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Dynamic Pore-Network Modeling of Solvent Vapour Extraction

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Solvent Vapour extraction (Vapex) of bitumen from oil sands is a promising technology for in-situ bitumen recovery. It is analogous to steam assisted gravity drainage (SAGD) where solvent is used as a substitute to heat to reduce bitumen viscosity. In the Vapex process, two parallel wells are employed. Solvent is injected in the upper well and recovered diluted bitumen is produced from the bottom well. GHG emissions and the environmental impact of bitumen extraction in Vapex are improved compared to the SAGD process.

In Vapex, solvent and oil mix by a combination of molecular diffusion, mechanical dispersion and capillary redistribution of fluids. The mass transfer layer between the vapour chamber and oil consists of a dynamic vapour-liquid capillary mixing zone and a single phase liquid-zone where dispersive forces mix solvent and oil. Oil production in Vapex experiments carried in porous media were found to be significantly higher than model predictions. This was attributed to increased surface contact in porous media, surface renewal at the bitumen front and capillary imbibition. It was reported that capillary imbibition is a dynamic pore-scale mechanism that draws diluted oil away from the solvent vapour-bitumen interface and contributes to periodic interface renewal and mass transfer rate enhancement.

In this work, a pore network model is used to describe the dynamics of two-phase flow and mass transfer during solvent vapor based extraction of bitumen from a two dimensional randomly generated porous medium. Thermodynamic equilibrium is assumed in the pores and a two-phase flash calculation is performed to compute phase composition. Solvent diffusion and dispersion, capillary imbibition and dynamic two-phase flow of diluted bitumen and solvent vapour in the pores are modeled. The model presented in this work can be used to investigate the impact of operating conditions on bitumen recovery and obtain macroscopic parameters for reservoir scale models of the Vapex process.

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References

Time Block Preference

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Participation

Online

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