ABSTRACT

The DL-1 well was drilled vertically to a total depth (TD) of 11,3xx ft. to penetrate the T sand formation. The bottom-hole temperature and pressure were 390°F and 7,910 psig respectively. The same sand formation was penetrated and tested in an adjacent well, resulting in a low gas rate due to low permeability. Referring to reference wells and well log analysis, the DL-1 sand formation was also exposed to low productivity risk, so hydraulic fracturing was planned to enhance well productivity.

For reasons described below, the formation was perforated using 2.875-in. high temperature explosive casing guns, 6 spf, 60° phasing, before conducting the fracture stimulation. During the first fracturing of the lower sand, a step-down analysis showed that the total entry friction was around 1,800 psig, at a rate of 18 barrels per minute (bpm). To reduce wellbore entry friction, a sand slug consisting of 2,200 lbm 100 mesh sand was pumped before the main fracturing. However, the main fracturing still prematurely screened-out after pumping only 15% of the designed proppant volume. The second main fracturing of the upper sand was successful and all the proppant, 76,651 lbm, was placed into the formation. In addition, some other improvements were made to the second job, such as less aggressive sand concentration, and double-perforating the interval to get a higher perforation density and narrow spacing in order to significantly reduce entry friction. A step-down analysis showed that compared to the first job, the perforation friction and near-wellbore friction were greatly reduced to just 46 psig and 782 psig respectively at 18 bpm.

This paper is intended to share the challenges in implementing a monobore completion and hydraulic fracturing under high pressure, high temperature (HPHT) conditions. The paper focuses on a perforating strategy to improve proppant fracturing and how to stimulate low-permeability formations in HPHT wells.

INTRODUCTION

DL-1 well is located in Y field area, South Sumatra. The primary objective of DL-1 is T sand formation. Two potential formations, lower and upper sand, were proposed to be tested. The same sand formation had been tested at the adjacent well, resulting in a gas flow rate around 1 MMscf/D, so a low productivity reservoir was anticipated.

DL-1 well was drilled vertically to a total depth of 11,350 ft. to penetrate T sand formation. Originally it was planned to have 8-1/2 in. hole and completed with a cased-hole completion of 7-in. cemented liner. Because of hole problems and high pore pressure, the T sand section was drilled using a 5-3/4 in. bit string from 9,405 ft to TD and completed with a cased-hole completion of 4.5-in. cemented liner from 9,206 ft to 11,350 ft.

Initially, the lower sand was perforated using 1-1/16-in. HMX, 0° phasing, 6 shots per foot (spf) running inside a tapered tubing string from 2-3/8-in. to 3-1/2-in. The using of HMX type in this well was not optimum because the actual temperature was higher than the prediction, therefore the gun only partially detonated. Because of this, it was decided to suspend the well and design a re-completion and testing program based on the smaller-sized liner at TD.

DATA AND METHODS

Existing Condition

The first formation for fracturing treatment was lower sand at interval 10,3xx ft – 10,3xx ft. The formation has an estimated bottom-hole pressure (BHP) of 7,245 psig and bottom-hole static