ChevronTexaco's Rangely Oil Field Operations

The Rangely Oil Field, located in northwestern Colorado, is one of the oldest and largest oil fields in the Rocky Mountain region. Since the 1940s, when large-scale development began, this field has produced nearly 800 million barrels of oil. ChevronTexaco, the current owner/operator of the Rangely Weber Sand Unit, has been injecting carbon dioxide into this reservoir since 1986 to increase the total volume of recoverable crude oil.

ChevronTexaco

ChevronTexaco Corp. ranks among the world's largest and most competitive global energy companies. Headquartered in San Ramon, California, the firm is engaged in every aspect of the oil and gas industry, including exploration and production, refining, marketing & transportation, chemicals, and power generation.

ChevronTexaco has a workforce of about 47,000 and is active in more than 180 countries throughout the world. The company has reserves of 19.7 billion barrels of oil and gas equivalent and a daily production of about 2.5 million barrels. It has a global refining capacity of 2.3 million barrels/day and operates more than 24,000 retail outlets. ChevronTexaco has total assets of $93.2 billion and a net annual income of $3.3 billion. The company is also a leader in gasification technology and is actively developing advanced energy technologies, including fuel cells, photovoltaics, advanced batteries, and hydrogen storage.

ChevronTexaco was formed in 2001, with the merger of Chevron Corp. and Texaco, Inc. The former traces its roots to an 1879 oil discovery in Pico Canyon, north of Los Angeles, leading the formation of the Pacific Coast Oil Company. The firm later became Standard Oil of California and marketed its products under the "Chevron" name during the 1960s and 1970s. The company formally adopted the Chevron name in 1984.

Texaco began in 1901 at the Texas Fuel Company in Beaumont, Texas, later becoming The Texas Company. In 1936, The Texas Company and Standard Oil Company of California (later Chevron) formed the California Texas Oil Company, Limited (later Caltex) to unite The Texas Company's extensive eastern hemisphere marketing network with Standard's production operations in the Middle East. In 1959, the company changed its name to Texaco. It acquired the Getty Oil Company in 1984 before merging with Chevron in 2001.

Geology

The field we are visiting sits atop the Rangely Anticline, which is located on the northeastern flank of the Uinta Basin. At this location, the Weber (WEE-bur) sandstone is the principal reservoir, accounting for over 98% of the total field production. The formation is overlain by a series of other sedimentary units, including the Mancos shale on top of the sequence, followed by the Dakota, Morrison, Curtis, Entrada, Carmel, Navaho, Chinle, Shinarump, Moenkopi, and Park City formations.

The Weber Formation is Permian to Pennsylvanian in age(245-315 million years ago), and typically consists of fine-grained, cross-bedded calcareous sandstones. Average thickness of the unit is 1,200 feet, although the gross reservoir thickness averages 700 feet, and the net production interval within the formation varies from approximately 50 to 400 feet. The oil occurs at depths of 5,600 to 6,800 feet, and the total surface area of the production zone is 19,153 acres.

History

The first oil was discovered in this field in 1901 in the Mancos shale, occurring between 500 and 1,700 feet below the surface. It was not until 1933, however, that oil was found in the Weber unit. Initial production from the Raven A-1 discovery well was 300 barrels per day (bpd)

from a depth of 6,335 feet. Due to the poor market that existed during the Depression, and transportation difficulties due to the remoteness of the location, the well was capped until September 1943.

Increased demand for petroleum created by World War II initiated a resurgence in development at the Rangely site. Drilling of a second deep well was begun in April 1944 and shortly thereafter numerous rigs began operating in the area. By the end of 1945, 182 wells had been drilled into the Weber reservoir, and by 1949, the Rangely field contained 478 wells drilled at a 40-acre spacing. At one point during 1946, a total of 54 rigs were operating simultaneously.

As production continued, the reservoir pressure began to drop. Because of this, the field was unitized in 1957 so that water-flooding could be put into effect to offset the pressure decline and increase oil recovery. By the end of 1958, Chevron, the designated unit operator, had a full scale water-flooding program in operation. This secondary recovery technique continued until 1986 when Chevron initiated a tertiary recovery program using carbon dioxide (CO_2) injection.

The Chevron CO_2 Project

Chevron began using CO_2 injection in the Weber Unit in the latter part of 1986. Had the company continued using only water-flooding, the expected total recovery from the field would have been 789 million barrels – roughly 42% of the 1.9 billion barrels of oil originally in place. By switching to CO_2 injection, ChevronTexaco expects to be able to extract an additional 114 million barrels.

The CO_2 for the project originates at Exxon's Shute Creek gas sweetening plant near LaBarge, Wyoming. The gas is transported via an Exxon pipeline 48 miles to Rock Springs, where it is transferred to a ChevronTexaco pipeline which transports it the 129 miles to the Rangely field.

Construction for the pipeline and injection process began in 1984. The initial capital investment was $158 million. The largest single investment was the construction of the CO_2 recompression facility, which includes the natural gas liquids extraction plant. The plant cost $70 million to build and costs $1 million per month to operate. Construction for the project of the Chevron Raven Ridge pipeline took five months to complete and cost $42.5 million. Initial CO_2 purchase rates in 1986 were 75 million cubic feet per day (MMCFD). Purchase rates peaked in 1990 at 150 MMCFD, and have dropped since to the current rate of 50 MMCFD.

How CO_2 Injection Works

When a well is first completed, the reservoir pressure is at its highest, which helps drive the oil to the well. As reservoir pressure drops, due to field production, the natural flow rates will diminish until the well reaches its economic limit under the original production scheme. On average, this primary production accounts for only a small fraction of the original oil in place.

Secondary recovery programs, such as water-flooding, can be used to recover more oil and extend the life of the field. This process is carried out by drilling additional wells, into which water is injected. The water displaces the oil in the formation and pushes it toward the production wells.

Tertiary recovery, such as carbon dioxide injection, is used in the final stage of the field's production when feasible to recover an additional amount of the original oil in place.

Injecting a miscible gas, such as carbon dioxide, into an oil pool causes a number of changes in the crude to increase its recoverability. Among the most important are:

- A reduction in crude oil viscosity, which makes the oil less resistant to flowing,
- A swelling of the crude which, as the oil expands, pushes the oil out of the rock toward the extraction well, and
- An increase in gas pressure, which also pushes the oil to the well.

While there are advantages to using this system in terms of productivity rates and ultimate production, there are some important considerations to be evaluated before a CO_2 injection program is undertaken. Tertiary recovery programs such as the one at Rangely require the investment of millions of dollars. Operating costs are also increased because the equipment used must be corrosion resistant. CO_2 reacts with water to form carbonic acid, which corrodes metal and other materials.

CO_2 and water are pumped into the unit in alternating cycles and travel through the reservoir rock to drive the oil into the producing wells (Fig. 1). As is often the case, the production stream at Rangely consists of a wide range or petroleum components, water, and gases. At the surface, this stream must be separated into its various parts to recover the petroleum as well as the water and gases that will be reinjected. Once separated, the water and carbon dioxide are treated and reinjected into the formation. The formation gas is separated into natural gas and liquefied petroleum gases (LPGs). The methane is sold in the natural gas market while the LPGs are further separated into components such as propane and butane. The recovered crude oil is then sent to Salt Lake City for refining.
In Rangely, ChevronTexaco has 373 active producer wells and 247 injector wells. Up to May 2005, the cumulative production was 856.7 million barrels of mostly light oil, and 8.7 million barrels of natural gas liquids (NGL). ChevronTexaco employs approximately 50 people at the Rangely operations.

ChevronTexaco's development plan for the Rangely Field is designed to increase production by improving current recovery methods, developing new areas, increasing and improving hydraulic fracturing operations, optimizing methods for artificial lift, and increasing drilling programs to 20-acre and 10-acre spacings.[1]

References

Personal conversation. July 14, 2005.

ChevronTexaco corporate website, 2005, www.chevrontexaco.com

Chevron U.S.A., Inc., *2005 Annual Report, Chevron U.S.A., Inc.*

Enhanced Oil Recovery. Don W. Green & G. Paul White. SPE Textbook Series, vol. 6, 1998.

Chevron U.S.A., Inc., *Informational* Brochure.

Enhanced Oil Recovery, National Petroleum Council, 1984.

Improved Oil Recovery, Interstate Oil Compact Commission, 1983, Oklahoma City, OK.

North, F.K., Petroleum Geology, Allen and Urwin, Inc., 1995.

	Table 1	
	Current	**Cumulative**
Oil Production	14,230 BPD	851 MMbbl
NGL Production	1,300 BPD	8.726 MMbbl
Water Production	241,000 BPD	3,842 MMbbl
Water Injection	250,000 BPD	4,729 MMbbl
Gas Production	140 MMCFD	1,412 MMCF
CO2 Purchase	46 MMCFD	436 MMCF
CO2 Injection	166 MMCFD	1,124 MMCF

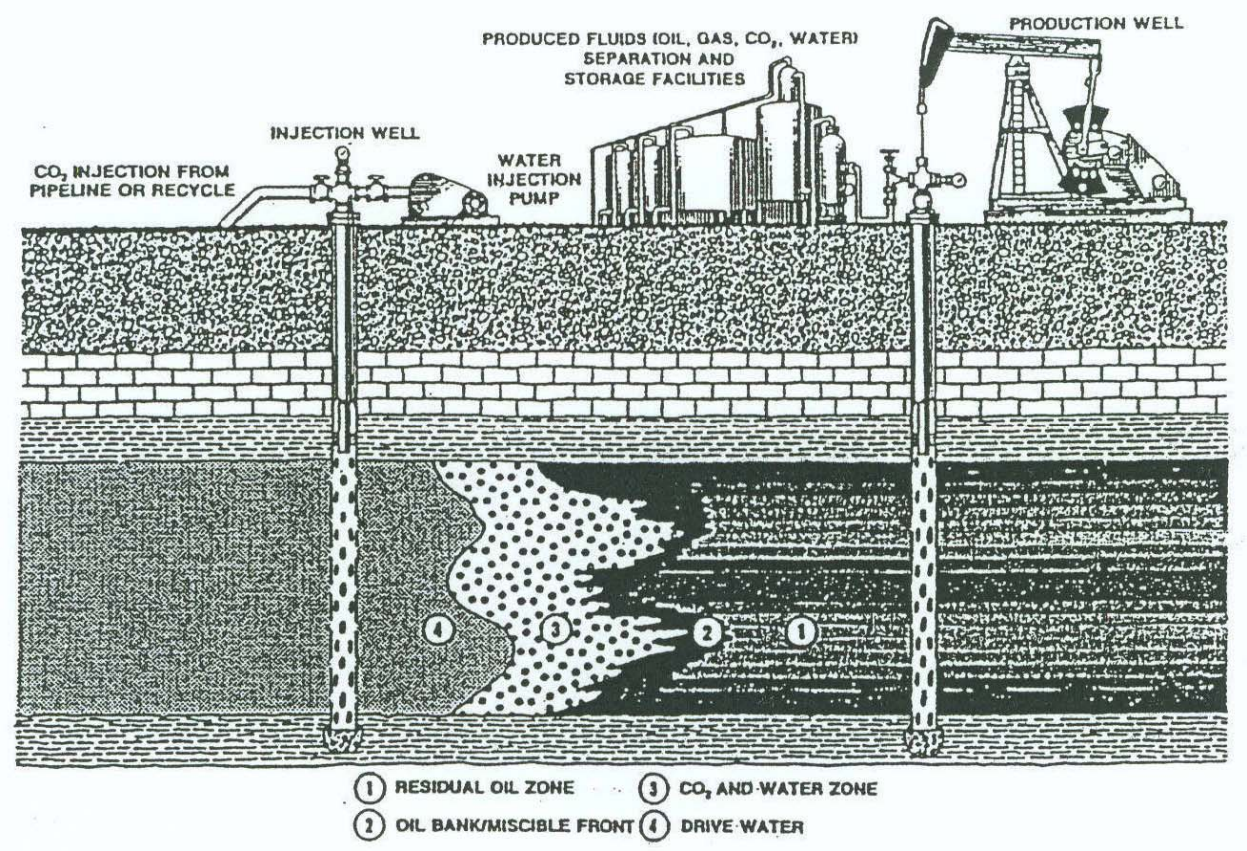

Figure 1
Oil well, CO2 flood.
Adapted from original drawings by Joe R. Lindley, USDOE.
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