EXPERIMENTAL AND ANALYTICAL CORE AND GEOMECHANICAL DATA ANALYSIS OF A TIGHT OIL CARBONATE FORMATION

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ABSTRACT
Unconventional resources around the world and particularly in North America have been revitalized as a result of advancements in hydraulic fracturing and horizontal wellbore technology. This has created a new wave of hydrocarbon exploration, exploitation and development in most of the tight hydrocarbon plays in western Canada. The multidisciplinary (geochemistry, geomechanics and geophysics) approach and the use of nanotechnology in the petroleum industry have not only helped us to improve our knowledge and understanding of these tight and complex reservoirs and their associated systems, but have also resulted in an upsurge of hydrocarbon recovery.

This study focuses on the results of several analyses performed on different core samples from the Swan Hills Formation, which is predominantly a calcium carbonate oil reservoir in the Western Canadian Sedimentary Basin. Routine and special core analyses of the core plugs were conducted to determine reservoir properties, including bulk and skeleton density, porosity by helium pycnometry, and pore size distribution by mercury injection capillary method (MICP). Stress-dependent permeability of the rock (matrix) was measured using the pulse decay permeability method. Triaxial compression tests were also conducted to determine the Young’s modulus and Poisson’s ratio, compressive strength, and residual strength after peak failure. Linear Mohr–Coulomb failure envelopes (cohesion and friction angle) were also constructed for the intact rock and the rock after failure. Furthermore, short-term and long-term conductivity of acid etched fractures were measured.

Empirical and theoretical correlations were used to model short- and long-term stress-dependent acid fracture conductivity. Nierode-Kruk’s model was found to best fit the laboratory data among all models. Constants in Nierode-Kruk’s model that depend on rock embedment strength and dissolved rock equivalent conductivity are reported. Effects of different acid concentrations on permeability and conductivity were discussed in detail. Creep testing was performed to determine time-dependent deformation of samples under confining stress. It was found that creep strain is dominated by primary creep stage. Time-dependent creep deformation is minimal for tested samples under various confining pressures. Mineralogy, rock fabric and wormhole growth were investigated using X-Ray Diffraction (XRD), Scanning Electron Microscope (SEM) and Computed Tomography (CT) scanning techniques.

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