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Dilation by Polymer Injection Enhanced SAGD Start-up Process in Oil Sands Project: Pilot Test and Numerical Simulation

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The preheating start-up is an indispensable and vital phase before converting to SAGD process. It is mainly achieved through steam circulation or stimulation. Either way, the preheating time and steam consumption is usually over 5 months and 30,000 tons, respectively, especially for well pairs in reservoir with bottom transition zone or widely distributed mudstone. Thus, a pilot test about dilation by polymer injection technology before steam circulation was conducted in certain oil sand project.

Based on the data of mini-fracture test, tri-axial test, and polymer core displacement test, the pilot test and follow-up steam circulation process were history matched by coupled geomechanical and thermal simulations, considering the mechanisms of polymer adsorption, degradation reaction, shear thinning and residual resistance, etc. The key to success and the mechanism of dilation by polymer injection technology was analyzed, the scope and size for porosity and permeability improvement were quantitatively evaluated, and steam circulation time, consumption and preheating connectivity rate were accurately compared with adjacent well pairs.

The min-fracture results indicated that the minimum principal stress for reservoir was oriented horizontally, and vertical dilated zone easily created and fast start-up process could be achieved under high injection pressure. The mechanical strength and deformation parameters were measured by tri-axial test such as elastic modulus, Poisson's ratio, cohesive strength, friction angle and Biot's coefficient, etc. The pilot test lasting less than a week was conducted on a pad with bottom transition zone, and it could be divided into five phases: wellbore clean-out and injectivity test, conditioning phase with polymer and slowly building pressure, dilation initiation and pressure connectivity judgement, dilation zone propagation as well as subsequent steam circulation. Numerical simulation results demonstrated that inter-well porosity and permeability significantly enhanced. Compared with adjacent well pairs, thermal and hydraulic connectivity obviously improved, both steam circulation time and consumption dropped nearly by half. Besides, the early oil rate would improve in follow-up SAGD process.

The field experience and findings can provide references for heavy oil or oil sands SAGD projects. The dilation by polymer injection technology can significantly improve the SAGD performance and early economic benefits especially for well pairs in reservoir with bottom transition zone or widely distributed mudstone.

References

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