Petroleum and Chemical Engineering Department-College of Engineering-Sultan Qaboos University

Enhancing Performance of Steam Assisted Gravity Drainage Using Foam (FA-SAGD) in an Omani Oil Field

Zawan AL Whaibi

Abstract

Steam assisted gravity drainage (SAGD) is one of the major thermal technique to produce heavy oil from the reservoir. In SAGD, two horizontal wells drilled one above the other. The above well performs as a steam injector and the one below as a producer. The reservoir oil is heated by the injected steam and drained to the producer under the effect of gravity. During steam injection, steam rises within the chamber under buoyancy forces and flows continuously to the perimeter of chamber, where it condenses and releases a large amount of latent heat. The heat is then transferred, by both conduction and convection, first to the condensate that flows inside the steam chamber, and then the touching oil. The mobilized oil and the condensate drain by gravity along the steam chamber toward the production well. The steam cannot expand more and will not be able to divert to un-swept region. The injected steam flows through the established bath between the injector and producer. This will reduce the amount of recovered oil. Different studies have been completed to improve the performance of SAGD method and maximize the oil recovery. Adding different chemicals and application of foams are some of these methods.

Foam is known as the dispersion of gas in a continuous water phase. While foam is injected to a reservoir under steam flooding, foam reduces steam mobility and the gravity override. Also, the macroscopic sweep efficiency and oil recovery will increase. During SAGD process, injection of foam blocks the thief zones between injector and producer wells and decreases channeling and breakthrough of steam. This improves the oil recovery under SAGD.

In this study, the performance of foam assisted steam gravity drainage technique is evaluated in an Omani heavy oil reservoir. This will help to establish a viable EOR option for the heavy oil fields in Oman and as an alternative method to thermally develop heavy oil in Oman besides

steam flooding. This thesis studied the possibility & benefits of application of foam-assisted SAGD (FA-SAGD) in Omani heavy-oil reservoirs. The use of foam will be a way for further increase in the oil recovery by controlling the steam channeling. In addition, foam controls the mobility of the steam and therefore diverts steam from higher permeable zones to lower permeable ones.

The simulation results indicate that using foam maintains uniform steam chamber growth and reduces heat loss to the overburden. Simulation of the foam assisted steam assisted gravity drainage (FA-SAGD) process shows considerable improvement in the process efficiency over the conventional SAGD process. Live steam production is reduced for FA-SAGD compared to conventional SAGD. Consequently, cumulative oil production is increased by about 7%, compared to the base case without foam. The optimum foam concentration was found to be 20 % based on the model sensitivity runs. Furthermore, steam quality has a noticeable effect on oil recovery due to the higher latent heat. The higher steam quality results in higher oil recovery that was clearly evidenced from analysis done in this study. Furthermore, changing the distance between the injector and producer, that control the sub-cool region, has direct impact on recovery rate and the production of steam. Decreasing the distance to 5 meters spacing between injector and producer reduces the recovery rate by 10%.

.