SRC

Five-step Experimental and Numerical Simulation Program (SVX)

SRC offers a five-step experimental and numerical simulation program that is intended to evaluate, select and optimize an SVX process for a particular reservoir. Initially a detailed pressure-volume-temperature (PVT) study is required to characterize the solvent–oil system(s), and to provide dynamic non-equilibrium solvent solubility estimates required for numerical simulation. Core displacement tests for relative permeability determination may be required, depending upon how much similar petrophysical information is available for the oil–solvent–reservoir system.

Once the fluids are characterized and petrophysical data are compiled, preliminary numerical simulation can be conducted. Various well types, well patterns and well spacings can be simulated to determine the best scenarios of SVX field performance. These are only preliminary estimates, but they can narrow down the possible scenarios when evaluated by clients using economic models particular to their business operations. Once the best candidate scenarios are selected, 3D physical modelling can proceed to test one or more of the process scenarios.

A minimum of two, and usually four, 3D physical model runs should be considered. Two runs are designed to investigate the effect on oil production rates and recovery of different process parameters, such as solvent–oil mixtures, solvent–steam injection rates, operating pressure, etc. These two runs are designed to compare two alternative cases, and, as such, require the same model geometries to be used.

An additional two runs with different model geometries are required to tune the numerical simulator while history matching the produced oil and gas from the physical model. The subsequent tuned field-scale simulator can be used to generate performance estimates to optimize oil production rates, recoveries and/or economics. The detailed simulations can also be used for field pilot design. Semi-analytical flow modelling and scaling can also be done on all the model runs, and are used as a check or constraint on the numerical simulation estimates.

Following table presents the summary of estimated duration for five-step experimental program:

Summary of Estimated Duration for Five-Step Experimental Programs

Experimental Program Per Runs, Tests or Sets Shown	Estimated Duration In Months	
	Work	Total
STEP 1: PVT Fluid Model Determination for Numerical Simulations		
Conduct solvent–oil special PVT analysis and fluid characterization.	1 – 2 mo.	Depends on no. of systems
STEP 2: Core Displacement Experiments for Pseudo-Relative Permeability Determinations		
Determine viscosity-dependent pseudo-relative permeability and endpoint saturations.	1 – 2 mo.	Depends on no. of runs
STEP 3: Preliminary Numerical Simulation – SVX Scenario Evaluation and Selection		
Evaluate possible scenarios for technical and economic feasibility. Select best process candidates.	0.5 mo.	Depends on no. of scenarios
STEP 4: 3D SVX Physical Modelling – Process Comparisons and Numerical Simulation Tuning		
Conduct 3D physical modelling for two or more runs to compare two or more different process scenarios.	6 mo. for two runs	8 mo. for final report
Conduct 3D physical modelling for two runs with different model geometries to tune numerical simulator.	6 mo. for two runs	8 mo. for final report
Conduct semi-analytical history matching and dispersivity coefficient determination for all 3D physical model runs.	Included in above	Included in above
STEP 5: Tuning of Detailed Numerical Simulation Model – Optimize Process Application		
History match SVX experiments to tune numerical simulator for dynamic non-equilibrium solubility effects and gridblock size, numerical/physical dispersion corrections for field-scale estimates.	1 mo. per scenario	Depends on no. of scenarios
Conduct 'generic' field-scale reservoir process simulations for best SVX scenarios for technical comparisons – validate initial process simulations.	0.5 mo. per scenario	Depends on no. of scenarios
Conduct 'specific' field-scale process simulations for best SVX scenario(s), and provide detailed information for field pilot design.	1 mo. per scenario	Depends on no. of scenarios

SVX process evaluation, selection and optimization require the field reservoir petrophysical and geological properties. The more detailed the geological and petrophysical description, the better the reservoir can be described. A minimum requirement is knowledge of the reservoir depth, pressure, temperature, permeability and porosity ranges and variation, fluid saturations, in-situ and/or producing gas/oil and water/oil ratios, produced gas composition, live and dead oil density and viscosity at reservoir temperature, the presence of any geological barriers or bedding, water influx tendencies/pressures, and any other pertinent information. General sample and information requirements are listed in Table below.

Summary of Client-Provided Information & Materials

Experimental Program	Information	Materials
STEP 1 Solvent–Oil Special PVT Analysis and Fluid Characterization (per set of five tests)	Wellhead location and preferred solvent mixture(s)	5 L of wellhead oil (net after cleaning) OR sufficient core to extract 5 L of oil
STEP 2 Viscosity-dependent pseudo-relative Permeability Determination (per set of five tests)	Any available core analysis of fluid saturations and petrophysical data on permeability and porosity	6–8 L of wellhead oil (net after cleaning) + 300 cm of preserved core plugs OR synthetic core
STEPS 3 & 5 Numerical Simulation	Any information on preferred scenarios AND scenarios that cannot be considered due to field constraints or economics. In addition, any available core analysis of fluid saturations and petrophysical data on permeability and porosity variation in the field	STARS® compatible geological models – if available
STEP 4 3D Physical Modelling for Two (2) Runs	Selected well type, pattern and spacing + available or planned solvent composition + injection rates and total solvent volume	600–800 L (1,600–2,100 kg) of reservoir sands OR synthetic materials + 400–800 L of clean oil + initial GOR + gas composition

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