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Study of pore pressure reaction on hydraulic fracturing

Mariia Trimonova (1), Nikolay Baryshnikov (1), Sergey Turuntaev (1,2), Evgeniy Zenchenko (1), and Petr Zenchenko (1)

(1) Institute of Geosphere Dynamics Russian Academy of Sciences, Moscow, Russian Federation (geospheres@idg.chph.ras.ru), (2) Moscow Institute of Physics and Technologies, Dolgoprudny, Russian Federation (info@mipt.ru)

We represent the results of the experimental study of the hydraulic fracture propagation influence on the fluid pore pressure. Initial pore pressure was induced by injection and production wells. The experiments were carried out according to scaling analysis based on the radial model of the fracture. All required geomechanical and hydrodynamical properties of a sample were derived from the scaling laws. So, gypsum was chosen as a sample material and vacuum oil as a fracturing fluid. The laboratory setup allows us to investigate the samples of cylindrical shape. It can be considered as an advantage in comparison with standard cubic samples, because we shouldn't consider the stress field inhomogeneity induced by the corners. Moreover, we can set 3D-loading by this setting. Also the sample diameter is big enough (43cm) for placing several wells: the fracturing well in the center and injection and production wells on two opposite sides of the central well.
The experiment consisted of several stages: a) applying the horizontal pressure; b) applying the vertical pressure; c) water solution injection in the injection well with a constant pressure; d) the steady state obtaining; e) the oil injection in the central well with a constant rate. The pore pressure was recorded in the 15 points along bottom side of the sample during the whole experiment.
We observe the pore pressure change during all the time of the experiment. First, the pore pressure changed due to water injection. Then we began to inject oil in the central well. We compared the obtained experimental data on the pore pressure changes with the solution of the 2D single-phase equation of pore-elasticity, and we found significant difference. The variation of the equation parameters couldn't help to resolve the discrepancy. After the experiment, we found that oil penetrated into the sample before and after the fracture initiation. This fact encouraged us to consider another physical process - the oil-water displacement. Have taken into account the phenomenon, we could find the parameter values for the best matching the experimental data with the analytical one. After such a comparison, we could estimate the permeability variation in the different directions due to changes in the pore pressure during fracturing. Thus it was found that for the correct solution of hydrodynamic problems in relation with hydraulic fracturing (for example, to estimate the production rate of the fractured well) one should take into account the change of the permeability in the vicinity of the fracture and solve nonlinear pore-elasticity problem.