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Horizontal Well Best Practices to Reverse Production Decline in Mature Fields in South China Sea

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Abstract

The Huizhou 6S and 3S oil fields in the Pearl River Basin, Offshore South China Sea are mature fields which have produced 40% to 60% of their original oil in place since 1991. Currently the field production is rapidly declining and water production is increasing. However, through reservoir surveillance data, geologic and reservoir modeling, significant recoverable oil was identified in shaly sandstone reservoirs and attic structural locations of clean sandstone reservoirs. As a result, a comprehensive portfolio of prospects has been built for a robust development program. Horizontal wells were utilized to improve oil recovery in shaly sands and to reduce water coning in thin remaining oil columns. Horizontal drilling best practices were applied during well planning and drilling executions, such as optimum well designs, specific LWD/MWD tool selections, low fluid loss drilling fluids, real-time geosteering data monitoring and the cleaning of the pay zone during completions were applied to maximize reserve recovery and successfully reverse the field's production decline.

Introduction

The Huizhou Oil Fields are located in the Pearl River Mouth Basin, South China Sea approximately 190 km southeast of Hong Kong (Figures 1). Agip, Chevron and Texaco signed the contract in 1983 and they discovered nine prolific oil fields by the year of 1989. First production in this area was from the Huizhou 1S field in 1990 followed by Huizhou 6S field in 1991 and Huizhou 3S field in 1995. There are currently 7 platforms and an FPSO which are producing oil and gas from 10 fields. New efforts were put in the exploration activity with the drilling of exploration and appraisal wells in the period of

2002-5 resulting in another significant discovery and the commercialization of two previously discovered fields.

Geological Overview

Huizhou 6S and 3S oil fields are located in Pearl River Mouth basin, South China Sea, which is a continental margin sedimentary basin formed during the rifting of the South China Sea in the Late Mesozoic to early Tertiary. The main pay zones where CACT deploys horizontal and multilateral well technology were deposited as delta front bar and coalesced, stacked fluvial-deltaic channel sands in early Miocene time. Oil accumulations with low gas saturation and no gas cap are mostly found in 4-way-dip closures, which are associated with basement highs. In some cases the traps are also associated with sand layer pinch-outs.

The reasons for drilling horizontal wells are predominantly based on the following two considerations: Firstly, after over 15 years of high rate oil production, these fields have gradually entered into a mature and high-water-cut phase. Oil to water contacts (OWCs) have significantly encroached upward leaving thin remaining oil columns and causing high water production from all of the existing wells. Due to reservoir heterogeneity, some of the reservoirs exhibit uneven strength of aquifer support causing OWCs to tilt after years of production. To reduce and reverse the rapidly declining oil production rate is a challenge CACT needs to confront. To significantly improve production efficiency of the remaining potential attic oil locations, horizontal well is the first priority among various alternatives.

In addition, the poor petrophysical properties of shaly layers did not effectively produce oil from vertical wells. The recent horizontal and multilateral wells in these shaly zones have greatly improved production performance and field recovery. The petrophysics and depositional environment of the reservoirs are briefly described as follows.

Middle Zhujiang Reservoirs. In the Middle Zhujiang formation (Figure 2) reservoirs consist of a coarsening upward sandstone layers which was probably deposited during a delta progradation over a shallow marine environment in early Miocene time. Sands are loose quartz and feldspars with dispersed silt and shale. Thin