Understanding the Pressure Cycling In-situ Combustion Process in the Morgan Field: Potential Applications to Post-CHOPS Reservoirs

Authors: Alex Turta, Reza Fassihi, Dubert Gutierrez, Ron Sawatzky,

Abstract

Enhanced oil recovery (EOR) from shallow, thin heavy oil reservoirs is still challenging for the oil industry. For those reservoirs that were exploited initially by Cold Heavy Oil Production with Sand (CHOPS), the complexity of the challenge is increased by the network of high-permeability channels (i.e., wormholes). Furthermore, the oil quality in these reservoirs is relatively poor, requiring higher oil prices to justify investments beyond primary development. Thus, a recovery technology that enhances both the production and the oil quality can offer better economics. An interesting example is the Pressure Cycling In-situ Combustion (PC-ISC) process piloted in the Morgan field in Alberta, many years ago.

The Morgan field has been exploited by primary production since 1980. However, in Section 35, after several months of primary production, this was followed by Cyclic Steam Stimulation (CSS) and Cyclic Stimulation with Air and Steam (CSAS) for 4 years. Although little sand was produced during primary production, sand influx into wells during the production phase of the CSS/CSAS operations was a frequent feature; communication was established between wells, apparently via such high-permeability channels. After four years of intensive thermal stimulation of all production wells (average: 8 stimulations/well), the PC-ISC was implemented as a pilot on a large scale, covering the entire Section 35, with 46 vertical wells grouped into 8 adjacent patterns. The scheme consisted of several months of air injection with production wells shut-in, leading to a significant increase in reservoir pressure. This was followed up by several months of oil production, with no injection. Five field-wide pressure cycles were conducted within 7 years.

The results of implementing PC-ISC were very positive. The best 9 producers averaged daily oil production rates in the range of 10-20 m^3/day exceeding the average daily rate of 5 m^3/day for wells under primary production in other sections of the reservoir. As of December 2010, Section 35 recorded a recovery factor of 22.5%, compared to 6% for all other field sections. The best producers exhibited significant oil upgrading, from 12 °API to 22 °API, with a 100-fold decrease in the oil viscosity. The air-oil ratio (AOR) was around 450 sm^3/m^3, considerably below the AOR range of 1,500-3,000 sm^3/m^3 in commercial ISC projects worldwide.

One of the key factors in this remarkable field performance of PC-ISC is attributed to the presence of a network of wormholes upon initiation of this process, and their subsequent growth, as operations unfolded, enabling an increasing level of communication between different wells. This presentation will discuss the impact of the wormhole network on the production mechanisms. It is anticipated that the learnings from this study could aid in the adaptation of PC-ISC as an EOR process for other heavy oil reservoirs, exploited by CHOPS.