Electrical Resistive Heating and Solvent Injection Hybrid Process to Enhance Heavy Oil Recovery

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Abstract

Electrical Resistive Heating (ERH) has been proposed as a thermal recovery method with low environmental impact for heavy oil reservoirs. ERH has great potential for the reservoirs which are not suitable for steam injection-related methods due to low incipient injectivity and formation incompatibility. Meanwhile, Vapor Extraction (VAPEX) has been tested as an environmentally sustainable oil recovery method in both lab scale and field scale. However, the field test results showed that this process is not efficient and economical due to slow mass transfer and low horizontal well efficiency. This paper presents a hybrid process of ERH and solvent injection. The hybrid process could enhance horizontal well efficiency and overall oil production rate, with less environmental impact than steam-related thermal processes.

Numerical simulation has been conducted to evaluate this process via CMG’s STARS. Well pattern similar to that in classical SAGD process was used. The simulation results suggest that this hybrid process utilizes both heating and solvent to reduce oil viscosity and is an effective method to overcome the effect of reservoir heterogeneity on horizontal well efficiency and oil production rate. This proposed hybrid process can have oil production rate at least two times higher than solvent injection alone process.

It is found that the proposed hybrid process has four features contributing to the enhanced oil flow: (1) the heat from electrode establishes quite uniform communication between the injector and the producer, even under reservoir heterogeneity. The in-situ generated heat through ERH along with the horizontal wellbore is insusceptible to reservoir heterogeneity. Therefore, horizontal well efficiency can be enhanced by ERH; (2) greater viscosity reduction can be achieved when heating and solvent coexist; (3) Solvent will keep reducing oil viscosity when electricity circulation loss happens due to
water evaporation at high temperature; (4) the solvent can still reduce the viscosity of the heavy oil in unheated zone where the ERH cannot reach. The factors affecting this hybrid process, such as voltage, different patterns and water saturation, are also discussed in this paper.