Projects

- **Evaluation of Solvent Vapour Extraction (SVX) Processes Using a 3D Physical Model Year 1**

  Abstract: In Canada, of the estimated 30 billion barrels of heavy oil in place, at least 26 billion barrels are considered unrecoverable using current technology. Solvent vapour extraction (SVX) processes offer an attractive alternative to thermal recovery processes because they are less energy intensive; use less water; avoid CO2 production; and are more suitable for thinner, partially-depleted reservoirs. This report describes the results of four SVX experiments conducted on a large 3D scaled physical model. Two model sizes were used with three different permeability materials. Horizontal wells arranged with lateral spacing are used to inject methane and butane solvents as a dense vapour. A flow model is used to history match the oil production and determine effective dispersion coefficients. The solvent chamber is imaged using temperature grids. The oil and solvent production is scaled to field dimensions.

- **Evaluation of Solvent Vapour Extraction (SVX) Processes Using a 3D Physical Model Year 2**

  Abstract: Solvent vapour extraction (SVX) processes offer an attractive alternative to thermal recovery processes because they are less energy intensive; use less water; avoid CO2 production; and are more suitable for thinner, partially depleted reservoirs. This report describes the results of three SVX experiments conducted on a large 3D scaled physical model. Field-type permeabilities and 12°API dead oil were used. Horizontal wells arranged with lateral spacing were used to inject methane and butane solvents at three vapour qualities. This study determined that the important process parameters were maximized with high solvent vapour quality injection; including oil production rates, recoveries, net solvent usage, good quality recycle stream, low butane retention in the model, and low water production. The solvent chamber(s) and conduits were imaged using thermal methods during solvent injection and blowdown phases. Effective dispersivity coefficients were determined by history matching the oil production using a flow model. The oil, water and gas rates and recoveries were scaled to field dimensions.

- **Evaluation of Solvent Vapour Extraction (SVX) Processes Using a 3D Physical Model Year 3**

  Abstract: Solvent vapour extraction (SVX) processes offer an attractive alternative to thermal recovery processes because they are less energy intensive; use less water; avoid CO2 production; and are more suitable for thinner, partially depleted reservoirs. This report describes the results of two SVX experiments conducted on a 2.5-m long 3D scaled physical model. Glass beads with 4-5 µm2 permeability and 12°API live oil were used to pack and saturate the model. A horizontal well pair, arranged with both vertical and lateral spacing, was used to inject two different solvent mixtures continuously, and to produce fluids for each run. The two solvent mixtures consisted of 14 mol% methane + 86 mol% n-butane, and 5 mol% ethane + 95 mol% propane. This study determined that operating conditions close to the dewpoint of the solvent mixture resulted in higher oil production rates and recoveries; however, they also resulted in more solvent retention in the models. The solvent chamber(s) were imaged using thermal methods during solvent injection and blowdown phases, and confirmed from the excavated models. The oil, water and gas rates and recoveries were scaled to field dimensions, and numerically history matched.

- **Evaluation of Solvent Vapour Extraction (SVX) Processes Using a 3D Physical Model Year 4**

Abstract: Solvent vapour extraction (SVX) processes offer an attractive alternative to thermal recovery processes because they are less energy intensive; use less water; avoid CO2 production; and are more suitable for thinner, partially depleted reservoirs. This report discusses the results of one SVX experiment conducted on a 2.5-m thick 3D scaled physical model. These results were compared with those of a previous experimental run SVX 10A to evaluate the effects of well type and well pattern spacing on oil production rates and recoveries. The solvent chamber(s) were thermally imaged during solvent injection and blowdown phases, and confirmed from the excavated models. The oil, water and gas rates and recoveries were scaled to field dimensions using an implicit dispersion flow model and scaling method. Based on data from previous laboratory experiments, an extensive numerical simulation study was performed to develop a tuned field prediction model. Advanced simulation methods were used to correct both the laboratory and field models for excess dispersion.

- **Evaluation of Solvent Vapour Extraction (SVX) Processes Using a 3D Physical Model**

Abstract: In this work a single physical model experiment was conducted using SRC's large 3D physical model. The model was vertically oriented such that the resulting model dimensions were 2.5-m thick, 0.2-m wide and 0.5-m long, with a 0.5-m long horizontal well. The model was resaturated with live, 12.2° API oil. After the resaturation process, a primary-production phase was performed through a pressure depletion process. The experiment was conducted under a constant operating temperature of 27°C. After primary production, an 11/89 mol% C_1/n-C_4 solvent mixture was injected at a continuous mass rate. Compared to

SVX runs conducted with field type permeabilities and vertical orientation of the physical model, this particular run resulted in the highest oil production rates, with a significant reduction in the produced dead oil viscosity, a substantial increase in the residual n-C_4 (expressed as weight percent) of the produced dead oil, and the highest weight percent of asphaltenes left in the residual oil.

- **Numerical Simulation of SVX Processes – K-Value-Controlled Non-Equilibrium Solvent Dissolving Method**

  Abstract: In this work advanced numerical simulation techniques were developed to improve estimates of the three most important parameters affecting the oil production rate and recovery from SVX processes. These parameters are three-phase relative permeability curves, total effective solvent mass transfer rates, and non-equilibrium solvent solubility. One of the objectives of this year's study was to develop a K-value-controlled non-equilibrium solvent dissolving method by combining the equilibrium K-value approach with the non-equilibrium solvent solubility approach. In this work a new approach was adapted to correct for larger gridblock size for field scale simulations. Numerical simulations were also performed to evaluate the effect of well spacing on SVX performance. A combination of equilibrium and non-equilibrium solvent solubility approaches showed a very good match between the experimental and simulation results for four SVX runs with same set of Kr curves. The simulation studies also revealed that increasing the well spacing on a field pattern results in increased oil production with reduced recovery factor.

CONTACT

Saskatchewan Research Council
129 – 6 Research Drive
Regina, SK Canada S4S 7J7
T: 306-798-9400
F: 306-787-9510
E: info@src.sk.ca
www.src.sk.ca