SPE 115816

Monitoring Inflow Distribution in Multi-zone, Velocity String Gas Wells Using Slickline Deployed Fiber Optic Distributed Temperature Measurements

H. Huebsch, M. Moss, and T. Trilsbeck, EnCana, and G. Brown, S. Rogers, and T. Bouchard, Schlumberger

This paper was prepared for presentation at the 2008 SPE Annual Technical Conference and Exhibition held in Denver, Colorado, USA, 21–24 September 2008.

Abstract

Fiber-optic systems are able to generate a temperature log along an optical fiber using a laser source and analysis of the backscattered light. This paper details a novel application of this technology using an optic fiber embedded in a $1/8^{th}$ inch slickline cable to calculate the inflow distribution of multi-zone gas wells with velocity strings.

EnCana's multi-zone gas wells in the Deep Basin of Western Canada are often completed with production tubing landed near the lowest perforated interval to act as a velocity string and lift produced water to surface. This completion technique makes spinner production logs impossible to run without initially performing a wellsite operation to lift the tubing shoe above the reservoir, requiring either a workover rig or a snubbing unit. Running a slickline containing an optical fiber to the bottom of the tubing and producing the well up the annulus for a short period allows the temperature profile of the well to be measured and therefore, the inflow distribution of the well can be calculated.

Determining the inflow distribution of multi-zone gas wells now becomes a simple slickline operation with no tubing shift required. Additional benefits are the detection of crossflow on shut-in and the measurement of flowing bottomhole pressure when a gauge is run at the end of the slickline. The process is cost effective, less risky than conventional production logging, and the slickline can be safely employed where there is significant surface pressure.

The paper uses case studies validated by spinner log comparisons to demonstrate that slickline fiber optic distributed temperature sensor measurements are a viable method for performing reservoir surveillance in multi-zone gas wells with velocity strings in Western Canada. Utilizing fiber optic measurements in these wells reduces operating costs and should ultimately lead to increased efficiency of reservoir stimulation practices.

Introduction

Temperature logs were the first type of production logging sensors employed in the oilfield in the 1950's and many papers have been dedicated to their interpretation. Most notable were Ramey[1] who defined the basic heat transfer equations pertaining to flow and temperature, Kunz and Tixier[2] and Schonblom[3] who introduced the interpretation of multi-zone gas wells, and Smith and Steffensen[4] who discussed the impact of the Joule-Thomson effect[5].

The temperature log faded in importance with the advent of the spinner flowmeter, mainly due to the relative ease of spinner log interpretation. One of the major historical problems with temperature log interpretation has been the length of time for a well to stabilize thermally often exceeds the production log duration, causing incorrect temperature log interpretations while the well is responding to transient shut-in effects.

The introduction of permanently installed fiber optic distributed temperature measurements (DTS) in the late 1990's revived the interest in temperature log interpretation and new rigorous thermal models were developed for the interpretation of DTS data. The combination of permanent installation and continuous temperature curve acquisition overcame problems with early temperature log interpretation by providing large data sets to properly identify transient temperature behavior. The natural extension of permanently installed DTS systems was wireline conveyed fiber optic systems where the distributed temperature sensor can add to, complement, or perform measurements not possible with standard production logs, including monitoring gas lift valves[6], leak detection[7], and detecting flow behind casing/tubing.