Use of microfluidic chips a first in bitumen-gas analysis

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A University of Toronto research team has developed a process to analyze the behavior of bitumen in reservoirs using a microfluidic chip, a tool commonly associated with the field of medical diagnostics. The process may reduce the cost and time of analyzing bitumen-gas interaction in heavy oil and bitumen reservoirs.

Dr. David Sinton, Professor with the Department of Mechanical and Industrial Engineering at the University of Toronto, and postdoctoral researcher Dr. Hossein Fadaei are using the chips to examine the way highly pressurized CO2 behaves when injected into bitumen. The new method, reported in the journal *Energy & Fuels,* could streamline the way fossil energy companies measure the diffusion of gases in heavier oils like bitumen.

"To my knowledge, this is the first application of microfluidics in the study of gas-bitumen diffusion," says Sinton. His project was funded in part by Carbon Management Canada, a national Networks of Centres of Excellence funding research to reduce CO2 emissions in the fossil energy industry and other large-scale emitters.

Bitumen and heavy oil are difficult to extract from reservoirs because they are thick and do not flow easily. There are several methods of extraction, one of which uses CO2-rich gas injections which helps liquify the bitumen for easier extraction. This process can supplement the steam-injection method which requires heavy inputs of energy and water, and it presents opportunities for sequestration of CO2 in the

reservoir.

But, says Sinton, before companies pump CO2 into reservoirs they need to first determine how the CO2 and oil will behave under specific pressures and in specific rock formations. Conventional methods of analysis are conducted using about .5 L of bitumen and a process that can take hours or even days for a single test result.

Sinton and his colleagues use a small glass microchip to replicate a pore within a rock reservoir. The channels in the pore are 50 microns wide, or about half the diameter of a human hair. The device is initially filled with CO2 at low pressure and a small sample of bitumen is injected into the centre of the chip. High pressure CO2 is then injected at both ends of the chip and the swelling of the oil is measured over time.

"This takes 10 minutes and uses a nanoliter plug of sample. If you can do a test in a few minutes and perform many tests in parallel, that's a lot cheaper," he points out. "The experimental setup is also quite simple compared to existing methods."

The method developed by Sinton shows potential as a rapid, reliable approach that could be used by both researchers and the oil and gas industry. And because it uses such small samples, the method could also be employed using hazardous solvents.

Next steps involve studying many types of oil or combinations of diffusion gases at one time in one chip; expanding temperature and pressure ranges of tests to match the variety of conditions found down-hole and in bitumen processing, and adapting the method to work with less viscous oils and other fluids such as brine. Diffusion of CO2 into brine at high pressures is of particular interest for carbon sequestration applications.

Provided by Carbon Management Canada