The Range of Impacts of Oil Price Crashes on CO₂ EOR

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L. Stephen Melzer
Melzer CO₂sulting
Midland, Texas
In the world of oil prices:

“It is déjà vu all over again” *

* Quote attributed to an American sports icon, Yogi Berra (we’ll miss you)
The Range of Impacts of Oil Price Crashes on CO$_2$ EOR

**OUTLINE**

I. What History Tells us About Oil Price Crashes on CO$_2$ EOR Activity
   - Impacts on Oil Production, Flood Starts, CO$_2$ Sales, Flood Longevity, Innovation, etc.

II. A “New Day” This Time Around?

III. Impact on CO$_2$ Capture & ‘Low Carbon’ Oil

IV. Factors in the Future
West Texas Intermediate Oil Price vs. Year and Oil Price Crashes Over the Last Four Decades

AVE. WTI POSTED CRUDE OIL PRICE - 1978-2015
Source: Energy Information Agency

YEAR


AVE. WTI CRUDE OIL PRICE, $/bbl

$110
$100
$90
$80
$70
$60
$50
$40
$30
$20
$10

$100
$90
$80
$70
$60
$50
$40
$30
$20
$10


1986 1998 2009

45%
30%
38%
45%

1 2 3 4

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CO₂ EOR and its Steady Growth (Production)

WW, U.S., & PB CO₂ EOR PRODUCTION
1986 - 2014

* Ref: O&GJ Biennial EOR Editions & UTPB
Petr Industry Alliance

YEAR

CO₂ EOR PRODUCTION - kbopd

Worldwide  U.S.  Permian Basin

* Ref: O&GJ Biennial EOR Editions & UTPB
Petr Industry Alliance
History of CO$_2$ EOR Project Growth*

GROWTH OF U.S. and PERMIAN BASIN CO$_2$ EOR PROJECTS
1986 - 2014

Growth but CO$_2$ Supply Limitations, Stifled the Permian Basin’s Growth

* Oil & Gas Journal EOR Edition & Petr Industry Alliance - 2014
Worldwide and PB Project Growth*)

GROWTH OF WW and PB CO\textsubscript{2} EOR PROJECTS
1986 - 2014

- Worldwide Projects
- Permian Basin Projects

* Oil & Gas Journal EOR Edition & Petr Industry Alliance - 2014

YEAR
NO. OF PROJECTS
…..and Growth Even with Languishing Oil Pricing

**GROWTH OF PERMIAN BASIN & WORLDWIDE CO2 PROJECTS**
1988-2000

- **No. of Projects**
- **WW Projects**
- **PB Projects**

Average Growth > 2 Projects/Yr

**WTI Posted Oil Prices - 1988-2000**

Average Price = $18.80 (U.S.)

Conclusion: CO₂ EOR Technology had Matured
Oil Prices Do Affect CO$_2$ Flood Starts

The History of Newly Implemented Floods (PB)
THE PHASES OF CO₂ ENHANCED OIL RECOVERY*

I. Demonstration/Observational Phase
II. Commercial Deployment Phase
III. 1st Oil Price Crash
IV. Maturation/Renewed Deployment
V. 2nd Oil Price Crash
VI. CO₂ Supply-Constrained Expansion

* as “Benchmarked” to the Permian Basin Region of the SW U.S.
A “New Day” This Time Around?
First, About Oil Supply in General, What is the Same?

- Oversupply of Oil When Compared to Demand
- Drop in Oil Price is Dramatic (about 45-50%)
  ~ Same as 1986 Crash

*We Might Look at the 1986 Crash as the Best Analogue?*
But...What is Different?

Oil Supply and Oil Demand

• Excess WW Production Capacity Today is Very Limited (~2 Million bbls/day)
  – In 1986, Just before Crash, it was in excess of 9 Million bbls/day
• Much of the Incremental Oil Creating the Surplus in Supply Will Decline Rapidly
• Maybe Early to Tell Yet but Demand Elasticity (to Oil Price) was Greater in the Past
What is Different?

CO$_2$ EOR in Particular

- The World Places a Higher Value on Clean Energy than in the Past
- Can CO$_2$ EOR Play a Role in the Clean Energy Transformation?
- We Entered the Current Oil Price Bust Short of CO$_2$ for EOR
What is Different?
CO$_2$ Supply and Demand in the PB

![Graph showing incremental CO$_2$ supply and demand in the Permian Basin.](https://example.com/graph.png)

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The CO$_2$ Suppliers Held the Cards

- In Order to Implement a New CO$_2$ Flood, the Companies were “Forced” to Accept Terms That they Now Regret, i.e., High CO$_2$ Price Floors, High Take or Pay Terms
- Will the Flooders Without their own CO$_2$ be Squeezed out of the Industry?
- Less Competition? Fewer Players?
Impact on CO$_2$ Capture and ‘Low Carbon’ Oil
How ‘Low Carbon’ Is My Oil?*

- CO₂ EOR projects store 240-460 kg CO₂/BBL in the reservoir
- Carbon balance is sensitive to the system boundary
- EOR project gate-to-gate: Net CO₂ storage of 75 to 410 kg CO₂/BBL
- Including up- and down-stream emissions (as in SACROC example):
  - Without oil combustion: Net CO₂ storage of 146 kg CO₂/BBL
  - With oil combustion: Net CO₂ emission of 260 kg CO₂/BBL (next best oil is North Sea at nearly double that amount (475)
- Additional work using industry data, region-specific storage metrics, and uncertainty quantification is needed to estimate these values with greater accuracy.

Factors in the Future

After the Crash
Energy Trends

• Peak Oil – OIP Limited? Let’s forget about that – there is plenty of oil (Unconventional, ROZs…)

• Cleaner Fuels (for both Electricity and Motors)

• Long-Trend Oil Demand Leveling Out?

• Oil at $100/bbl too Elevated for Long Term Demand Trends
CO$_2$ and CO$_2$ EOR Trends?

- The CO$_2$ EOR Business is a Long Term Investment and can (and has) Survive the Ups and Downs of Oil Pricing

- Potential for Accelerated Growth has been Present for Twenty years but Held Back by:
  - Lack of Available, Affordable CO$_2$ Supplies
  - Limited Experienced Engineering Staffs
  - Belief Held by Many that CO$_2$ EOR was Small, Niche Industry
  - Wide Understanding of Technology of CO$_2$ EOR and Misunderstanding about CO$_2$ Retention, e.g., “EOR only Stores Half the Injected CO$_2$”
  - “Just Prolongs the Age of Hydrocarbons” and Not Deserving of Clean Energy Incentives
  - Cost of CO$_2$ Capture and Cost of Large Scale Trials to Prove Economics
  - Cannot Compete in the Financial Markets with the Quick Returns (and Quick Exit Opportunities) from the Unconventionals

- Only the Strong Survive so Where will EOR Competition Come from after the Bust?

These may be changing
“Chaos often breeds life, when order breeds habit”

Henry Adams

We should be breeding a lot of new life at $45/bbl
Thank you

Questions?
BACKUPS
Supply Destruction

Texas & PB Rig Counts for Recent Months

- Statewide Tx Rig Counts
- PB Rig Count (Recent Months)
- Tx Rig Counts Less PB

Source: Baker Hughes
Effects of On-going Price Crash on Texas

Sources: Production: Drilling Info  Rig Counts: BakerHughes
Collaborate and create with CO₂’s leading Practitioners

CO₂ Conference Week, December 8-11, 2015
# The Annual CO₂ Conference in Midland

www.CO2Conference.net

## 2014 CO₂ Conference Week: Midland, Texas

(All Events to be held in Downtown Midland Center (MC))

<table>
<thead>
<tr>
<th>Time</th>
<th>Tue 12/9</th>
<th>Wed 12/10</th>
<th>Thur 12/11</th>
<th>Fri 12/12</th>
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<tbody>
<tr>
<td>7am</td>
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<td>Check-In (MC)</td>
<td>CO₂ Theme Session I: CO₂ EOR Policy and Flood Ops</td>
<td>Session III CO₂ Theme Session: Reservoir Case Histories</td>
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<td>8am</td>
<td>Session I Carbon Mgmt Workshop</td>
<td>ROZ Core Display (Rooms 1 &amp; 3)</td>
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<td>Luncheon - Keynote Speaker MC</td>
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<td>12pm</td>
<td>Session II Carbon Mgmt Workshop</td>
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<td>Seminar on Well Control for CO₂ Operations (Room 5)</td>
<td>Field Trip to a Mature CO₂ EOR Flood and Surface Facilities</td>
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<td>Optional Field Trip to Nearby Produced Water Plant</td>
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<td>Reception - Midland Center</td>
<td>Reception - Perm Basin Petroleum Museum</td>
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