CO2 released by enhanced oil recovery (EOR)

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Summary: For every metric tonne of CO2 buried below ground in an "enhanced oil recovery" operation, two to five tonnes of CO2 are released into the air.

The only commercial use for CO2 is called "enhanced oil recovery" or EOR for short. Of 12 carbon capture projects operating in the U.S. today, 11 (or 92 percent) are using the captured CO2 for EOR. This entails purchasing some CO2 (usually mined out of the ground at a naturally-occurring source), compressing it to more than 1000 pounds per square inch to turn it into a "dense phase" liquid, then pumping it through a pipeline to a depleted oil field, then pumping it below ground to free-up some oil that is stuck to rocks, allowing the freed oil to flow to an oil well which brings it to the surface (where the CO2 is removed and re-injected below ground). The oil is then sold and eventually burned just like any other oil.

Here I calculate the metric tonnes of carbon dioxide (CO2) released into the atmosphere for each tonne ofCO2 injected underground in an EOR operation.

According to Oak Ridge National Laboratory (ORNL), there are 7.2 barrels of oil per metric tonne (2205 pounds) of crude oil, or 306.25 pounds of crude per 42-gallon barrel.

The same ORNL source tells us that crude oil is 85±1 percent carbon (C). Therefore, the carbon in a barrel of crude is 306.25 × 0.85 = 260.3 pounds. When this oil is burned, 93 percent of its carbon turns into carbon dioxide, according to Jaramillo, Griffin and McCoy pg. 8027.

To convert combusted C [carbon] to CO2 [carbon dioxide], multiply by (44÷12). [The atomic weight of carbon is 12 mass units, and the weight of CO2 is 44 units because it contains two oxygen atoms, each weighting 16 units.]

If we assume 93% conversion of C to CO2, then 260.3 pounds of C (in one barrel of crude), when burned, produces 887.6 pounds of CO2.

Jaramillo's Table 1 reports the following relationships between barrels of oil retrieved and metric tonnes of CO2 injected to retrieve the oil:

Northwest Purdy Unit: 36 million barrels retrieved by injecting 6.2 million metric tonnes of CO2 (or 5.8 barrels retrieved per tonne of CO2 injected).

SACROC Unit, Kelly Snyder Field: 402 million barrels retrieved by injecting 87.5 million metric tonnes of CO2 (or 4.6 barrels retrieved per tonne of CO2 injected).

Ford Geraldine unit: 13 million barrels of oil retrieved by injecting 2.37 metric tonnes of CO2 (or 5.48 barrels of oil retrieved per tonne of CO2 injected).

Joffe Viking Unit: 23 million barrels of oil retrieved by injecting 3.6 million metric tonnes of CO2 (or 6.39 barrels of oil retrieved per metric tonne of CO2 injected).

Weyburn unit: 130 million barrels of oil retrieved by injecting 20 million metric tonnes of CO2 (or 6.5 barrels of oil retrieved per metric tonne of CO2 injected).

The average (mean) volume of oil retrieved per tonne of CO2 injected in these 5 EOR projects = (5.8+4.6+5.48+6.39+6.5)÷5 = 5.75 barrels of oil per tonne of CO2 injected.

If we inject one tonne (2205 lbs.) of CO2 into an oil field and retrieve 5.7 barrels of oil which, when burned, release (5.75 × 887.6 = 5103.7 lbs. = 2.3 metric tonnes) of CO2 we are making the world's CO2 problem worse, not better.

Note: This analysis is a bare-bones minimum accounting for CO2 released during EOR operations. This analysis does not account for any CO2 emitted during CO2 mining (or capture), transport, storage, or injection underground. Using a full life-cycle analysis, Jaramillo, Griffin and McCoy (cited above) showed that, when CO2 is captured from a coal-fired power plant, then used for EOR, 3.7 to 4.7 tons of CO2 are emitted for every ton stored in the oil field.