CARBON CAPTURE AND STORAGE (CCS) DESIGN STUDY IN A DEPLETED HEAVY OIL RESERVOIR

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Introduction & Scope

- In the scope of the petroleum industry, the term Carbon Capture and Storage (CCS) is a process that eliminates CO_2 from the environment while storing it in the suspended/depleted reservoirs or using it as an ingredient for enhanced oil recovery.
- The initial stage of CCS involves CO_2 being acquired from large-scale industrial facilities and transported through pipelines to injection sites.
- From this stage, CO_2 is injected into rock formations for enhanced oil recovery (EOR) purposes.
- The geological storage option promises the utmost chance of success with relatively low costs, where CO_2 is injected into depleted reservoirs, oil, and gas fields.
- The suitability of potential CO_2 storage well is evaluated to ensure safe and permanent storage of CO_2 by considering existing reservoir properties for CO_2 injection and calculating storage volume.

Objective

The objective of this project is to run a design study on using Carbon Capture and Storage (CCS) process along with an economic analysis on a depleted heavy oil reservoir near Cherhill area Banff reservoir.

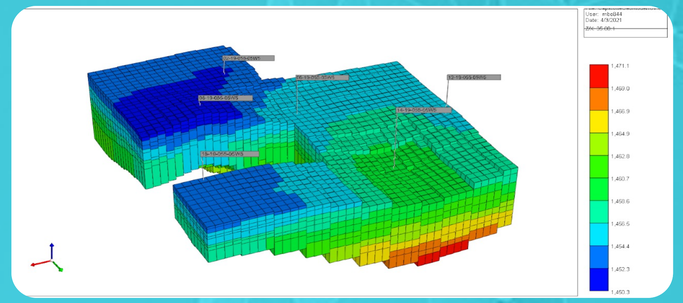
Methodology

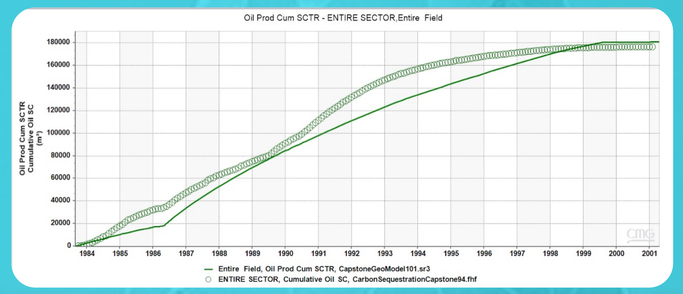
- **Accumap**
  - Located field and well location
  - Obtained Core data
  - Obtained Wellbore Perforation data
  - Obtained PVT data
  - Obtained production data for history matching
- **CMG Win prop** — Simulated PVT data to create fluid model
- **CMG Builder (STARS)** — Created Geological model using core and perforation data
- **CMG Results** — Matched results from STARS with history data production
- **CMG Builder (STARS)** — Created scenarios with several combinations of producers and injectors to find an optimum CO2 injection strategy
- **CMG Results** — Compare Results of simulations to find the best strategy
- **Excel** — Performed Economic analysis

Table of Properties

Properties	Values
Reservoir Location	Cherhill area, Banff F reservoir
Gross Formation Volume (Actual Reservoir model)	1.60 x $10^8 m^3$
Gross Formation Volume (Geological model)	2.33 x 10^7 m^3
Pore Volume (Geological Model)	4.73 x 10^6 m^3
Oil phase volume (OOIP) (Geological Model)	2.48 x 10^6 m^3
Initial Pressure	11474.00 Kpa
Initial Temperature	40 ℃
Mean Formation Depth	1450.00 m
Density	910.00 kg/m^3
Viscosity at initial temperature	34.25 cp
Average Porosity	0.17
Average Permeability	59.76 md
Average Water Saturation	0.39
Average GOR	1037.45 m^3/m^3
Initial GOR	46.00 m^3/m^3
API	24.00

Geological Model & History Matching





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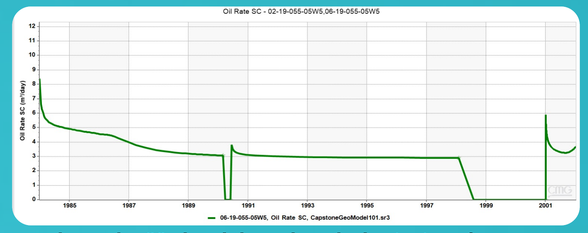
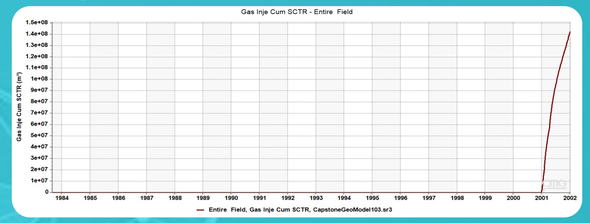
Results



- This image shows the CO2 breakthrough at the beginning of 2001.
- Cumulative oil production before CO2 injection : 180665 m3
- Cumulative oil production after CO2 injection : 181982 m3



- This image shows the cumulative gas injection until 2002.
- Cumulative gas injection till 2002: 1.44 x 10^8 m3

Economic and Environmental Analysis

- The injection of CO2 into a depleted heavy oil reservoir is an optimistic opportunity for reducing GHG emissions. For the purpose of this project, the model is using $50/bbl WTI oil price with the following costs:
  - Field delivered CO2 price : $60/tonne
  - Injection well maintenance : $1/tonne
  - CO2 transportation and distribution: 220,000 per 40 acre
- CCS can attain approximately 14 % of GHG emissions reduction and is one of the only methods that can decrease the carbon in the industrial sector.
- With Federal Carbon tax increasing from $30/t in 2019 to $50/t by 2022 and receiving carbon credit from the government, many companies in Alberta are shifting towards CCS strategy for oil production.

Conclusions

- CO2 storage in this Banff F reservoir looks promising for increased production of oil through the process of CCS.
- Studies show that CCS method can store between 130 to 1310 million tonnes over the span of next 30 years.
- With carbon credits from the government, companies reduce them to reduce net cost of CO2 purchase by increasing the break-even CO2 price by the distributed credit amount.

References

- https://prism.ucalgary.ca/bitstream/handle/1880/112625/capstone_Hares_2020.pdf?sequence=1&isAllowed=y