A COMPARATIVE EVALUATION OF MISCIBLE AND IMMISCIBLE CO_2 FLOODING PERFORMANCE IN A LIGHT OIL RESERVOIR IN SASKATCHEWAN

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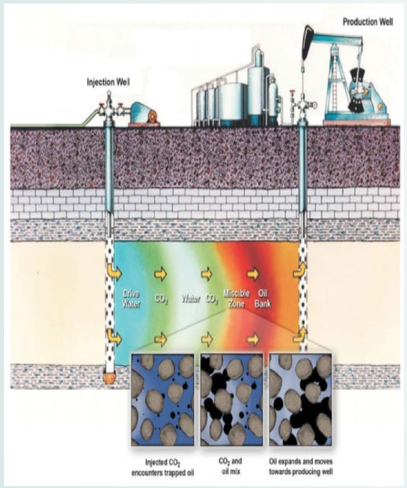
CO_2 FLOODING

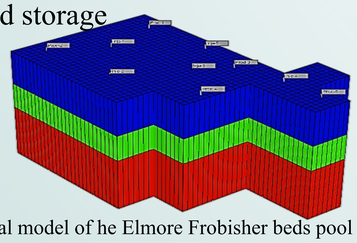
- Carbon dioxide (CO_2) flooding is an enhanced oil recovery method
- It can be achieved in two ways: Miscible and Immiscible Flooding.
- The gas is injected into the reservoir to increase oil production
- Using CO_2 gas is cost efficient compared to hydrocarbon gases
- Reduction of Greenhouse gases



Source: National Energy Technology, 2010

CASE STUDY

- The selected pool is Elmore Frobisher Beds Pool
- Located in Southeastern Saskatchewan (001-31W1)
- Suitable for CO_2 recovery methods and storage
- Porosity: 10.6%
- Viscosity: 5.057 cp



Geological model of he Elmore Frobisher beds pool

OBJECTIVES

- To determine which flooding type (Miscible and Immiscible Flooding) is the most feasible approach for the selected pool
- To find the most viable operational conditions for the selected flooding type

IMMISCIBLE FLOODING

- Oil displacement by injected fluid(CO_2)
- Swelling of oil phase due to injected gas
- MMP > Injection pressure
- Low recovery factor
- Reduction in Interfacial Tension (IFT)
- Reduction in oil viscosity and density

MISCIBLE FLOODING

- Residual oil mixes with displacing fluid
- IFT=0 (single phase)
- Requires MMP < Injection Pressure
- Miscibility is achieved during multiple contact
- Swelling of oil phase due to injected gas
- Reduction in oil viscosity

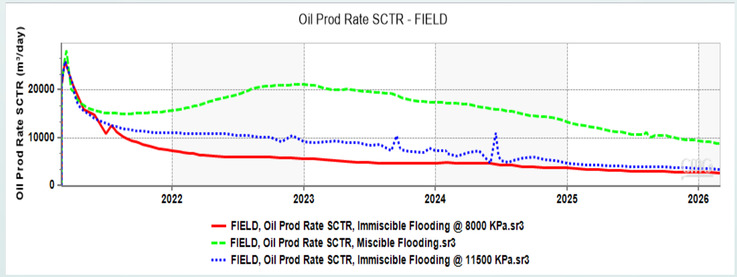
METHODOLOGY

- CMG Win Prop: To create the reservoir fluid model and predict the Minimum Miscibility Pressure (MMP)
- CMG GEM: To build the geological model of Elmore Frobisher Pool and run simulations for both flooding types
- CMOST: To facilitate optimal oil production and History matching

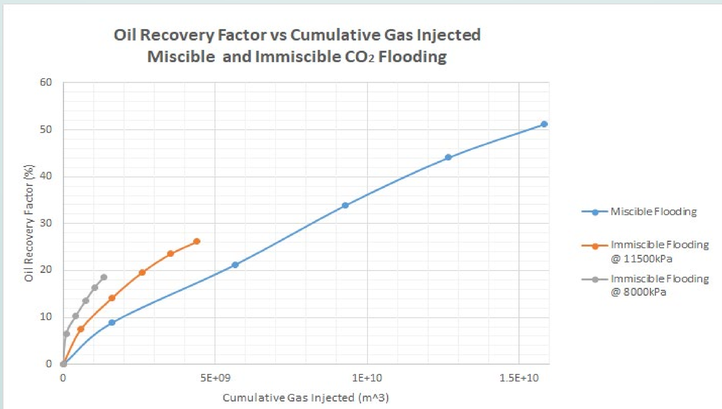
ENGINEERING DESIGN

- Model was built using CMG GEM on a Cartesian grid (X,Y, Z plane)
- Total of 6912 blocks (48*48*3) were used to create the model
- 2 cases of injection pressures were considered below MMP (8000kpa & 11500kPa) for immiscible flooding
- For miscible flooding, pressure was set at 15000kPa
- Five injector wells and five producer wells used
- An impure stream of 80% CO_2 and 20% impurities

RESULTS

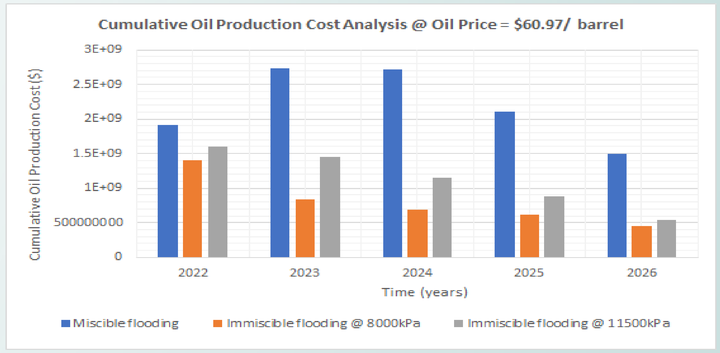


Oil production rate from immiscible(8000KPa & 11500KPa) and miscible flooding



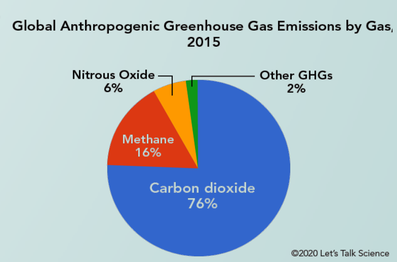
ECONOMIC ANALYSIS

- Oil Price: $60.97/barrel
- Cost of naturally occurring CO_2: $14/ton
- Readily available from source (Weyburn plant) to delivery site
- Carbon tax incentive: $20/ton of emissions
- CO_2 recycling and storage encouraged
- At this oil price the process is economically beneficial



ENVIRONMENTAL EFFECTS

- Current situation of greenhouse gases (GHG) emissions by the G20 countries projected the year 2050 although fossil fuels are still in use
- Petroleum industries taking steps to reduce CO_2 through carbon capture and storage for EOR projects
- Corrosion of equipment as CO_2 reacts with water to form carbonic acid
- Pipeline leakages as a result of transportation



Source: Inventory of US Greenhouse gas emissions and sinks1990-2015

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References

1National Energy Technology Laboratory. (2010, March). *Carbon dioxide Enhanced Oil Recovery*. Untapped Domestic Supply and Long Term Carbon Storage Solution. Retrieved April 03, 2021, from https://www.netl.doe.gov/sites/default/files/netl-file/co2_eor_primer.pdf

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