Project Facts

Production of "Stranded Oil" in the Residual Oil Zone Could Add New Domestic Oil Resources

Background. The presence of an oil bearing transition zone (TZ) beneath the traditionally defined base (oil-water contact) of an oil reservoir is well established. What is now clear, and as documented by this series of five reports, is that, in certain geologic and hydrodynamic conditions, an additional residual oil zone (ROZ) exists below this transition zone. This lower zone may be extensive, thick and filled with residual oil that may be recoverable using CO_2 enhanced oil recovery (CO_2-EOR) technologies. These thick residual oil zones exist where nature has already waterflooded the lower portion of an oil reservoir.

Past investigations of the origins and presence of these naturally-formed residual oil zones have been hampered by two limitations: a general lack of interest in these intervals, as they may add little additional oil during primary and secondary production; and clear preference for avoiding drilling into these residual oil transition zones to reduce the production of water.

Topics Addressed by These Reports. The advent of advanced tertiary oil production technology now enables previously waterflooded oil zones (with low oil saturations) to be further exploited, particularly using CO_2-EOR technologies. The residual oil saturation and reservoir properties in naturally-created residual oil transition zones are like those in the waterflooded intervals of the main pay zone. As such, new interest is emerging to better understand the nature, size and recoverability of this "stranded oil" resource. To facilitate and further support this new interest in the ROZ, the Fossil Energy Office of Oil and Natural Gas has issued a series of reports:

1) The first report, ***Stranded Oil in the Residual Oil Zone,*** discusses the origin of residual oil zones of abnormal thicknesses, beyond those formed by capillary pressure.

2) The second report, ***Assessing Technical and Economic Recovery of Oil Resources in Residual Oil Zones,*** applies reservoir simulation to study the technical feasibility of recovering oil from the transition and residual oil zones. It then reviews the results of three on-going CO_2-EOR projects to examine the commercial merits of CO_2 flooding in residual oil zones.

3) The third, fourth and fifth reports, ***Technical Oil Recovery Potential From Residual Oil Zones: Permian Basin***, ***Technical Oil Recovery Potential From Residual Oil Zones: Williston Basin***, and ***Technical Oil Recovery Potential From Residual Oil Zones: Big Horn Basin***, document the sizable, previously unaccounted-for oil resource within three domestic oil basins -- Permian, Williston and Big Horn.

Origins of Abnormally Thick ROZs. All reservoirs have oil-to-water transition zones, of varying thicknesses, that owe their origin to capillary forces. These forces cause gradational changes in the oil and water saturations beneath the main pay zone. However, much larger "stranded" oil targets exist in residual oil zones of non-capillary origin. These thicker and more extensive residual oil zones stem from the displacement of oil previously trapped in an oil reservoir, such as those documented in the thick ROZ intervals observed at the Wasson Field (Denver Unit) and the Seminole Field (San Andres Unit). The first report describes the affects of basin tectonics and hydrodynamics on the tilt of the oil-water contact of an oil reservoir leading to the oil trapped in the ROZ.

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Current ROZ Field Projects. Three residual oil zone CO_2-EOR projects are underway in the Permian Basin of West Texas. They are: Occidental's Transition Zone project in the Denver Unit of the Wasson Field; Amerada Hess' Residual Oil Zone pilot in the San Andres Unit of the Seminole Field; and Occidental's Main Pay and Transition Zone project in the Bennett Ranch Unit of the Wasson Field.

Preliminary Estimates of ROZ Size and Recovery Potential. Given the data and information on tilted oil-water contacts and supporting reservoir data available for the Permian, Williston and Big Horn Basins, initial efforts have been undertaken to develop a methodology and a first order estimate of the size of the "stranded oil" target in the ROZ.

These reports used tilted oil-water contacts as the key attribute for identifying settings with potentially thick ROZs. Fortunately, oil-water contact contouring is a basic input for efficient exploitation of an oil field, and these data exist for most major oil fields and are often filed in the public records of state regulatory agencies. Based on this currently available data, initial estimates of the ROZ size and potential are provided for three basins:

- *Permian Basin*. The report identifies 56 oil reservoirs, in five Permian Basin oil plays, that may contain significant volumes of TZ/ROZ resources. The oil in-place in the TZ/ROZ is estimated at 30.7 billion barrels, with 11.9 billion barrels potentially technically recoverable.

- *Williston Basin*. The report identifies 20 oil reservoirs that hold 6.8 billion barrels of oil in-place in the TZ/ROZ, of which 3.3 billion barrels is potentially technically recoverable.

- *Big Horn Basin.* The report identifies 13 oil reservoirs that hold 4.4 billion barrels of oil in-place in the TZ/ROZ of which 1.1 billion barrels is potentially technically recoverable.

Next Steps. Obtaining sufficient reservoir data for defining the ultimate size and productivity of the TZ/ROZ will be challenging. However, there will be great value from undertaking this task, as it will add previously undocumented domestic oil to the Nation's resource base. The next step would be conducting a series of additional regional and basin studies. Ultimately, field-by-field analyses will be necessary and will require considerable effort to fully establish the size and economic potential of this new, previously undocumented oil resource.

Further information

This resource assessment was prepared by Advanced Resources International for the U.S. Department of Energy Office of Fossil Energy. Copies of the assessment are available at www.fossil.energy.gov. For information about DOE Oil and Natural Gas Program research on emerging EOR technologies, see www.netl.doe.gov.

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