Impact of Tar Mat on Steam Development Options

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Summary

This presentation is about the impact of a tar mat on steam development options for heavy oil fields with a strong bottom aquifer.

In principle the standard steam development options, Cyclic Steam Stimulation (CSS), Steam Drive or Steam assisted Gravity Drainage (SAGD), can be used to develop heavy oil fields with strong aquifers. Efficient operation of such steam developments require that aquifer water influx is controlled and fields are operated at low pressure. A low reservoir pressure maximizes usage of the latent heat content of steam, which is the main source of heat transferred to the reservoir. Both effects, water control and low pressure, can be achieved by implementing an aquifer pump-off scheme. A potential additional benefit of an aquifer pump-off scheme is to use the produced water as source water for steam.

A tar mat at the bottom of a heavy oil field shields the aquifer from the reservoir. Water influx will not be an issue, but achieving a low reservoir pressure for optimal steam development conditions may now provide a challenge. One of the key challenges is to get a steam development started and to achieve off-take from the reservoir. To start a first CSS cycle, some fluid mobility is required to be able to inject steam in sufficient quantities to create a steam chamber. For reservoirs with a viscosity gradient, the oil viscosity at the top of the reservoir may be sufficiently low to allow CSS, but deeper in the reservoir and certainly in the tar mat these mobility conditions will not apply. With a tar mat it will also not be possible to establish a mobile water zone by drawing in aquifer water during a cold production phase. Under these conditions only fracturing options remain to initiate steam cycles. Once started it may still take many cycles to get an appreciable oil production response.

A cyclic steam stimulation development can be followed by a steam drive. A steam drive consists of two phases: initially a true drive, followed, once steam has broken through in a producer and a steam blanket has formed, by gravity drainage. With the top part of the reservoir in a steam drive/gravity drainage phase it will be difficult to initiate cyclic steam stimulation or new steam drive phases at deeper levels of the reservoir, as injected steam will tend to connect with the steam blanket at the top. Extending a steam development deeper into the reservoir, towards the tar mat can then only be done by a slow gravity drainage process.

A SAGD development scheme potentially addresses the injectivity and pressures issues. In SAGD a long horizontal injector is located above a long horizontal producer. The idea is to generate a steam chest that will develop upwards from the injector. Heated oil on the side of the steam chamber will drain under the influence of gravity to the horizontal producer. Production rates are controlled to allow the draining oil to be produced but to avoid production of steam. For the scheme to work communication between injector and producer has to be achieved. For high viscous conditions this can be achieved by locating the injector closely above the producer (distance ~ 2 meter) and by pre heating the wells. The pressure in the developing steam chest can be controlled and can be kept low. In principle this technique can be used to develop the tar mat itself. No communication with the aquifer should develop, to avoid quenching of the steam chest. However, SAGD requires favorable geological conditions, in particular a good vertical permeability.

This presentation will discuss the different steam development options and highlights issues and challenges that may occur for developments targeting parts of the oil field close to the tar mat, or even the tar mat itself, as input for a discussion on how to develop a heavy oil field with tar mat and strong aquifer.