

CO₂ Capture from Industrial Emissions and Injection for Kuwaiti Oil Reservoirs: A Dual Benefit for EOR and Environment

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Outline

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- CO₂ Sources Survey



Introduction

To cope with KOC 2030 strategy of delivering 4 MM STBOD, EOR technology is a key project to be adopted by KOC.



Feasibility and Environmental Aspects

The prospects of using CO₂ flood as an EOR process have gained much interest, as this could provide a new opportunity to dispose of CO₂ captured from industrial sources emission to the atmosphere.



Feasibility and Environmental Aspects

The capture of CO₂ emissions from the refinery sites and their subsequent storage, sequestration and / or usage in EOR will play an increasingly important role in positioning Kuwait towards implementation of any GHG protocol and helping her stabilize its surrounding atmosphere and the earth's natural systems by protecting it from the impairment of a major greenhouse gas.



Kuwaiti Oil Reservoirs Screening for EOR



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KOC - KISR EOR Screening Study

EOR Evaluation (EOR Master Plan)

Field Data: 86 Fields

Screening for All EOR Techniques

Reservoir Selection

Conclusions of Screening Studies

Successful processes:

- Horizontal Wells
- Waterflood
- Miscible HC and CO₂, More Than 80%
- Steam Injection for Heavy Oil



EOR Reservoir Screening Results (Example)

| | | Reservoir | | | | | | | | | | | | | | |
|--------------------|--------------------------------------|--------------|------|------|------|------|------|------|------|------|------|-------------|------|------|------|-------|
| | | North Kuwait | | | | | | | | | | West Kuwait | | | | |
| | | Processes | SALB | SAUB | SAMA | RQLF | RQZU | ADZU | RAUB | FALB | FAMA | FAZU | MNWS | MNES | MNMD | EUGMD |
| | | Waterflood | FAIL | PASS | PASS | PASS | COND | PASS | PASS | FAIL | PASS | PASS | PASS | PASS | PASS | COND |
| Chemical Processes | Polymer Flooding | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL |
| | Alkaline/Polymer Flooding | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL |
| | Surfactant/Polymer Flooding | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL |
| | Alkaline/Surfactant/Polymer Flooding | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL |
| | | | | | | | | | | | | | | | | |
| Gas Processes | Carbon Dioxide Miscible | PASS | PASS | PASS | FAIL | PASS | PASS | PASS | COND | PASS | PASS | COND | COND | PASS | COND | |
| | Hydrocarbon Miscible | PASS | PASS | PASS | FAIL | PASS | PASS | PASS | COND | PASS | PASS | COND | COND | PASS | COND | |
| | Nitrogen Miscible | FAIL | FAIL | FAIL | FAIL | COND | COND | FAIL | FAIL | FAIL | PASS | FAIL | FAIL | PASS | FAIL | |
| | Immiscible Gas | FAIL | PASS | PASS | FAIL | COND | PASS | PASS | FAIL | PASS | PASS | PASS | FAIL | PASS | COND | |
| Thermal Processes | Cyclic Steam Simulation | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL |
| | Steam Flooding | FAIL | FAIL | FAIL | PASS | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL |
| | Steam Assisted Gravity Drainage | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL |
| | In Situ Combustion | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | FAIL | PASS | PASS | FAIL | FAIL | |



KISR – JNOC – KOC CO₂ Injection Project



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Road Map OF CO₂ EOR PROJECT

- Comprehensive data collection, compilation and database
- Comprehensive reservoir/technique screening
- Carefully designed experimental program
- Simulation and optimization studies
- Conceptual Pilot Plant design
- Monitoring
- Up-scaling
- Field Development



CO₂ Sources Survey



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Investigation of Sources and Availability of CO₂ for EOR Application in Kuwait

Investigate the availability of possible CO₂ sources with enough capacity to supply CO₂ for EOR projects.

Study the appropriate process(s) to produce high quality CO₂ from each source

Evaluate the feasibility by estimating CO₂ delivery cost for each CO₂ source plant in Kuwait.



CO₂ Gas Quantity and Cost in Kuwait

1. Energy and Chemical Plants:

- High quality CO₂ in excess of 1650 MMscfd

2. Power plants (5) and the desalination plant (1):

- 1537 MMscfd at cost of US\$1.04/Mscf or less

3. Steam Reformers in refinery plants(3):

- 114 MMscfd of high quality CO₂ (98% purity) at US\$0.32-0.36/Mscf.
- Acid gas remover in a refinery plant- not considered

This amount of CO₂ is enough to conduct a normal-scale EOR project



Advantages in Conducting CO₂ EOR Projects in Kuwait

1. CO₂ sources in Kuwait are available.
2. Sufficient to sustain adequate supply of CO₂ gas for field EOR projects.
3. High CO₂ quality as high as 98% purity in Refinery-immediate injection.
4. All locations of CO₂ sources are close to the oil fields in Kuwait

Otherwise be emitted to the atmosphere



**Win-Win situation for Kuwait
both on the environmental and
economical aspects.**



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