Oxy’s CO\textsubscript{2} operations in Hobbs, New Mexico, United States

Most CO\textsubscript{2} Floods
In the Permian Basin, we operate more active CO\textsubscript{2} flood projects than any other CO\textsubscript{2} flood operator.

650 Billion
Oxy injected more than 650 billion cubic feet of carbon dioxide (CO\textsubscript{2}) into oil reservoirs in the Permian Basin in 2013, making Oxy one of the largest injectors of CO\textsubscript{2} for enhanced oil recovery in the United States and a world leader in this technology.

Increased Recovery
Oxy is an industry leader in applying CO\textsubscript{2} flooding technology, which can increase ultimate oil recovery by 10 to 25 percent in the fields where it is employed.
OXY FAST FACTS

ADVANCED TECHNOLOGY
Oxy is committed to using advanced technology to maximize oil and natural gas production in a safe and efficient manner. The company invests in state-of-the-art equipment and tools to find, develop, produce and deliver energy resources around the globe. Technology plays an integral role in every phase of this process, from exploration to field development to operations management. Advanced technologies contribute to top performance in areas including safety and environmental stewardship, reservoir description and modeling, new well drilling, facility construction, field automation, artificial lift, well and equipment maintenance, and fluid processing.

OXY’S STRATEGY
Oxy’s competitive strategy relies on increasing production through developing conventional and unconventional mature and underdeveloped fields, enhanced oil recovery (EOR) projects and strategic acquisitions.

LEADER IN SAFETY
In 2013, Oxy’s employees and contractors achieved their best-ever safety performance. Oxy’s 2013 employee Injury and Illness Incident Rate (IIR) of 0.30 is less than one-tenth of the 2012 U.S. industry average IIR of 3.4.

MOST ADMIRED
Fortune magazine ranked Oxy No. 1 among Most Admired Companies in the Mining, Crude-Oil Production category for 2014 – the seventh year in a row that Oxy achieved the top ranking.
Carbon dioxide (CO₂) flooding technology can increase ultimate oil recovery by 10 to 25 percent in the fields where it is employed. Despite being a mature technology, it is considered a highly specialized niche enterprise with few players that have large commercial CO₂ enhanced oil recovery (EOR) projects.

The CO₂ flooding process typically involves injecting CO₂ into oil-producing formations to enhance the recovery of the remaining oil when waterflooding is no longer effective. CO₂ injected into an oil-producing formation under pressure acts as a highly efficient solvent that releases oil trapped by water in the pore spaces in the rock. This exacting, integrated process requires abundant, readily accessible, pure supplies of CO₂. Oxy controls a large supply of high-quality CO₂ reservoirs in northern New Mexico.

CO₂ flooding is expected to recover between 1 and 3 billion barrels of additional oil from Permian fields operated by Oxy.

Oxy uses advanced visualization software to monitor its more than 1,900 patterns of CO₂ injection and oil production wells throughout the Permian Basin. This enables more efficient allocation of carbon dioxide and has resulted in production improvements.

PERMIAN OVERVIEW

Oxy is the largest oil producer in the Permian Basin. In 2013, Oxy’s Permian production was 212,000 barrels of oil equivalent per day (BOEPD). Approximately 74 percent of our Permian EOR production is from fields that actively employ CO₂ flooding.

WATER MANAGEMENT

Oxy’s worldwide water production is in excess of 11 million barrels of water per day. Oxy Permian handles around 3 million barrels of water per day for EOR.
A key example of Oxy’s technological capability is the application of EOR techniques to generate growth of production and reserves. Oxy is a global leader in CO₂ EOR technology and actively employs other EOR techniques to maximize production. We use these techniques in existing oilfields that have substantial remaining oil in place to greatly increase recovery and extend field life.

In a collaborative work environment, Oxy engineers and geoscientists combine expertise and ingenuity with cutting-edge technology to achieve the results that help define our success.

This approach adds value in various ways:
- Increases oil recovery
- Optimizes CO₂ utilization
- Lowers capital expenditure
- Sets proper flood expectations
- Narrows subsurface uncertainties
- Prioritizes flood portfolio
- Trains next-generation CO₂ practitioners
- Provides environmental benefits

Oxy employs hundreds of people with CO₂ experience, covering all disciplines including: CO₂ transportation, drilling/completions, geology, reservoir engineering, facilities for CO₂ capture and recycling. Our highly skilled staff help to ensure that Oxy remains an efficient CO₂ operator.
In both domestic and international operations, Oxy is a leader in cost-effectively increasing production from mature oil and gas fields and accessing hard-to-recover reserves through the application of EOR techniques. Among these is CO₂ flooding, commonly known as CO₂ EOR.

After primary recovery and secondary displacement processes such as waterflooding, a significant portion of the oil remains trapped in the rock. Unlike water, which does not mix with oil, CO₂ works as a solvent to remove the interfaces between oil and the displacing fluid, allowing the removal of oil once thought unrecoverable. In the reservoirs where it is employed, CO₂ flooding can increase ultimate oil and associated gas recovery by 10 to 25 percent over and above that which can be achieved using conventional waterflood technology. Results may vary by field due to reservoir properties.

*Typical field* oil production history demonstrating relative contribution of primary, waterflood and CO₂ flood development stages.
ENVIRONMENTAL BENEFITS

In addition to boosting oil and gas production, CO₂ EOR benefits the environment in various ways.

 Recovering additional oil from existing fields requires fewer resources than installing new infrastructure and equipment in new locations. Thus, EOR maximizes the efficient use of existing infrastructure and reduces land and habitat disturbance. Expansion of EOR operations as new man-made sources of CO₂ become available has the potential to substantially reduce greenhouse gas emissions — by capturing and sequestering the produced CO₂ instead of releasing it into the atmosphere. Ultimately, essentially all injected CO₂ becomes sequestered in the oil and gas reservoirs.

Currently, the majority of CO₂ that Oxy uses is produced from natural underground CO₂ reservoirs. Oxy is actively developing projects that will capture CO₂ emissions for use in our EOR operations, and we are seeking other economic anthropogenic sources of CO₂.

Further production increases at mature oilfields could be achieved through CO₂ EOR if additional economical sources of CO₂ become available to supplement natural sources. One such source is the Century Plant, a southwest Texas hydrocarbon gas processing plant where CO₂ that otherwise would have been emitted is instead being captured for injection in Oxy’s EOR operations.
OXY’S CO₂ PRINCIPAL ASSET

REALIZING THE FULL POTENTIAL OF THE PERMIAN BASIN

The Permian Basin of West Texas and southeast New Mexico is home to the biggest oilfields in the 48 contiguous United States. Oxy is one of the largest CO₂ flood operators in the world. Oxy’s Permian operations are the company’s largest business unit, where we operate 31 active CO₂ floods, of which 19 floods involve sour gas reinjection. Oxy also operates six major recycling plants.

More than two-thirds of Oxy’s Permian oil production is from fields that actively employ CO₂ flooding.

Oxy operates huge waterflood projects in the Permian Basin. Reservoir characterization of these mature oilfield assets is key to Oxy’s success in maintaining its base production and developing its proven reserves. Use of 3D reservoir models to test various scenarios for field development allows Oxy to select the best economic strategy for development of each asset. Prioritization of large project implementation for yearly budgets is also aided by our reservoir characterization efforts.

Oxy’s reservoir characterization projects are “fit-for-purpose.” Multidisciplinary teams of petrophysicists, geologists, geophysicists and engineers work in concert to develop static 3D reservoir models. All available data, including well logs, core data, reservoir rock descriptions, 3D seismic data and historic well information, are blended to create the fine-scale, detailed static model.

The 3D static reservoir model can be used with classical field reservoir and production engineering techniques to identify infill drilling opportunities, improve flood conformance and better manage water and CO₂ injection.

The 3D static reservoir model can be upscaled to allow for 3D dynamic reservoir simulation, which is used to forecast future development response for improving existing CO₂ floods and waterfloods, as well as designing “grassroots” CO₂ floods.

Oxy uses reservoir characterization techniques to more effectively produce reserves from our historically proven oilfield assets. We are extending these techniques to additional unconventional assets such as Residual Oil Zones to extend our Permian oil production well into the 21st century.

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**U.S. CO₂ EOR Projects**

- **Number of injection wells**
- **Size of bubble = CO₂ EOR Production Volume**

- **Kinder Morgan**
- **Apache**
- **Exxon/ XTO**
- **Chevron**
- **Hess**
- **Merit**
- **Anadarko**
- **Denbury**

**U.S. CO₂ EOR Enhanced Production**

- **Barrels per day**
- **All other**
- **Oxy**

**Source:** Oil & Gas Journal 2014 Biennial EOR Survey; Oxy Analysis
FIELD AUTOMATION

Oxy applies advanced automation and surveillance technology in conjunction with a centralized operating strategy to safely and efficiently operate thousands of water and CO\textsubscript{2} injection patterns, production facilities and gas plants across extensive geographic areas. This combination of technology and operating philosophy lowers operating costs, reduces production variability, improves control of EOR operations, extends the economic life of oil and gas fields, reduces health and safety risks for all stakeholders and facilitates monitoring of environmental conditions.
Oxy has a surveillance process and data integration system to optimize performance of oil production and CO₂ injection. The process starts with data collection and validation, including live production data, well test data, pressure, temperature data and surveys, as well as information on watercut and geophysical and geological data. This information is used to identify and analyze variances to enable timely decision making to minimize downtime and optimize CO₂ floods and waterfloods. Based on this analysis, solutions are implemented to optimize production and injection systems and to minimize uncertainty, and new and improved targets are set. The surveillance process enables continuous improvement with maximum decision quality.

Oxy uses the latest visualization software and employs a standardized approach. This enables reviews within hours in order to inject the CO₂ effectively and extend the floods to selected parts of the reservoir.
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