Hydrocarbon Solvent Injection Study for Heavy Oil Recovery in the Colombian Oil Sands

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Abstract

There are huge, well-known resources of heavy oil, extra-heavy oil, and bitumen in Canada, Venezuela, Russia, USA, and many other countries, including Colombia. Historically, over the past 10 years, the Colombian Llanos basin has been the main source of oil and gas production in the country. Currently production from heavy oil sands in this basin are about 700 thousand barrels of crude oil; which represents over 70% of the country's production, and more than 500 million cubic feet of natural gas. Therefore, successful heavy oil technologies deployment in the Colombian Llanos Basin will represent a key factor for the Oil and Gas Industry to increase the recovery factor and the country's production in the nearest future.

Up to 80% of estimated heavy oil reserves could be recovered by in-situ thermal operations. Sophisticated technologies have been required to economically develop complex and varying oil fields (Nasr and Ayodele, 2005). To achieve this goal efficient techniques using steam combined with appropriated hydrocarbon solvents resulting in a most cost-efficient recovery process. Equion Energia Limited is currently conducting a study to define a singular opportunity that can be developed in the east of Colombia, where reach gas reservoirs discovered near the big heavy oil accumulations can provide plenty of solvents (LPG) for enhanced recovery of heavy oil. Thus, a clear synergy between the heavy oil and the light hydrocarbon solvents resources becomes evident.

In most cases, viscosity reduction is the one common element of in-situ methods of heavy oil recovery with the exception of cold production. Currently, steam assisted gravity drainage (SAGD) and cyclic steam stimulation (CSS) are being used commercially in the field where the oil's viscosity is reduced by injecting steam. Thermal methods are energy intensive requiring vast volumes of water such that any improvement would be beneficial. Solvent extraction is one alternative requiring no water, the solvent is recoverable and reusable, and depending on the mode of operation the heavy oil is upgraded in-situ. Vapour Extraction (VAPEX) and enhanced solvent extraction (N-SolvTM) are two such methods. VAPEX and N-Solv reduce the bitumen's viscosity via mass transfer and a combination of mass and heat transfer, respectively. A light hydrocarbon solvent (instead of steam) is injected into an upper horizontal well where the solvent mixes with the heavy oil, reduces its viscosity and allows the oil to drain under gravity to a bottom production well.

This work presents numerical simulation studies; supported by laboratory experiments results, conducted in order to evaluate the technical feasibility of Equion's solvents coming from Cusiana´s LPG Plant as vaporized hydrocarbon solvents for heavy oil extraction in the Colombian Oil Sands. A mechanistic model was built in CMG-STARS to understand the production behavior in heavy oil under a hydrocarbon solvent injection process, based on petrophysical and fluid properties typical from the Colombian Oil Sands. Cold productions, cyclic hydrocarbon

solvent injection, solvent-aided CSS among others cases, were studied regarding the key variables in this kind of process: steam-injection rate, oil-production rate, oil-recovery factor, solvent-retention rate, fluid-saturation distribution, and temperature distribution.