What is EOR and where is it used in the United States?

(This article is the first in a periodic series exploring legal issues relating to CO₂ enhanced oil recovery and serves as an introduction to the process. Our next article will focus on issues relating to the regulatory regime for CO₂ transportation.)

Background

In the primary phase of oil production, after a conventional oil well is first drilled, the natural pressure of the oil reservoir, sometimes assisted by pumping, lifts the oil to the surface.¹ When the reservoir’s natural pressure subsides following a well’s initial production, oil producers may extend the life of a well through secondary recovery processes, which usually involve injecting water or gas into the reservoir through a non-production well to increase pressure and direct underground oil to the production well.² These first two phases typically recover 30-40 percent of the original oil in a conventional oil field.³ In the third and final phase, enhanced oil recovery (EOR) techniques can be used to further extend the useful life of a conventional oil well. This final phase can result in recovery of up to 5-15 percent of the oil otherwise trapped in a conventional oil field.⁴

EOR encompasses several tertiary recovery methods to extend the life of multiple wells in an oil reservoir. Generally, EOR methods aim both to increase reservoir pressure and change the properties of the oil, including by altering its density to improve recovery.⁵ This article focuses on one EOR method, the use of carbon dioxide injection (CO₂EOR), one of the most common EOR methods in use by producers today.⁶
CO$_2$ EOR usually requires the producer to inject intervals of compressed, supercritical CO$_2$ into an oil reservoir. The CO$_2$ typically dissolves in the oil, reducing its viscosity or changing its density as it displaces the oil from the reservoir’s porous rock. Producers then alternate supercritical CO$_2$ injections with water injections to further direct and drive the oil-CO$_2$ solution toward the production well. As above, CO$_2$ EOR can result in a 5-15 percent increase in the production from a well and can extend the productive life of an oil field, in some cases, for decades.

In 1972, Chevron installed the first large-scale CO$_2$ EOR project in the western Texas Permian Basin in the U.S. By 2013, CO$_2$ EOR contributed approximately 3.7 percent (about 280,000 barrels per day) to U.S. oil production. Today, there are approximately 70 oil fields in eleven U.S. states located largely in the Gulf Coast, Mountain West and Great Plains, which have employed CO$_2$ EOR technology as a means to enhance oil recovery. The Permian Basin project remains the most productive CO$_2$ EOR project in the U.S. in terms of daily oil production. This use of CO$_2$ EOR in Texas is set to continue. Globally, the U.S. has the highest number of active CO$_2$ EOR projects and ranks first in terms of total oil production from CO$_2$ EOR, accounting for approximately 80 percent of oil sourced globally from CO$_2$ injection.

Other regions are investing in CO$_2$ EOR technology for mature fields as well, although with a relatively small contribution to global production. There are some 140 CO$_2$ EOR projects worldwide that contribute approximately 0.35 percent to global daily oil production, or about 300,000 barrels per day. In 2014, the Asia Pacific Economic Cooperation (APEC) commissioned a review of eight member countries for CO$_2$ EOR potential and estimated the process could incrementally increase recoverable oil resources by 18-78 billion barrels for the countries studied. However, as the review noted, for these APEC countries to increase production from CO$_2$ EOR injection, a steady source of low-cost CO$_2$, together with a means to transport the CO$_2$ to oil fields and greater legal certainty, are critical. Additionally, APEC foreshadowed that it will be key for these countries to identify potential CO$_2$ sources in close proximity to suitable oil reservoirs, to create more responsive policy and legal frameworks, and to create methods to evaluate proposed CO$_2$ EOR projects in order to plan, finance and implement successful proposals.

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1. Int'l Energy Agency, Storing CO$_2$ Through Enhanced Oil Recovery: Combining EOR With CO$_2$
Storage (EOR+) For Profit 9 (2015).

2. Id.


14. U.S. Dep’t Of Energy, Office Of Fossil Energy, supra note 3. (See also Nat’l Enhanced Oil Recovery Initiative, 5 Things to Know about CO₂-EOR.)


16. Id.


18. The countries studied include Brunei, People’s Republic of China, Indonesia, Malaysia, Thailand, Mexico, Peru and Vietnam. Apec Energy Working Grp., supra note 6, at ii.


20. Id. at 110.