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In-Situ Low Temperature Catalytic-Aquathermolysis for Enhanced Heavy Oil and Oil Sands Recovery

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Reducing the viscosity of heavy oil can improve its mobility, thereby improving the displacement efficiency. The challenge is how to reduce the oil viscosity to significantly improve heavy oil recovery and to make the process profitable. Thisstudy is aimed at coupling the low-temperature catalytic aquathermolysis process with thermal process for enhanced heavy oil and oil sands recovery.

The catalytic aquathermolysis process can break the C-S, C-N, and C-O bonds of heavy oils, thereby reducing oil viscosity and enhancing the flow of heavy oils in reservoirs. Many laboratory catalytic aquathermolysis tests have shown a significant reduction in heavy oil viscosity and some degree of upgrading of heavy oils. However, the reported laboratory and field tests were carried out at high temperatures ranging from 200^{o}C to 300^{o}C. Ourresearch has shown that some low-temperature catalysts are effective in low temperature catalytic-aquathermolysis for heavy oil samples. Specifically, tests at temperatures ranging from 120^{o}C to 150^{o}C showed promising results in viscosity reduction.The catalyst used in this study have the special features which are required for field application. To achieve a good distribution of the catalyst in the reservoir, the catalyst system has different properties at the following injection stages: 1) During the catalyst slug injection at relatively lower temperatures than that required for aquathermolysis, the water soluble catalyst has a tendency to adsorb at the oil-water interface whenever the solution contacts the oil in the reservoir; 2) when the temperature is raised to catalytic reaction temperature by the thermal process (such as hot water injection), the catalyst becomes oil soluble and is transported in the pores in the form of nano-particles which can then react with the oil.

Field tests of SAGD dilation start-up in oil sands reservoirs showed that injecting a unique catalyst can evoke the in-situ catalytic aquathermolysis mechanism. The reservoir is first dilated to form a high-porosity and high-permeability conduit connecting the SAGD well pair. The catalyst is then injected into these newly created pore space, contacting the heavy oil in a large volume and helping to reduce its in-situ oil viscosity. This technology has been applied on more than ten SAGD well pairs and excellent field results are generated in terms of reduced steam use, shortened steam circulation time and increased initial oil production.

Biography:

Dr. Mingzhe Dong is a professor in the Department of Chemical and Petroleum Engineering, University of Calgary. Prior to the appointment at the University of Calgary in 2007, he was a professor of petroleum systems engineering in the Faculty of Engineering at the University of Regina (2001-2007). He holds a B.A. Sc from Northwest University, Xi'an, an M.A. Sc from the China University of Petroleum, Beijing, and a Ph.D. from the University Of Waterloo, Ontario, all in chemical engineering. He was a senior research engineer in the Petroleum Branch of Saskatchewan Research Council between 1998 and 2001. Previously, he worked in the Department of Research and Technology of Imperial Oil Limited, Calgary, as an NSERC industry post-doctoral fellow. His research interests include multiphase flow in porous media, enhanced oil recovery, unconventional oil and gas development, reservoir simulation, and interfacial phenomena in oil recovery processes. He has published over 150 peer-reviewed journal papers, 50 conference papers and more than 30 technical reports.