Evaluation of the subject geological area suitability for oil recovery by High-Pressure Air Injection method

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The considerable decline of conventional oil and gas reserves and respectively their production introduces new challenges to the energy industry. It resulted in the involvement of hard-to-recover reserves using advanced enhanced oil recovery (EOR) techniques. Thermal methods of EOR are recognized as most technically and commercially developed methods for the highly viscous crude. High-Pressure Air Injection (HPAI) is one of the thermal production methods that reduce oil viscosity and increases the recovery (Yoshioka et al., Moore et al., 2002). HPAI has been already effectively applied for different types of reservoirs development and proven to be economically feasible.

The application performance of the HPAI technology strongly depends on the quality of experimental and numerical modeling conducted on the target object basis. Prior to the field tests physicochemical and thermodynamic characteristics of the process were studied. Further consequent numerical modeling of laboratory-scale oxidation experiments and field-scale simulation were conducted to estimate HPAI method feasibility based on the results of oxidation studies. A medium pressure combustion tube (MPCT) oxidation experiment was carried out to provide stoichiometry of the reactions and field design parameters. A 3D numerical model of the MPCT experiment was constructed taking into account the multilayer design, thermal properties, heating regimes and reaction model (Sequera et al., 2010; Chen et al., 2014; Yang et al., 2016). The “history” matched parameters such as fluid production masses and volumes, temperature profiles along the tubes at different times and produced gas composition demonstrated good correspondence with experimental results. The results obtained during the experiment and modeling of MPCT (fluid properties, relative phase permeability, kinetic model, technological parameters) were used in field-scale modeling using various thermal EOR scenarios. Air breakthrough into production wells was observed, thus a 2 percent oxygen concentration limit where implied. The overall performance of four different scenarios was compared within 15 years timeframe. The development system was also examined to achieve the maximum economic indicators with the identifications of risks and main uncertainties.