



OTC 20112

Extended Reach Drilling and Causeway Utilization in the Development of a Shallow Water Oil Field

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This paper was prepared for presentation at the 2009 Offshore Technology Conference held in Houston, Texas, USA, 4–7 May 2009.

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Abstract

This paper describes the unique development plan of the M field, a giant offshore field with an areal extent of more than 800 square kilometers (km²), laying under shallow waters northeast of Saudi Arabia. Due to the large number of wells to be drilled, conventional offshore development methods required over 30 offshore platforms to meet the production target efficiently. However, a novel drilling island concept in the form of a causeway was adopted, since the shallow water areas do not allow ocean vessels to set up the jackets and platforms. Utilization of a causeway, combined with the implementation of ultra extended reach drilling (ERD), reduced offshore operations to 11 platforms resulting in enormous savings to the operator.

The backbone of the upstream infrastructure is the 20 kilometers (km) long, 11 meter (m) wide main causeway, and 25 drilling islands linked to it through 21 km of lateral causeways. The task of constructing these structures involves movement of more than 40 million cubic meters of sand and rock. The main causeway includes a 2,400 m bridge, in addition to five 150 m and eight 50 m bridges for minimal environmental impact on marine life.

Being one of the largest drilling projects to be undertaken, with various reservoir, ERD, and logistical challenges were encountered during the planning and initial execution phases of the project. Meeting the expected production rate, at the lowest development and operating costs, in the safest and most environmental-friendly manner were the main drivers for the current plan. Reservoir heterogeneity, torque and drag, hydraulics, rigs specifications, well intervention, waste management and other specific challenges were overcome successfully using different techniques that are discussed in depth in the paper.

Introduction

The M field was discovered in 1957 and production began when the C reservoir came on stream in 1964 and the B reservoir was brought on production in 1974. Production from M field is Arabian Heavy with about 27° American Petroleum Institute (API) gravity. The field was shut in during January 1984 due to low demand with less than 1% of the reserves produced.

Geological Setting

M field is a northwest-southeast trending anticline and measures approximately 28 miles (45 km) in length and 11 miles (18 km) in width. There are six oil-bearing reservoirs in the field: A, B, C, D, E and F/G. The reservoirs in this increment development are the B and C reservoirs, **Fig. 1**.

The C and B reservoirs are primarily limestone with occasional dolomitic intervals and generally exhibit high porosity and permeability. The reservoirs were deposited in a shallow marine carbonate platform capped by tight lime mudstones and algal bounds tone facies. A continuous tar mat, which underlies the oil column in both reservoirs effectively separates the oil column from the aquifer.

Development Scenarios

A conceptual study was undertaken and evaluated three options for M development in terms of life-cycle costs, safety, and environment.

Offshore. This option was the base case and considered 100% offshore development. Due to the shallow water depth, a lot of dredging would have to be done for channels to allow for platform installations, rig movement, and support. In addition, it would also have required more than 30 platforms to develop the field efficiently.