ABSTRACT

New gas wells at Tunu field in East Kalimantan are normally perforated using the extreme underbalanced (EUB) technique, in which a large static pressure differential between the wellbore and formation, or initial underbalance, is set before the gun is fired. This requires an operation to unload wellbore liquid, a wireline operation to set an anchoring tool, and several slickline operations to run and retrieve the gun string. The required degree of underbalance depends primarily on rock properties such as permeability, porosity, and strength.

A new approach produces a well dynamic underbalance (the transient underbalance just after creating the perforation cavity). By basing the job design on the properties of the reservoir, wellbore, and gun string, the technique consistently minimizes perforation damage and thus maximizes productivity. This technique is based on recent single-shot perforating experiments that show that it is the maximum dynamic underbalance - not the initial underbalance - that governs perforation cleanup. The wellbore pressure was found to vary considerably during the first half-second after the charges were detonated. This variation in wellbore pressure can be manipulated to give a large dynamic underbalance.

Perforating with the new technique and electric wireline was performed on 10 wells in the field. Software that considered wellbore geometry, fluid, gun-string selection, and reservoir properties was used to design a specific gun-string configuration and to predict the productivity increase contributed by the underbalance. The jobs were performed smoothly with significant cost savings compared to conventional EUB operations and yielded an increased productivity. Details of the perforating jobs with the new technique will be described, including a cost reduction of approximately 40% and a significant production increase. Testing revealed an average skin value for four wells of -0.29, versus the average skin of 4.73 from 35 conventional EUB perforating jobs executed during the multi-year interval from 2000 to 2004.

INTRODUCTION

The Mahakam production-sharing contract, with Inpex and Total E&P Indonésie as operator, covers the Bekapai and Handil oil fields and Tunu, Peciko, Sisi-Nubi, South Mahakam gas-condensate fields. Tunu field, the major gas supplier of the East Kalimantan system, is at the eastern limit of the Mahakam delta, (Figure 1). The field is 75 km long and 15 km wide and is composed of interbedded hydrocarbon-bearing sandstones between a depth of 2,300 and 4,500 m. The field started producing in 1990 and more than 370 wells have been drilled to date. It exported an average 1.3 billion cubic feet per day (Bcf/D) and 23,000 stock-tank barrels per day (STB/D) of condensate in 2004.

In Tunu field initial perforations are normally performed immediately after new wells are completed to allow the wellbore to fill with gas or to avoid sedimentation during well-connection work. The first reservoir to be perforated is selected based on bottom-up reservoir policy, and perforating technique is chosen based on reservoir and wellbore condition. To reduce the skin effect for initial perforation in Tunu field, the dynamic underbalanced perforation technique has been applied since November 2004.