Effective Stress Law for Gas Permeability in Tight Gas Sandstones

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ABSTRACT

Gas permeability of tight gas sandstones (TGS) is found to be more stress sensitive compared to conventional sandstones. Net stress is commonly defined as the difference between the confining stress (Pcon) and the pore pressure (Pp), assuming equal effect on permeability. However, an effective stress law introduces an effective stress coefficient x (Pcon – x Pp). It is critical to determine such coefficient to understand which pressure has more effect on gas permeability and to what extend specifically on tight gas sandstones. To examine the gas permeability stress sensitivity, permeability of TGS samples was measured under a range of net stresses of 1000-4000 psi with different combination of pore pressure and confining stress. The pore pressure ranged from 2000 to 4000 psi and the confining stress was in the range from 3000 to 8000 psi. Permeability was measured at each pore pressure starting with 2000 psi with confining stress of 3000 psi and then increased in step of 1000 psi. Then pore pressure was increased by 1000 psi and confining stress was set at 4000 psi and increased in step of 1000 psi. Process was repeated with all pore pressures to get a wide range of net stresses. To determine the effective stress coefficient, permeability was plotted against the classic net stress (Terzaghi, 1925), and against the effective stress law. A best fit was determined for each sample by varying the effective stress coefficient. All the TGS samples showed effective-stress coefficients <1 indicating that permeability was more sensitive to confining stress than to pore pressure.