

Enhanced Mass Transfer in the Vapex Process Using Non-Condensable Gas Fingering

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ABSTRACT

Results from several SAGD projects in the province tend to indicate that Non-Condensable Gasses (NCG) tend to finger through bitumen when the SAGD chamber pressure exceeds the reservoir pressure. This has been evidenced at the Dover Project (formerly the Underground Test Facility) through pressure data at the Phase E observation wells after the commencement of gas wind-down in the Phase B pattern. Also, previously published temperature data from Phase B tends to show fluid movement far ahead of the steam chamber advance.

The chief concern with respect to the future development of Vapex lies in the ability to of the process to deliver commercial bitumen rates. It was first shown by Butler that, by diffusion alone, the predicted rate for Vapex might be only 7% of the rate which could be delivered by SAGD in the same reservoir. Butler, Das and others have also shown that in addition to diffusion, that dispersion or capillary pressure may play some role in additional mass transfer at the condensation front. It has been shown, however, that this enhancement is not sufficient to generate rates on par with or exceeding SAGD.

This paper outlines studies conducted to examine the possibility of using NCG in an overpressured Vapex chamber to greatly enhance mass transfer at the condensation front by utilizing the fact that NCG will tend to flow ahead of the front into the bitumen. This flow of NCG can carry propane with it directly into the bitumen, which tends to lift the control on bitumen production rate usually anticipated with a dispersion/diffusion mass transfer mechanism.

The study was conducted by first history matching using a compositional model, physical model studies of the Vapex process conducted by Das in Hele-Shaw cells and Packed Models. Secondly, the field results of the Phase B wind-down were also history matched to determine the appropriate relative permeability curves in matching NCG flow through bitumen. By understanding both mechanisms, a model was constructed to determine the effect on production rate associated with running a Vapex chamber at a pressure above the initial reservoir pressure and using a solvent composed of a mixture of propane and NCG (methane).