HORIZONTAL DRILLING HELPS RECOVERY RATES

TECHNOLOGY CONNECTIONS
PETROLEUM TECHNOLOGY TRANSFER COUNCIL

BOTTOM LINE

Horizontal wells have a higher productivity and pay contact per well than vertical wells, thereby reducing the number of wells required to drain the reservoir. Horizontal wells allow operators to take advantage of highly heterogeneous or layered reservoirs, reservoirs with fractures, or water or gas coning problems.

PROBLEM ADDRESSED

New technologies in horizontal drilling include coiled-tubing drilling, underbalanced drilling, multilateral completions, and geosteering. The advantages and disadvantages of each of these technologies must be addressed during the selection process for horizontal well candidates.

KEY WORDS:
Horizontal Wells
Underbalanced Drilling
Multilateral Completions
Geosteering

TECHNOLOGY OVERVIEW

Horizontal wells are a controlled, directional completion technique for exploiting unrecovered mobile hydrocarbons in existing fields. These reserves usually remain because the reservoir's heterogeneity has prevented efficient development using vertical wells.

The primary screening tool is recovery efficiency as measured by the percentage recovered of original oil-in-place (OOIP) or original gas-in-place (OGIP). Screening is carried out by reservoir characterization, followed by reservoir simulation.

The advantages of horizontal wells include higher productivity and a larger drainage area per well. In Texas and Louisiana, horizontal wells in the Austin Chalk have become attractive because of the relatively rapid payout from good initial production rates. The disadvantages include higher drilling costs and greater mechanical risks. The economic success rate in the US is about 60%, with failure usually occurring as a result of high drilling/completion costs, formation damage, reservoir heterogeneity, or insufficient geological characterization.

Primarily based on the following PTTC workshops:

"*Advanced Drilling Technologies*," held on November 5, 1997, in Jackson, MS (Eastern Gulf)

"*Horizontal Drilling Workshop*," held on December 8, 1997, in Mt. Pleasant, MI (Midwest)

"*Horizontal Drilling Applications for Kansas*," held on June 16, 1998, in Wichita, KS (North Midcontinent)

Insights

Horizontal wells are typically grouped in three categories and referred to as short-, medium-, and large-radius wells depending on build rate.

Short-radius wells have a radius of curvature between 20 to 60 ft, a bit size less than 6-3/4 in., and a drain-hole length up to 1,000 ft. Medium-radius wells have a radius of curvature between 200 to 1,500 ft., a bit size less than 8-1/2 in., and a drainhole length up to 1,500 ft. Large-radius wells have a radius of curvature greater than 1,500 ft, a bit size greater than 8-1/2 in, and a drainhole length up to 15,000 ft.

Short- and medium-radius wells can be completed open hole or with slotted liners. Long-radius wells are typically completed with slotted liners or casing.

There are four basic completion approaches: open-hole, slotted liner, cased, or hybrid completions.

1. Open-hole completion, which requires a stable hole, has several advantages: it preserves options after the well has been produced and evaluated, it is the easiest and least expensive on which to perform selective stimulations, and it provides the best production logs. In general, completions other than open hole are to preserve the integrity of the hole (guard against collapse and sand production) and to allow zones to be shut off.

2. Slotted liners are desirable in many cases for sand control and hole support.

3. Cased completions are used by operators to allow

more flexibility for shutting off selected zones after production has begun.

4. Hybrid completions take advantage of the many drilling technologies available today. Since large sections of the formation are exposed to drilling mud (with potential damage) during horizontal drilling, horizontal wells lend themselves to underbalanced drilling (UBD) methods.

Among its advantages, UBD can minimize formation and environmental damage, reduce sticking in the differential drillstring, and lessen circulation losses. Gravity-induced mud invasion of fractures also tends to be reduced. Disadvantages of UBD include the cost of extra equipment and rig time, pipe connections, and mechanical problems including sticking, bit jetting and flushing, and mud-pulsed logging. In addition, hole collapse is possible.

The best UBD technique currently available utilizes coiled-tubing drilling, since it minimizes most of the problems listed above. As a result, some drilling costs may ultimately be reduced. The disadvantages of coiled tubing drilling include decreased directional control, limited casing and bit size, associated costs, and pressure monitoring.

Multilateral horizontal wells access several target zones in the same well. Potential problems include: achieving an effective kickoff from the previous leg, formation damage from mud, and slower cleanup. Once a well begins producing, it is also difficult to allocate production to specific pay zones.

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Enhanced oil recovery applications of horizontal drilling include heavy oil reservoirs and steam-assisted gravity drainage (SAGD). In contrast to vertical wells using thermal processes, the benefits of SAGD are increased oil productivity for the number of required wells, higher production volumes compared to injected steam volumes, and more ultimate recovery of oil in place. However, SAGD may not be applicable to reservoirs with low absolute vertical permeability.

LESSONS LEARNED

Horizontal wells have been effectively applied to naturally fractured reservoirs. In addition, horizontal drilling is used in reservoirs that are layered or have problems with water or gas coning, gas storage reservoirs, waterflood and enhanced oil recovery operations, and heavy oil reservoirs. They now are used in the Austin Chalk of Louisiana and Texas, as well as North Dakota's Red River Formation. Horizontal drilling is being applied in the heavy oil steam floods in California, waterfloods and CO_2 floods in west Texas, and a variety of carbonate and sandstone reservoirs across the country.

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