Effect of Pore Pressure on Laminated and Homogenous Rocks Permeability under Hydrostatic and Triaxial Loading

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Accurate knowledge of reservoir physical properties such as permeability is crucial for accurate prediction of reservoir performance. Single-phase permeability measurement is normally performed at hydrostatic external loading. Reservoir rocks are subjected to stress anisotropy and tectonic movements thus in-situ stress state is non-hydrostatic. Pore pressure decreases or increases with production or injection operations result in an increase or decrease in the net effective stress exerted on the rock mass. This in turn causes permeability to be a dynamic property throughout the reservoir life. Experimental work was performed on laminated (lamination parallel to flow direction) and homogenous sandstone rock samples to investigate the effect of pore pressure variation on absolute rock permeability when subjected to hydrostatic and triaxial stress state conditions.

Experimental results of all tested rock samples indicate that permeability tends to decrease as pore pressure decreases for both hydrostatic and triaxial stress conditions. Permeability reduction is much more pronounced when rock samples are subjected to external triaxial stress compared to that obtained under hydrostatic stress loading. The permeability reduction occurs early on the reservoir depletion process in low permeability laminated rocks while it occurs at very late stage in high and low permeability homogenous rock samples. These observations indicate that permeability is stress type dependent and that permeability- external pressure state- Internal pore pressure relationship is mainly affected by rock microstructures.