Cenovus Grand Rapids SAGD Pilot - ICD Field Trial and Analysis

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Summary

Learnings From the Grand Rapids Field Trial of Tubing Deployed Inflow Control Devices for SAGD Application. Tubing deployed ICDs were tested in Well Pairs 1 and 2 at the Grand Rapids SAGD pilot project. The field trials lasted 7 and 18 months, respectively. Simulation and post-trial analyses were performed on the ICDs, including teardowns and a detailed failure analysis to assess benefits of ICDs in SAGD wells.

Introduction

A field trial was conducted from 2014 to 2016 where tubing-deployed inflow control devices (ICDs) were installed and operated at the Grand Rapids SAGD pilot project. The objectives of the trial were to evaluate the performance of the ICDs, improve thermal conformance along the length of the well and to increase oil recovery. After the trial, a comprehensive study was undertaken using the data from the trial along with engineering fundamentals and transient wellbore and reservoir simulation models. The purpose of the study was to improve understanding of the underlying physics that govern flow and thermodynamic behavior through the ICDs, and specifically, the effectiveness of: restricting steam production, restriction effects on hot and cool liquid inflow, heat exchange effects and changes to the steam-assisted gravity drainage (SAGD) inflow under varying conditions of well skin. The results of the study seek to identify some design principles that can be used for proper application of ICDs to SAGD wells.

Theory and/or Method

Well pairs 1 and 2 at the Grand Rapids SAGD pilot project were used to test the ICD completions. Both field trials were carried out on a staggered timeline and made use of different ICD completion designs. Flowing and shut-in temperature profiles were collected to understand near wellbore conditions and 4D seismic was used to ascertain changes to SAGD performance in the reservoir. Analytical and numerical models were developed to match phenomenon observed from the field trial.

Once the trial was complete, the devices were removed from both well pairs. A sample population of devices underwent a series of inspections and tests to gauge mechanical integrity and provide insight on changes to the ICD performance curves.

Examples

There is limited experience removing and inspecting ICD devices post-operation and is a not a widely published topic.

Conclusions

The well pair 1 field trial lasted 7 months and the well pair 2 trial lasted 18 months. Results from the field trial provided unique learnings with respect to the benefits that tubing-deployed ICD systems provide for SAGD wells. Little to no performance uplifts were noted for oil rates or steam to oil ratio however, changes in conformance and temperature distribution in the lateral sections were identified.

Due to the nature of the installation, it was difficult to provide conclusive evidence that the devices restricted steam in some or all areas of the well. However, it became evident from temperature profiles that restrictions were noted for oil and water inflow. Based on the trial and subsequent modeling efforts, ICD pressure drop curves were re-calibrated and the effects of counter-current heat exchange, steam restriction, steam flashing and restriction to liquid inflow were all believed to be prevalent in the operation.

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