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Advanced core/cutting analysis for evaluation of enhanced oil recovery in tight rocks: Examples from Montney and Duvernay formations (Canada)

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Summary

Development of unconventional hydrocarbon resources has been historically focused on primary recovery (depletion) with multi-fractured horizontal wells (MFHWs). However, the current primary production processes are inefficient with low recoveries (<10% of oil in place). There are currently major uncertainties associated with identifying an optimal development strategy for enhanced oil recovery (EOR) applications in the Western Canadian tight hydrocarbon reservoirs.

In this study, through the application of multiple advanced core/cuttings analysis techniques on diverse sample suites, fundamental controls on the EOR process in unconventional reservoirs are examined. An innovative multidisciplinary approach that combines routine and non-routine experimental techniques is used for a selected sample suite from multiple prolific tight oil and liquid-rich gas reservoirs (e.g. Montney, Duvernay) in Western Canada. The characterizing techniques are Rock-Eval pyrolysis, extended slow-heating (ESH) Rock-Eval pyrolysis (Sanei et al., 2015), helium pycnometry (grain density, porosity); low-pressure gas (N_2, CO_2) adsorption (surface area, pore size distribution); crushed-rock gas (N_2, CO_2) permeability; matrix/unpropped/propped fracture permeability (N_2) and ultrasonic velocity under controlled stress conditions (Ghanizadeh et al., 2016; Riazi et al., 2017), rate-of-adsorption (ROA) analysis (N_2, CO_2) (Haghshenas et al., 2016); liquid (formation oil/brine) and relative (hydrocarbon liquid/gas) permeability and lastly combined scanning electron microscopy (SEM) and micro-wettability analysis (Deglint et al., 2017). In particular, this study highlights the application of laboratory results for constraining numerical simulation studies used to evaluate the technical viability of EOR techniques to improve oil recovery from these reservoirs.

Combined with necessary field and simulation studies, the innovative experimental workflows provided herein could be beneficial to operators developing the Western Canadian tight oil resources by allowing them to identify/target specific zones within the reservoirs of interest with reservoir quality amenable to maximizing gas storage/transport during cyclic solvent injection for EOR applications.

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