PTRC — 6 Research Drive, Regina, Saskatchewan, Canada, S4S 7J7

The Latest

from the Petroleum Technology Research Centre
Spring 2003

in innovation for the oilpatch

Come visit the PTRC in Weyburn, Calgary

The Petroleum Technology Research Centre will be hosting booths at the Saskatchewan Oil and Gas Show in Weyburn, SK, June 4 and 5, and at GO-Expo in Calgary, AB, June 10-12. Drop by to pick up some information about our R&D project packages, chat with our staff, or simply to drop your business card in our draws.

In Weyburn, we're at Booth 4; in Calgary at Booth 1511 near the Luncheon Facility. See you there!

The Petroleum Technology Research Centre is a partnership of Natural Resources Canada, Saskatchewan Industry and Resources, the University of Regina, and the Saskatchewan Research Council.

Welcome to *The Latest*

a note from PTRC Managing Director Michael Monea

It's my pleasure to introduce you to the inaugural edition of ***The Latest***, the electronic quarterly newsletter from the Petroleum Technology Research Centre in Regina, Saskatchewan.

The PTRC strives to meet the highest standards in R&D to advance oilfield practices and production. We also strive to communicate effectively about our work and your investment in it. You'll find progress updates on all PTRC-sponsored projects. The updates are grouped according to research area:

- Heavy Oil Cold Flow
- Enhanced Waterflooding
- Miscible/Immiscible Injection
- Near-Wellbore Conformance Control

Please let me know if you have any questions or comments about our services or the contents of ***The Latest***. Email me at monea.ptrc@src.sk.ca or call me at 306-787-9400.

You can reach the project leaders at their email links or The Latest's editor, Brenda Tacik, at tacik@src.sk.ca.

More Money for Sask. Field Pilots

The Saskatchewan Petroleum Research Incentive (SPRI) has been extended to March 31, 2007. The $7 million program will fund royalty credits to offset 30 per cent of eligible costs of approved field pilot projects in the province, said Howard Loseth, Senior Engineer in the Energy Development and Climate Change Branch of Saskatchewan Industry and Resources (IR).

The research incentive encourages oil and natural gas companies to test, prove, and commercialize new-generation technologies in Saskatchewan reservoirs. Conventional methods have recovered, on average, only about 15 peer cent of the province's vast but often technically challenging petroleum resource.

The SPRI program enabled Numac Inc., now Devon Energy Corp., and its partner, Nexen Energy Inc., to claim nearly $600,000 against royalties when they implemented a $2.3 million field test in southeast Saskatchewan in 2000. The pilot confirmed that CO_2 injection would mobilize and recover additional oil in the Elswick Midale Beds Pool.

Don Spencer, Exploitation Engineer with Devon, said the company was happy with the information it got from the field test. Even though a planned CO_2 flood has been deferred, the pilot gave insight into communication patterns within the different reservoir zones. The operators have applied this knowledge to further horizontal development drilling.

A 15 per cent royalty credit on industry investment in laboratory research—a feature of the original SPRI program—has not been renewed. However, the Petroleum Technology Research Centre (PTRC), located in Regina, works closely with producers in all aspects of field piloting. The PTRC will assist producers in making applications for SPRI funding, pre-pilot laboratory confirmation testing, and support at the field site.

To apply for SPRI program credits or find out more information, contact:

Howard Loseth, SIR, 306-787-3379

Michael Monea, PTRC, 306-787-8290 or monea.ptrc@src.sk.ca.

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PTRC Project Update

Core Area 1:

Heavy Oil Cold Flow

Phase Behaviour Data for Vapex Correlations

This project is aimed at enabling oil producers to operate Vapex field projects at optimum fluid property conditions. It will define the range of conditions, governed by phase behaviour issues, for successful Vapex implementation. To date, the literature survey has been completed; data analysis and equipment design are well underway. The new equipment, which will provide the full suite of measurements needed for Vapex projects, will be deployed by a grad student in Winter 2003/04. **Project Leader:** Norman Freitag; email freitag@src.sk.ca.

Propane / Heavy Oil Diffusion Measurement

This project's aim is to improve the performance prediction and design of Vapex processes through the accurate measurement of diffusion coefficients of Vapex solvents into heavy oil. Recent work has focused on optimizing the experimental procedure to ensure good results for simulation procedures. An optical method to determine dispersion as well as diffusion coefficients will be complemented by a more complex mathematical approach, as follow-up work. A refractive laser is also being constructed to measure density variations to determine the diffusion coefficients alone. **Project Leader:** Harald Liebe; email liebe@src.sk.ca.

Generic Modeling of Wormholed Reservoirs

Could wormhole structures in reservoirs be employed to aid the sweep efficiency of cold flow follow-up processes? This project is using 3D scaled physical modeling to find the answer. The model was constructed, and a method for incorporating wormholes into it was finalized. Permeability measurements were taken with and without wormholes. The first two of eight planned runs were done in April. The high-pressure component of this project is planned for Winter 2003/04. **Project Leader:** Harald Liebe; email liebe@src.sk.ca.

Cold Flow Field Data Acquisition

This project is aimed at assessing the availability of good quality field production and reservoir data to guide the development of new and effective follow-up processes for primary production heavy oil fields. Several producers were contacted and a limited amount of data collected. The largest single information database in this area was collected by a consortium of research organizations some years ago. We are discussing a joint project with one of the main contributors to reexamine and extend the amount of field data available. **Project Leader:** Patrick Jamieson; email jamieson@src.sk.ca.

Solvent-Based Post-CHOP in Wormholed Reservoirs

Results from this project will lead to improved recovery from wormholed reservoirs while reducing capital and operating costs of solvent injection. The experimental set-up has been constructed, and the numerical program for determining convective dispersion coefficients in wormholed reservoirs has been coded. The project team will now test some solvents at high pressure and at elevated temperature. **Project Leader:** Peter Gu; email peter.gu@uregina.ca.

Core Area 2:

Miscible/Immiscible Gas Injection

Enhanced Oil Recovery by Flue Gas / CO_2 Huff and Puff in Saskatchewan Reservoirs

Determining if a flue gas/CO_2 huff and process is technically and economically feasible in waterflooded oil reservoirs is the goal of this project. Work is proceeding on three fronts:

1) measurement of the phase behaviour and physical properties of oil/gas mixtures at increasing and decreasing pressures that mimic the process conditions in the reservoir
2) corefloods to measure the oil recovery efficiency of each huff and puff cycle
3) numerical simulation to enable prediction of the fluid properties at conditions beyond those of the experimental measurements

Measurements are almost complete for Elswick reservoir fluids. **Project Leader:** Sam Huang; email huang@src.sk.ca.

Immiscible CO_2/Enriched Flue Gas Injection for Heavy Oil Recovery

This project's aim is to develop a viable, cost-effective EOR method for thin heavy oil reservoirs and accelerate its application. A candidate heavy oil reservoir in the Kindersley area was selected and oil samples were received from a client. We are working with CMG to develop an enhancement of STARS that will enable the modeling of immiscible gas floods using CO_2. **Project Leader:** Sam Huang; email huang@src.sk.ca.

Effects of Capillary Pressures, Interfacial Tension and Viscosity in Vapex

This project seeks to improve predictive models and reservoir screening criteria for Vapex field application. We are completing the background and preparatory work. A literature survey evaluated hundreds of papers. We are now developing a model design as well as modifying an existing model. **Project Leader:** Muhammad Ayub; email muhammad.ayub@uregina.ca.

Core Area 3:

Enhanced Waterflooding

Heavy Oil Waterflooding Scoping Study

An initial survey of all Saskatchewan waterflood projects was done to identify their common factors of success, or lack thereof. The goal is to develop a database of waterflood projects and start developing screening criteria for future ones. The study will be broadened to include Alberta. Although many factors may influence it, success was found—in this preliminary evaluation—to correlate most strongly with operating practices (such as the operator's willingness to coax good outcomes and try different approaches). **Project Leader:** Doug Soveran; email soveran@src.sk.ca.

Low-Cost Chemicals for Enhanced Waterflooding

This project aims at reducing the costs of chemically enhanced waterflooding by identifying low-cost sources of caustic or caustic substitute (such as sodium carbonate from cleaned pulp smelt) and confirming their effectiveness. A process flow sheet has been developed, samples of smelt feedstock have been obtained, and a lab scale unit is now being assembled to produce the caustic substitute. **Project Leader:** Cindy Jackson; email jackson@src.sk.ca.

ASP Flooding in SW Sask. Medium Oil Reservoirs

A field test of a cost-effective alkaline/surfactant/polymer flooding technique is this project's aim. In preparation, several corefloods were carried out to determine the influence of key process variables (e.g., type of surfactant and alkaline, chemical concentration, and injection sequence) on oil recovery. The most recent floods have used reservoir cores and live oil to determine oil recovery under more realistic conditions. A series of field-scale simulations was successfully completed, in part to arrive at economic assessment of the process. **Project Leader:** Sam Huang; email huang@src.sk.ca.

Enhanced Waterflooding Using Colloidal Gas Aphron (CGA) Solutions

This project is examining the use of microbubble solutions to lower the density and raise the viscosity of injected water to sweep previously unaccessed portions of a reservoir. A literature search was done to update the state-of-technology since Alberta Research Council (ARC) completed their preliminary work in 1996. SRC will continue to identify better/cheaper surfactants. ARC will confirm that they can make these CGA solutions under high pressure and carry out core tests. SRC will test the solutions in a two-dimensional visual model to determine if they override oil. **Project Leader:** Doug Soveran; email soveran@src.sk.ca.

Modified Polymers for Water Permeability Reduction

The aim of this project is to develop a means of overcoming excessive water production and increasing oil recovery by modifying natural polymers to better adsorb on reservoir surfaces and plug reservoir pores. Our partner at the University of New Brunswick has obtained commercial starch polymers and is working to tailor them. We have obtained and characterized Saskatchewan cores for core surface/polymer adsorption measurements. Baseline flow tests using Berea cores will start when the new polymers are received from UNB. **Project Leader:** Mingzhe Dong; email mingzhe.dong@uregina.ca.

Core Area 4:

Near Wellbore Conformance Control

Information System for Saskatchewan Reservoirs for Applying Conformance Control Techniques

Enabling managers and reservoir engineers to select suitable conformance control processes for any given reservoir is this project's aim. This will be achieved through development and organization of a structured database of Saskatchewan reservoirs that have encountered conformance problems. The database structure is currently being written and tested on MS Access by a contract computer programmer. The data gathering is going well, and the project team plans more frequent sessions in Calgary to obtain more information from industry about their experience with conformance problems in Saskatchewan reservoirs. **Project Leader:** Koorosh Asghari; email koorosh.asghari@uregina.ca.

Developing Near Wellbore Conformance Technologies for Wormholed Reservoirs

A modified gel-foam system may have the potential to block wormholes effectively, thereby improving the sweep efficiency of waterfloods in Lloydminster-type reservoirs which have undergone cold production. Lists of candidate surfactants and foam stabilizers have been compiled, and initial screening and grading are underway in benchtop bottle tests. The team is awaiting the arrival of some of the chemicals. As well, the team created wormhole structures in a visual model and used gels to plug the high-permeability wormhole channels. **Project Leader:** Koorosh Asghari; email koorosh.asghari@uregina.ca.

Other Areas:

CO_2 Extraction from Flue Gas Using Hydrates

This feasibility study was one of only 24 proposals (out of 95) to attract funding from Natural Resources Canada's "Innovative Research Initiative for Greenhouse Gas Mitigation." NRCan's $50,000 for a year-long extension will be supplemented by $25,000 from SRC. The project is exploring the formation of clathrate hydrates to isolate CO_2 from flue gas. **Project Leader:** Selim Sayegh; email sayegh@src.sk.ca.

IEA Weyburn CO_2 Monitoring and Storage Project

Work done at the PTRC had two components: Dynamic Fluid Testing; and Reinjection of Recycled CO_2. Sampling and analysis are on schedule, but demands on equipment postponed coreflood testing. Additional work has been proposed to investigate reservoir-related aspects of the Weyburn CO_2 flood. **Project Leader:** Norman Freitag; email freitag@src.sk.ca.

Displacement of Heavy Oil Through Interfacial Instability

This project is aimed at developing a viable, cost-effective non-thermal EOR technique for heavy oil reservoirs, in which the major recovery mechanism is the oil's self-dispersion into and transport through the water phase. Work is nearing completion and the final report is being written. Two companies are interested in the process. We are considering a second phase which would include more corefloods with a specific oil. This would be in preparation for a third-phase field test and a 3D model test to see what problems might be encountered in the field. **Project Leader:** Mingzhe Dong; email mingzhe.dong@uregina.ca.

Application of Gels for CO_2 Conformance

This project is examining optimal gel composition and gel placement techniques for conformance control of carbon dioxide in Weyburn field, with the aim of increasing CO_2 sweep efficiency. The work is wrapping up: the gel systems have been characterized and their performance tested for water and carbon dioxide media. The systems are being tested for temperature/ gelation time. All results will be reported in a Master's thesis and in other reports. **Project Leader:** Koorosh Asghari; email koorosh.asghari@uregina.ca.

Biosurfactant-Enhanced Technologies for Remediation of Petroleum-Contaminated Sites

More petroleum-contaminated sites in Saskatchewan were investigated, including those of TransGas and Husky Oil. Soil, aquifer, and contamination conditions were examined, and the systems simulated under different remediation technologies.

Some research results of biosurfactant identification and culturing were obtained experimentally. Further culturing and purification studies are underway. In addition, some surfactant samples have been prepared for on-site application in Summer 2003. A TransGas site will be used first for testing the developed surfactants.

A literature review for related publications in surfactant, biosurfactant, environmental microbio-technology and site remediation practices was done. **Project Leader:** Gordon Huang; email Gordon.Huang@uregina.ca.

Interfacial Phenomena in CO_2 Flooding

This nearly completed project is aimed at improving understanding of how CO_2 miscible flooding enhances oil recovery and sequesters CO_2. We are determining the effects of CO_2 flooding on the oil/rock/brine reservoir system by carrying out high-pressure tests at reservoir temperature in a recently constructed high pressure cell. The study will eventually be extended to flue gas flooding. As well, tests have recently begun examining diffusion of CO_2. **Project Leader:** Peter Gu; email peter.gu@uregina.ca.

Separation of Oil / Water Emulsions Using a Coalescer Column

The goal of this project is to develop an effective mechanical phase separation technique for petroleum industry applications. A student has done several dynamic test runs with the column using several different packings and different flow rates to evaluate the effect on oil droplet enlargement and separation acceleration. **Project Leader:** Peter Gu; email peter.gu@uregina.ca.

Detection and Reuse of Chemicals in Chemical EOR

In any chemical EOR process, a substantial portion of the chemical will be produced. This project is determining if the chemical can be reused. Chemical adsorption is also being investigated. All research on the "A" (alkaline) component of ASP flooding has been completed in sandpack corefloods. We are now studying surfactants in Berea cores, which will also be used for the subsequent work on polymers. Finally, combinations of the different chemicals will be studied. **Project Leader:** Peter Gu; email peter.gu@uregina.ca.

Selective Permeability Reduction by Polyacrylamide Polymers for SK Reservoirs

This project is examining the potential for using polyacrylamide injection as a means of selective permeability reduction. The goal is to enable oil companies to improve oil production by reducing water production and viscous fingering. A useful predictive model is being developed for this process, which has gained increasing industry interest. We have studied the effects of polymer injection rate, water injection rate, polymer concentration, and polymer flow rate. **Project Leader:** Koorosh Asghari; email koorosh.asghari@uregina.ca.