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ICD Screen Technology in Stag Field to Control Sand and Increase Recovery by Avoiding Wormhole Effect

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Abstract

This paper presents the first installation of nozzle-based passive inflow control devices (ICD) for Apache Corporation in Australasia. This recent technology was simultaneously applied in a production well and a water injection well, and served as a demonstration of its potential benefits in the development of Stag oilfield.

Located offshore in the North-West shelf of Australia, Stag field is a shallow and unconsolidated glauconitic sandstone reservoir with a top and bottom sealing shale. The reservoir pressure is low and it contains heavy and viscous oil of 19° API - 9 cP. This causes sand production, high water cut, wormhole development and requirement for artificial lift, increase drainage area and improve sweep efficiency.

In the early stage of field development a reservoir failure was observed. A documented investigation indicated that the failure mode appeared to be wormhole-like failure². To date, there have been several failures with similar characteristics occurred in Stag field. Water injection post wormhole-like failure has been reported very inefficient as the water passes through to producer via the wormhole channel and does not sweep any oil. Overall horizontal injection wells performance in the field was poor with injection rates typically dropping quickly with constant injection pressure. Increase in injection pressure to bring the injection rate up is limited due to the low formation frac pressure. ICD technology was sought in effort to mitigate these dynamic challenges. It has showed good results and further investigation is ongoing.

The paper describes the processes in delivering the tailor-made ICD system, i.e. completion modeling in the reservoir grid to simulation analysis of various scenario and sensitivities. Solution to tight product delivery time, the ICD completion installation and performance evaluation is also discussed.

Introduction

Stag field background and reservoir challenges

The Stag field, operated by Apache Energy, is a reservoir within the *M. Australis* formation at 2230 ft TVD subsea. The average reservoir pressure is currently around 415 psia with rock strength (UCS) in the range of 0.12-1.03 MPa. Since the commencing field production in 1998 major redevelopment had been undergone to achieve and enhance the field's recovery¹. In July 2000 the Stag field reached its peak rates in excess of 30,000 BOPD.

Late that year a failure occurred in the reservoir between a horizontal water injector and a horizontal producer, some 2130 ft apart. Both wells were completed with un-cemented pre-perforated liners. A comprehensive investigation by McDiarmid et al² led to a conclusion that the failure was caused by high stresses in the reservoir compared to the formation strength. The high stresses caused wormhole-like failure, propagating from the producer to the injector. This characterized by large volumes of sand matrix and fine clay particles being produced where water breakthrough. Pulse tests and tracer study indicated that a short circuit had occurred in the reservoir between the two wells, where it took 2 hours 50 minutes to travel from surface to surface. The wormhole dimension was calculated to be greater than a 6 inch equivalent diameter. To date, there have been several failures in the field with similar characteristics where biocide tracer confirmed the direct communication between several producers and injectors.

Water injection post wormhole-like failure is very inefficient as the water passes through to producer via the wormhole channel and doesn't sweep any oil. Remedial attempts proved to be expensive and ineffective due to the inability to effectively isolate the targeted formation interval through the un-cemented pre-perforated liners.