PERSPECTIVES ON

CONCURRENT CO₂ EOR AND CARBON CAPTURE AND STORAGE (CCS)

Enhanced Oil Recovery Institute’s
3rd Annual CO₂ Conference
Casper, Wyoming

L. STEPHEN MELZER
Melzer CO₂sulting

June 2009
PERSPECTIVES ON
CO₂ EOR AND CARBON CAPTURE AND STORAGE (CCS)

• CO₂ EOR AND CCS CONVERGENCE
• ‘SECURE’ UNDERGROUND STORAGE
• STATUS OF THE EOR INDUSTRY AND SIZE OF THE TARGETS
• OPPORTUNITY KNOCKS
• THE SKIRMISH LINE: ENVIRONMENTAL AND RESOURCE LAW
• LIMITING FACTORS FOR GROWTH
• POLICY INITIATIVES
THE CONVERGENCE OF CCS AND CO₂ ENHANCED OIL RECOVERY

- CONTINUING MATURITY OF OILFIELDS
- CO₂ EOR TECHNOLOGY GROWING AND MORE WIDELY APPLIED; SOME RESERVOIRS ARE BEING EXTENDED VERTICALLY (TZs and ROZs)
- REQUIRES ‘SECURE’ STORAGE AND DOCUMENTATION OF NET CO₂ SEQ VOLUMES
- COMING PROFILERATION OF ANTHROPOGENIC CO₂ SOURCES
  - MORE EXPLOITATION OF LOW BTU (CO₂ ‘LADEN’) NATURAL GAS w/ CO₂ CAPTURE
  - CAPTURE OF INDUSTRIAL CO₂ SOURCES (FERTILIZER, CEMENT, HYDROGEN, HELIUM, ETHANOL ETC.)
  - ONSET OF THE AGE OF IGCC, NG AND SUPERCritical COAL POWER PLANTS w/ CO₂ CAPTURE
‘SECURE’ CO$_2$ STORAGE (1)
EOR INDUSTRY PERSPECTIVES

• REGULATORY JURISDICTIONAL CERTAINTY (STATE-BASED?)
• PERMITTING THE RIGHT SITES
• COMMERCIALY GROUNDED MONITORING, VERIFICATION AND ACCOUNTING
‘SECURE’ CO₂ STORAGE (2)
EOR INDUSTRY PERSPECTIVES

• FACILITATING INITIAL CAPTURE PROJECTS
  – VOLUNTARY OPTION
  – INCENTIVES FOR FIRST MOVERS
  – CAP AND TRADE, ALLOWANCES (‘Waxman-Markey’)

• LONG TERM FATE OF CO₂ – RISK SHARING

• WHO OWNS STORAGE RIGHTS? WHAT IS THE DYNAMIC BETWEEN THE STORAGE, SURFACE AND MINERAL ESTATES?

• HOW TO AGGREGATE SUFFICIENT RIGHTS?
CURRENT EOR/CCS ACTIVITIES

• CONVENTIONAL CO₂ SUPPLIES HAVE HAD LIMITATIONS – SOME EXPANSIONS UNDERWAY

• ACTIVITY PRIMARILY CONCENTRATED IN CURRENT EOR AREAS – BUT IS EXPANDING

• INITIAL CO₂ PIPELINES IN NEW AREAS

• USING EOR TO GROW CAPTURE AND BUILDOUT OF INFRASTRUCTURE: INCORPORATING ANTHROPOGENIC CO₂ SOURCES (QUESTION: ARE WE NOW RECOGNIZING THIS WITH THE NEW ADVANTAGES OF ANTHRO CO₂? e.g., 45Q, Tx HB469, SB1387)
SandRidge, Oxy break ground on Century gas processing plant

By Mella McEwen
Oil Editor

Announced last summer, the $1.6 billion Century Plant planned for Pecos County by SandRidge Energy and Occidental Petroleum has moved closer to existence with a recent groundbreaking ceremony.

Under the agreement, Oxy will spend $1.6 billion to build and operate the new plant and a 160-mile pipeline from the plant through McCamey to Denver City. SandRidge will drill, produce and deliver high-CO2 gas to the plant, which Oxy will treat under a 30-year agreement. SandRidge will retain all the methane gas and Oxy will keep all CO2 for use in enhanced oil recovery projects in the Permian Basin.

It will be completed in three phases and fully operational by 2011.

Speaking at the groundbreaking ceremony, Bill Albrecht, president of Oxy Oil & Gas USA, told the crowd that the project “marks a great partnership between SandRidge and Oxy. It’s also a bellwether for our industry, as we dedicate ourselves to increasing domestic oil supplies while also protecting the environment.”

He estimated that the new plant will provide Oxy with a major new source of CO2 for its enhanced oil recovery projects, allowing the company to increase Permian Basin production by at least 50,000 barrels a day within the next five years.

The second prong of the project, said Kevin White, SandRidge’s senior vice president, business development, is that the plant will take “what we decree is waste gas,” remove the CO2 and leaving SandRidge with methane gas to market. The new plant will also let it produce more from its Pinon (Overthrust) field, he said, noting that production was hampered by restrictions on plant capacity to produce sour gas.

The third prong of the deal, he said, is that the new plant will benefit the environment by preventing CO2 — considered a leading greenhouse gas responsible for global warming — from being emitted into the atmosphere.

The current decline in natural gas prices and energy demand has not impacted plans for Century, White said. “It is a big plant and will take awhile to build. We also have a partner in Oxy that has a longer view of the natural gas market and doesn’t have a knee-jerk reaction to prices.”

Still, White acknowledged that the partners are being cautious moving forward with the project.

“Oil and gas prices are cyclical,” he reminded. “Just when we think they’ll never go down, they will go down. Just when we think there is no up cycle, it goes up. We have a 30-year agreement with Oxy. Neither company thinks this price level will last 30 years.”

Mella McEwen can be reached at casell@mrt.com.
A LOOK INTO THE MIND OF ‘A SUPPLIER’

• A HUGE NATURAL RESOURCE (NAT’L GAS*)
• A PURIFICATION REQM’T TO SELL THE NAT’L GAS (SEPARATE THE CO₂)
• A NEED TO AVOID THE BY-PRODUCT CO₂ EMISSIONS
• A LARGE CO₂ MARKET TO READY THE BY-PRODUCT TO DELIVER A PRODUCT OF VALUE

* IT COULD ALSO BE PETROLEUM COKE, COAL, OR CEMENT PLANT
A LOOK INTO THE MIND OF ‘AN EOR OPERATOR’

- Rapidly depleting oil resources with marginal economics
- A large and reliable resource (CO₂) to further develop the oil resources to the EOR stage
- But no rules established to document (stored) volumes in order to:
  A) Opt in to concurrent storage & EOR or
  B) Go with business as usual EOR

Leaving

- The capturer with its full liability for emissions: disconnected with the injector (no commitment to store)
TWO THOUGHTS TO KEEP IN MIND …
(as a result of the new day*)

- CO$_2$ EOR petroleum professionals are at the center of the ongoing debates over climate change

- CO$_2$ EOR petroleum professionals who become “CCS-certified” should find themselves facing remarkable new business opportunities

* 2006, Kipp Coddington (North American Carbon Capture and Storage Association)
THE COMING PARADIGM …*

- Networks of anthropogenic sources will be connected via pipelines in a hub & spoke arrangement
  ✓ Such networks are already being built

- To the extent feasible and relevant, industrial facilities will be collocated with CCS-suitable geologic reservoirs
  ✓ This is already being done (FutureGen, ethanol plants, etc.)

- CO₂ will be purchased, traded and used as a commodity, not regulated as a pollutant
  ✓ “Memo to Rest of the World: This has been done successfully in the U.S. for the past 30+ years”

- Petroleum professionals will play an integral role in these new industries
  ✓ i.e., Where and where not to put the CO₂ underground
  ✓ “Memo to listeners: Update your resumes and keep ‘em handy”

* 2006, Kipp Coddington (North American Carbon Capture and Storage Association)
Two Markets for Same Molecule*

- Commodity CO$_2$ for Use in Enhanced Oil Recovery in the US and Globally
- Sequestered CO$_2$ or Greenhouse Gas and Resulting Tradable Offsets (Carbon Allowances)

* 2006, Mike Moore (EOR Carbon Management Workshop Director)
THIS CO$_2$ EOR IS BIG BUSINESS*

Case History: Permian Basin Fields & Infrastructure

* Est. yearly PB figures:
  - the 180,000 bopd is directly valued at $3.3 billion ($50/bbl)
  - The 1.7 bcfpd commodity CO$_2$ transaction value is ~$400 million

And just the 2500 miles of CO$_2$ Pipelines themselves are conservatively worth over $2 billion
A Growing and Significant EOR Industry


* Source: Melzer Consulting (2008) and Oil & Gas Journal Biennial EOR Editions
CO₂ EOR and Storage

CUMULATIVE CO₂ UTILIZATION IN EOR (TX & U.S.)

- Cum Tx CO₂ Purchased* BCF
- Cum US CO₂ Purchased* BCF
- Cum Tx CO₂ Purchased* Million tons (rt scale)
- Cum US CO₂ Purchased* Million tons (rt scale)

* 'Back' Calculation Using 7 mcf/bbl of oil

YEAR

CUM CO₂ USED (Billions cubic feet)

CUM CO₂ USED (Millions of tons)
CONCEPTUAL CO₂ RETENTION
with the Denver Unit (West Texas) Example
CO₂ Retention: Case Histories

HCPV CO₂ Produced VS HCPV CO₂ Injected

- Denver Unit (1)
- Slaughter Estate (5)
- McElmo Creek (21)
- Hough Morrow 'A' Unit (22)
- Seminole Unit (4)
- ODC Unit (2)
- Rangely (20)
- Adair Phase1 Apache (23)

50% Retention Line
50% (Cum)
Mississippi Annual Oil Production

Total Cumulative Oil: 2.387 Billion Barrels (through 2006)

Denbury Resources Inc.
Denbury’s Current & Planned CO₂ EOR Operations
Source: Denbury’s May 2007 Corporate Overview

CO₂ Projects - Total Potential Tertiary Oil Reserves

- **Phase 1**: 31 MMBbls
- **Phase 2**: 41 MMBbls
- **Phase 3**: 77 MMBbls
- **Phase 4**: 82 MMBbls
- **Phase 5**: 36 MMBbls
- **Phase 6**: 26 MMBbls
- **Phase 7**: 50 - 90 MMBbls
- **Seabreeze Complex**: 30 - 40 MMBbls
- **Faustina Project**: 190 - 225 MMcf/d of CO₂

- **Picking up A-CO₂**

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(1) Probable tertiary oil reserves as of 12/31/06 based on 10% to 17% recovery factors. Hastings Field is under contract but not owned.
(2) Projected CO₂ production of petroleum coke to ammonia plant expected to be completed during 2010.
SKIRMISH AHEAD?

- Storage: Environmental Law (CCS)
- Oil: Resource Law (EOR)

For Example: Where Should the Regulatory Jurisdictional Bill be Heard?

*House Environmental Regulation Committee or House Energy Resources Committee*
PERMITTING COMPLEXITIES (1)

- Resource Extraction (SOGRAs*)
  - Have the Underground Injection Experience
  - Have the Tools for Rights Aggregation

- Storage (Environmental Agencies)
  - Are the States’ Growing Regulatory Arm
  - But They Bring the Waste Label

- Solution: Divide the Jurisdiction According to Primary Purpose of Injection Activity?

* STATE OIL & GAS REGULATORY AGENCIES
PERMITTING COMPLEXITIES (2)

SOGRA PERMIT

ENVIRONMENTAL AGENCY PERMIT
Who Permits?
GROWING CAPTURE AND STORAGE
LIMITING FACTORS

• Qualified Personnel

• Difficult (or Confusing) Policy
The U.S. CO$_2$ Policy World

- INTERSTATE OIL & GAS COMPACT COMMISSION
- FEDERAL ACTIVITY
  - Draft EPA Rules on Sequestration
  - Draft GhG Source Reporting Rules
  - Senate Energy Bill
  - Waxman-Markey Climate Change Bill
  - Stimulus (ARRA) Funding
- OTHER ACTIONS (e.g., WRI)
- STATE POLICY ACTIONS
  - Wyoming
  - Texas
  - Others
The IOGCC Carbon Capture and Geological Storage Regulatory Task Force

Phase II Task Force Objectives

1. Creation of a nationwide guidance document, approved by the IOGCC, which is specific enough to enable each state to develop its own statutes and regulations while at the same time helping to lay the essential groundwork for a state-regulated, but nationally consistent, “cradle to grave” system for the capture and geologic storage of CO₂.

2. Provide assistance to Regional Partnership Pilot Projects in (a) understanding and complying with regulatory requirements for field testing and injection; and (b) work with member state in implementing draft model laws and regulations and assessing adequacy of those laws and regulations.
EPA GS Regulatory Recommendations

- Authorized Via Safe Drinking Water Act
- Looks at Subsurface Injection
- Scope Limited to GW Protection
- Extends UIC Approach to GW Protection
- Attempts to Avoid Waste Injection Labels
- Mentions, but Does not specifically treat, Commercial CO₂ Injection activities
- Establishes a Well Class VI for Injection

*Note: Multi-Stakeholder Group Input*
World Resources Institute’s Guidelines for Carbon Capture and Sequestration

- Only Work to Broadly Treat Capture, Transportation, and Sequestration (i.e., Surface and Below Ground)
- Most Thorough Treatment of Subjects
- Actively Recruited Injection Industry’s Experience
The Gathering of Interested Parties

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<tr>
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WHAT IS TEXAS DOING?

• Adding Certainty (SB 1387) to New Projects By Clarifying Who Regulates the Surface and Subsurface Arena

• Adding Incentives for the Risk Takers in this New Age of Energy (HB 2811 and HB 469 “NowGen”)

WHAT WASN’T DONE (in the 2009 session)

– Assisting Aggregation (Unitization) of Rights
– Clarifying who owns storage rights
Texas Senate Bill 1387

An Act Relating to the Implementation of Projects Involving the Capture, Injection, Sequestration, or Geologic Storage of CO₂

- Defines Anthropogenic CO₂
- Establishes Jurisdiction of TRRC over Oilfield Related Storage
- Will Define Monitoring Activity Required to Verify CO₂ Storage
- Creates an Anthropogenic CO₂ Storage Trust Fund
- Commissions a Report to Recommend a Framework for Managing Activities on GS on State-owned Lands
- Project Grant and Loan Program (under TCEQ)
- Commissions a Study to Analyze Requirements for Storage into Saline Formations

Sponsors: Senator Kel Seliger and Congresswoman Myra Crownover

Status: Signed into Law by the Governor on May 27, 2009
Texas House Bills 469, 1796

An Act (469) Relating to the Establishment of Incentives for the Implementation of Certain Projects to Capture and Sequester CO₂ that Would Otherwise be Emitted into the Atmosphere

- Defines Advanced Clean Energy Project (>50% CO₂ Capture w/ Storage)
- Establishes a New Sales Tax Exemption for CCS Personal Property
- Established 3 ea ACEP projects eligible for up to $100 million in Franchise Tax Exemptions
- Recognizes CO₂ EOR as sequestration
- Allows some exemptions from taxes on capital items for pollution control
- Affirms TRRC Jurisdiction over Geologic Storage and commissions a Study for Jurisdiction over Saline Reservoirs
- EOR severance tax exemption extended from 7 to 30 years and Requires “a reasonable expectation” that at least 99% of the CO₂ will remain sequestered for at least 1000 years

Sponsors: Senator Kel Seliger and Rep. Phil King
Status: Passed both House – waiting on Gov signature
For More Complete Information on Texas CCS Policy

see the Texas Carbon Capture and Storage Association’s website:

www.txccsa.org
WHAT WYOMING IS DOING

Wyoming has Moved Quickly and More Broadly than any State so is an Interesting Case History for Modeling how CCS may Further Develop Elsewhere

- HB89 (2008 Session) – “Codified Surface Landowners Ownership of the Pore Space”
- HB57 (2009 Session) – “Declared the Mineral Estate Dominant over Pore Space”
- HB58 (2009 Session) – “Declared that the Liability of CO$_2$ in-situ Lies with the Injector”
- HB80 (2009 Session) - “Outlined the Mechanics of Sequestration Site Unitization”
OTHER STATES (1)

• NORTH DAKOTA (SB2095, passed in March)
  – Clarified Surface Ownership of Pore Space
  – Disallows Severance of the Storage Estate from the Surface
  – Declares the Mineral Estate Dominant
  – ‘Amalgamation’ Procedures of Storage Rights (60% threshold)
  – 10-yr Post Closure CO₂ Injector Ownership Whereupon Transfers to State if Meets Criteria of Transfer
  – EOR Separate but Conversion to Storage Allowed
  – Industrial Commission has Regulatory Jurisdiction
  – Storage Fee and Trust Fund

• MONTANA (HB498, Passed in May)
  – Declared Surface Ownership of Pore Space
  – Sets up a State Trust Fund
  – Declares Intent is to Seek Injection Primacy
OTHER STATES (2)

- State of Washington
  - First State to Draft Rules
- Kansas
  - Kansas Corporation Commission Empowered by Legislature to Write Rules for non-oil field Sequestration (draft of rules now written but waiting on Board Review)
- New Mexico and Oklahoma
  - Broad Scope CCS Legislation Unsuccessful to Date
WOTF*

- Some States are Frozen, Waiting On The Federal Rules (e.g., cap & trade, EPA rules)
- Many of These and Other States are Moving only in a Renewable Energy Direction with Enormous Transmission Line, other Infrastructure and Environmental Challenges Ahead
Summary of Key Items Addressed
(For Those Moving Ahead in CCS)

1) Incentives for First Movers
2) Regulatory Jurisdictional Authority
   – Separate EOR and Sequestration
   – Concurrent EOR and CCS
   – Site Approvals?
3) Storage Rights Ownership
   – Severability, Dominance Issues
4) CO₂ Composition?
5) Long Term Fate of CO₂ (Trust Fund, State Ownership)
6) Rights Aggregation (Unitization)
7) Posturing for State Primacy
The Existing (and Modifying) Underground Injection Control (UIC) Program Reference
Underground (USDW) Regulation

The Experience; Tx, Wy, Ok, NM, etc.

Underground (USDW) Regulation

The Past (e.g., UIC)

EPA

The Experience; Tx, Wy, Ok, NM, etc.

Inexperienced States

Today (GS)

EPA

All States, Broadly Prepared (Willing?) or Not

The Concept of State Primacy
EXISTING INJECTION WELL CLASSES

http://www.epa.gov/safewater/uic/index.html

- Industrial & Municipal Waste Disposal Wells (Class I)
- Oil and Gas Related Wells (Class II)
- Mining Wells (Class III)
- Shallow Hazardous and Radioactive Injection Wells (Class IV)
- Shallow Non-Hazardous Injection Wells (Class V)
UIC Regulatory Framework
(Currently Under Revision to Incorporate CCS)

• **Class II**: Business as Usual CO₂ EOR
• **Class II**: BAU CO₂ EOR with Storage (& Monitoring Overlay)
• **Class IIB (or 7)**: Post EOR to Maximize Storage with Minimal Extraction and/or Increased Pressure
• **Class V**: Experimental Storage (Coal Bed Methane, Gas Shales, Salt Caverns)
• **Class VI**: Deep Saline Formation Sequestration
CONCLUSIONS

• CCS (aka Sequestration) in Texas and the U.S. is “Incidental” and Underway but not yet “Official”

• Concurrent CO₂ EOR & CCS Destined to Become a Major Industry in the US and Globally

• Large CCS Project Opportunities Exist for Potentially Huge Economic Rewards

• Demand for Training and Development of New Geologic Professionals will be Substantial

• The Enabling State and Federal Policy is Underway; More is Needed and is Critically Important to Properly Balance Commercial and Environmental Goals
WHAT’S AHEAD?

• POLICY FRONT
  – Federal
    • ARRA Stimulus Funding Opportunities
    • Waxman-Markey House Floor Debate
    • Senate Climate Change Bill and Conf Committee
    • Senate (and House) Energy Bill (Liability Provisions)
    • New Draft of EPA Rules on Sequestration
    • EPA Source Reporting
  – States

• PROJECTS AND INFRASTRUCTURE
  – IOGCC Pipeline Transportation Task Force
  – Pipeline Authorities
  – Incentives
QUESTIONS?
Supplemental Slides
Hess to Expand

CORP. ANNOUNCES $300 MILLION PROJECT PLANS

Warren, Grado Honored at Annual" SISD Employee Banquet Tuesday
EXAMPLES OF THE RESERVE SIGNIFICANCE OF THE RESIDUAL OIL ZONES (WASSON AND SEMINOLE FIELDS)

Adapted from Ref 4
Seminole Field Water Saturation Profile*  

* from Ref 6 {Brown, A. (1991)}
## Wasson Field Area with San Andres Formation Producing Units and Attributes

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<th>OPERATOR</th>
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* Source: Reference 5
EXXON MOBIL’S MEANS FIELD
KEY CO$_2$ REFERENCES
Key Reference Work (1)

- The Annual Wyoming CO$_2$ Flooding Conferences
- The Annual EOR Carbon Management Workshop (Held each December in Houston)
- The Annual CO$_2$ Flooding Conference and Field Trip (Held each December in Midland)
- The CO$_2$ Flooding Shortcourses (Part of Above)
- The SPE Monograph Volume 22
- The Applied Technology Academy’s CO$_2$ Schools Held Twice a Year in Midland
DO NOT SIT THIS ONE OUT! MAKE YOUR GAME PLAN NOW TO ATTEND THE MOST IMPORTANT CO2 EVENT OF THE YEAR. KEY PLAYERS FROM AROUND THE INDUSTRY WILL BE THERE, SHARING THE LATEST INFORMATION ON TRENDS AND TECHNOLOGY.

2007 CONFERENCE WEEK KICKS OFF DECEMBER 3.

KICKOFF
Website: www.spe-pb.org

5TH ANNUAL FOR CARBON MANAGEMENT WORKSHOP
DECEMBER 3-4, IRVING, TEXAS

13TH ANNUAL CO2 FLOODING CONFERENCE
DECEMBER 5-7, MIDLAND, TEXAS

Workshop Sponsors
Lawn-Boy; M. J. Morgan CO2 Company; Denbury Resources; E. J. Butler Company; Rice Energy; and Halcón Resources

5TH ANNUAL FOR CARBON MANAGEMENT WORKSHOP
DECEMBER 5-7, MIDLAND, TEXAS
Key Reference Work (2)
The Annual CO₂ Flooding Conference

- Held Each December in Midland, Texas – Home to 57 Active CO₂ Floods
- Concentrates on Actual Case Histories
- Includes a CO₂ Flood Field Visit
- Includes a CO₂ Shortcourse
- Includes an EOR Carbon Management Workshop
- Great Networking Opportunity

Visit:  www.spe-pb.org or call 432-552-2430
Key Reference Work (3)

THE CO2 FLOODING CONFERENCE SHORTCOURSES

2. Is My Field a Candidate for CO2 Flooding?, September 1995
4a. CO2 Flood Surveillance and Monitoring, December 2004
5. How to Put Together a CO2 Flood, December 1996
6. CO2 Measurements and Metering, December 1997
7. CO2 Facilities and Plants, December 1998
8. CO2 Flooding: Sandstones vs. Carbonate Reservoirs, December 1999
9. Issues for Beginning CO2 Flooders, December 2000
10. Reservoir Modeling and Simulation for CO2 Flooding, December 2001
11. Wellbore Management in CO2 Floods, December 2002
12. Carbon Dioxide Health And Safety, December 2004
13. CO2 Sourcing for Enhanced Oil Recovery, Dec 2006
14. CO2 Injection in Subsurface Reservoirs: Geological Parameters Affecting CO2 EOR and CO2 Storage

(http://www.utpb.edu/ceed/co2/shortcourses.html) or phone 432-552-2430
Key Reference Work (4)

- Practical Aspects of CO$_2$ Flooding, Society of Petroleum Engineers Monograph Volume 22, 2002

PRACTICAL ASPECTS OF CO₂ FLOODING
SPE MONOGRAPH VOLUME 22 TABLE OF CONTENTS (1)

Chapter I – Introduction
  1.1 Purpose, Scope, and Organization
  1.2 CO₂ Flood Design Variations
  1.3 Major Influences on CO₂ Flood Success
  1.4 Current and Planned CO₂ Projects
  1.5 CO₂ Sources
  1.6 Industry Projected CO₂ Potential

Chapter 2 - Review of CO₂ Process Mechanisms
  2.1 How CO₂ Becomes Miscible with Oil
  2.2 Small-Scale Reservoir Mixing Mechanisms
  2.3 An Overview of Relative Permeability
  2.4 Field Examples of Relative Permeability Effects on Fluid Mobility
  2.5 Modeling Solvent Relative Permeability Under Miscible Conditions
  2.6 Sweep Aspects of a CO₂ Flood

Chapter 3 - The Technical and Economic Screening Process: Factors To Be Assessed Before Starting a Detailed Study
  3.1 Reservoir Considerations-Can Incremental Oil Be Recovered?
  3.2 Cursory Prediction of CO₂ Flood Performance-How Much Oil Can Be Recovered?
  3.3 Cursory Investment and Operating Cost Estimates-What Will It Cost?
  3.4 Scoping Economics - Will the Incremental Oil Justify the Costs?
Chapter 4 - Reservoir Engineering Design Aspects of a CO₂ Flood
   4.1 Data Requirements
   4.2 History Matching To Develop the Reservoir Description
   4.3 Predicting CO₂ Flood Performance
   4.4 Optimizing the CO₂ Flood Design

Chapter 5 - Surface Facilities Design
   5.1 Introduction
   5.2 Specification Methods for Material Selection
   5.3 Production
   5.4 Injection
   5.5 Gas Processing

Chapter 6 - Well Design
   6.1 Producing Well: Wellhead to Bottomhole
   6.2 Injection Well: Wellhead to Bottomhole

Chapter 7 - Implementation: How Can the Design Become Reality?
   7.1 Planning
   7.2 Preinjection Data Gathering
   7.3 Permits, Contracts, and Agreements
   7.4 Monitoring a CO₂ Flood
Chapter 8 - Operations: How Can the CO₂ Flood Process Be Managed Effectively?
  8.1 Reservoir Management
  8.2 Well Management
  8.3 Facility Management

Chapter 9 – CO₂ Flood Environmental, Health, and Safety Planning
  9.1 The CO₂ EHS Plan
  9.2 The Dangers of CO₂

Appendix A - Worldwide CO₂ Floods;
  Active Floods,
  Inactive Floods
Appendix B - Single-Well Cyclic CO₂ Injection Treatment;
  Procedure, Mechanisms, Applications and Design
  Considerations, Results

Appendix C - Case Histories
Appendix D - Adjustments to Water Relative Permeability Curves to Account for CO₂ Solubility;
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The Applied Petroleum Technology Academy

CO₂ School

- Conducted Twice a Year in Midland (late January and August), limited to 40 students
- Four Days: Covers the Practical Side of Commercial CO₂ Injection with ‘lite touch’ of the Theory
- A Nice Dose of Emphasis on Reservoirs and Building CO₂ Demand for the Coming Industrial Supplies of CO₂
- Includes a Field Trip to a ‘NGL Recovery’ and a ‘BGF’* Recycle Plant and Flood

* BGF = “blood, guts and feathers” reinjection project

Ref: www.aptapb.org or call Midland College’s Petroleum Profession Development Center (432-683-2832)