

PERMIAN BASIN

Operators apply CPR to a giant

Miscible CO₂ flooding in the Sacroc Unit has not only arrested the steep decline in oil production, but actually increased production 50%.

AUTHOR

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The Scurry Area Canyon Reef Operators Committee (Sacroc) Unit in the Permian Basin of West Texas comprises the majority of the **Kelly-Snyder** field, North America's seventh largest oil field with about 3 billion bbl of original oil in place. The 1990s found operations at a critical milestone: oil production had dropped more than 20% per year from a peak of 210,000 b/d in the mid-1970s to only 9,000 b/d in 1995. Much of the unit cost structure was driven by old contracts with out-of-date terms, excessive rates and obligations that were difficult to manage. With about 1,600 wells, 94 production and injection facilities and hundreds of miles of pipelines and electric transmission lines, the owners faced a significant abandonment effort and the rapidly approaching estimated economic limit of 7,000 b/d of oil.

Rather than face the prospect of negative cash flow and abandonment liability, the owners decided upon a long-term plan in an attempt to arrest the production decline, reduce expenditures and ultimately restore the unit's economic viability. To reduce operating expenses, contracts for CO₂ purchases, CO₂ transportation, CO₂ processing, hydrocarbon gas processing and electric utilities were renegotiated in a win-win atmosphere.

CO₂ processing is the second costliest endeavor at Sacroc after well work. The operator reduced those expenses by increasing field-gathering pressures to 400 psig. This, in turn, reduced compression needs and electricity requirements. The wells continue to flow and respond to CO₂ injection at these elevated pressures, and there has been no visible impact on recovery. Field lifting costs were appreciably reduced.

The unit had excess capacities in its CO₂ recovery and recompression facilities. Arrangements with neighboring CO₂ projects were made to handle their produced gas for a fee or a portion of the natural gas liquids and residue gas sales. Membrane separation

technology is employed as a cost-effective means of separating CO₂ from the hydrocarbon gas. This technology is being expanded in the field in parallel with the field project.

Production turns around

Ideally, production increases would be better than simply mitigating the steep decline. A review of past CO₂ operations found several flaws. While the previous operators probably intended to conduct a miscible CO₂ flood, it never happened, although there was some response to immiscible injection and production qualified for Tier III oil prices during the Windfall Profit Tax era. Inconsistent deliveries of CO₂ plagued the early years.

CO₂ never was delivered in enough quantity at any given time to develop a proper oil bank. The recycled gas contained an ever-increasing amount of methane, which moved the miscibility of the system beyond operating practices. And CO₂ with an ultimate solvent slug size at 13% of the hydrocarbon pore volume, well below industry practices of about 70%, peppered the unit. The end result through the mid-1990s was an immiscible CO₂ flood with far less recovery than miscible operations would have produced. A concerted effort to apply the CO₂ in a miscible state is necessary. To do this, a "curtain" of water injection is placed around all CO₂ project areas. Otherwise, miscibility pressure cannot be maintained in this high-permeability carbonate reservoir.

These practices for achieving miscible CO₂ flooding have increased production to relatively new highs. The miscible process appears quite healthy (Figure 1). The unit has increased production nearly 50% in the past 2 years under the new operator. The operator's miscible CO₂ flooding approaches are expected to recover an



Gas gathering pipe is laid as part of the CO₂ flood expansion at Sacroc, expected to add 234 million bbl of oil production.

additional 234 million bbl of oil and extend field life at least 25 years. Oil production is expected to peak at more than 30,000 b/d.

The plugging and abandonment liability is whittling away, managed as a long-term cost of operations. Study showed that many of the unit's leaks and their associated impact on overall field lifting costs resulted from maintaining an extensive network of decaying piping in the field, even though many areas had no CO₂ future. A consolidation of operations is under way to eliminate those areas and concentrate on increasing production with a proper miscible flood in the most promising and high-graded reservoir areas. **E&P**

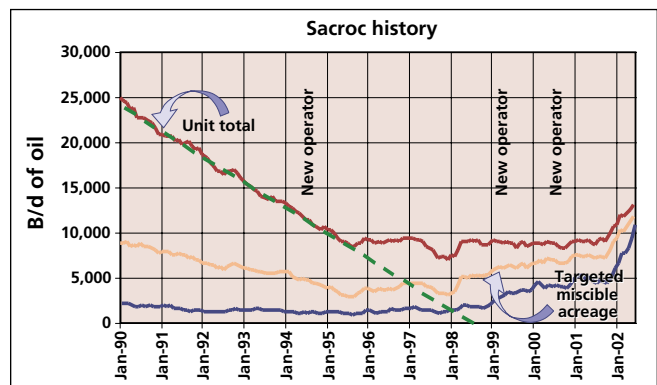


Figure 1. The steep production decline at the Sacroc unit leveled and began to increase due to the successful implementation of miscible CO₂ floods. The blue line represents the best-producing field project that is being replicated.