROI	not profitable	0.47	not profitable	0.08
EUR (bbl)	2,216,367.00	2,216,367.00	1,424,807.82	1,424,807
F & D Costs ($/bbl)	6.4	6.4	10	10.1
Recycle Ratio	0.316	2.9	0.23	1.44
NPV	-$4,800,685	$6,709,361	-$7,343,659	$1,199,585

CAPEX with Pipeline	
Pipeline	$ 9,960,000.00
Process Line	$ 420,000.00
Compressor	$ 200,000.00
Storage Tank	$ 1,300,000.00
Total	$ 11,880,000.00
Total CO2 Costs	$ 2,511,636.12
Total Investment	$ 14,391,636.12

Without Pipeline				
	Cyclic Injection at $30/bbl	Cyclic Injection at $65/bbl	Continuous Flooding at $30/bbl	Continuous Flooding at $65/bbl
Payout	6.2 years	3.6 years	7.3 years	4.8 years
Netback ($/bbl)	9.46	26.1	7.72	24.3
Recovery Factor	7%	7%	4.50%	4.50%
ROI	1.16	3.56	not profitable	2.52
EUR (bbl)	2,216,367.00	2,216,367.00	1,424,807.82	1,424,807
F & D Costs ($/bbl)	1.99	2.089	3.11	3.11
Recycle Ratio	4.72	12.49	2.48	7.9
NPV	$5,159,314	$16,468,361	$2,616,341	$11,159,585

CAPEX without Pipeline	
Pipeline	$ -
Process Line	$ 420,000.00
Compressor	$ 200,000.00
Storage Tank	$ 1,300,000.00
Total	$ 1,920,000.00
Total CO2 Costs	$ 2,511,636.12
Total Investment	$ 4,431,636.12

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