Integrated Study of Pore Structure Characterization and Geomechanical Properties of Unconventional Tight Rocks

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Abstract

Unconventional energy resources have gained the attention of the industry as conventional resources of oil/gas are depleting worldwide. The complex and irregular geometry of unconnected and extremely small pores make the characterization more challenging for tight rocks. The integrated study of pore structure characterization using Nuclear magnetic resonance (NMR) and micro-computed tomography (MCT) and relationship with geomechanical properties would lead to a novel approach for interpreting the deformation behaviour for different pore-scale structures. A number of tight rock and cement samples were prepared for the study. Cement samples were prepared using different sand grades for having different pore network and porosity. Nuclear magnetic resonance and micro-computed tomography were implemented for qualitative and quantitative characterization of different pore systems. Failure and static elastic parameters were determined through uniaxial and triaxial compression testing for all samples. Continuous strength profile, acoustic velocity and dynamic elastic parameters were determined through scratch testing. Mechanical properties were correlated with pore throat, pore size distribution, pore fluid saturation, and pore connectivity. Qualitative and quantitative characterization of different tight rock and cement samples using NMR relaxation and MCT quantified different pore sizes including adsorption, seepage and fractures pores. Continuous profile of uniaxial compressive strength low strength for the samples having fracture pores with more transverse relaxation time as compared to adsorption and seepage pores. Acoustic velocity exhibited higher compression and shear waves

velocities for samples with more adsorption pores as compared to seepage and fracture pores and transverse relaxation time is less for these samples. Tight rocks with more seepage pores found to have higher static and dynamic Young's modulus and lower Poisson's ratio. Failure/deformation behaviour exhibited that fracture pores reduced the strength of rock samples. The integration of pore structure characteristics and mechanical behaviour found to be an efficient approach for successful development and production of rocks with extremely low permeability. Pore structures have strong influence on the elastic and failure mechanical parameters , however, implementation of an integrated approach will optimize the parameters in order to produce from tight formations.

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