

Heavy Oil Recovery with Chemical Viscosity-Reduction: An Innovative Low-Carbon and Low-Cost Technology

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Abstract : China has abundant heavy oil resources, and thermal recovery is the main recovery method for heavy oil reservoirs. However, high energy consumption, high carbon emission and high production costs make heavy oil thermal recovery unsustainable. It is urgent to explore a replacement for developing technology. A low Carbon and cost technology of heavy oil recovery, chemical viscosity-reduction in layer (CVRL), is developed by the petroleum exploration and development research institute of Sinopec via investigated mechanisms, synthesized products, and improved oil production technologies, as follows: (1) Proposed a cascade viscous mechanism of heavy oil. Asphaltene and resin grow from free molecules to associative structures further to bulk aggregations by π - π stacking and hydrogen bonding, which causes the high viscosity of heavy oil. (2) Aimed at breaking the π - π stacking and hydrogen bond of heavy oil, the copolymer of N-(3,4-dihydroxyphenethyl) acrylamide and 2-Acrylamido-2-methylpropane sulfonic acid was synthesized as a viscosity reducer. It achieves a viscosity reduction rate of >80% without shearing for heavy oil (viscosity < 50000 mPa·s), of which fluidity is evidently improved in the layer. (3) Synthesized hydroxymethyl acrylamide-maleic acid-decanol ternary copolymer self-assembly plugging agent. The particle size is 0.1 μ m-2 mm adjustable, and the volume is 10-500 times controllable, which can achieve the efficient transportation of viscosity reducer to enriched oil areas. CVRL has applied 400 wells until now, increasing oil production by 470000 tons, saving 81000 tons of standard coal, reducing CO₂ emissions by 174000 tons, and reducing production costs by 60%. It promotes the transformation of heavy oil towards low energy consumption, low carbon emissions, and low-cost development.

Keywords : heavy oil, chemical viscosity-reduction, low carbon, viscosity reducer, plugging agent

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