DGMK/ÖGEW-Frühjahrstagung, Fachbereich Aufsuchung und Gewinnung
Celle, 5./6. April 2017

History matching and preliminary optimization of the whole process from multiple hydraulic fracturing till production in a tight gas horizontal well using the newly developed THM-simulator FLAC3D^{plus}/TMVOCMP

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Abstract

In the frame work of the running DGMK-680-IV "Optimization of a complete fracking-operation for the maximum productivity from a tight gas reservoir" the already well developed simulator FLAC3D^{plus} is extended with the heat transport model and gel breaking model, in order to do the history matching of the fracturing phase as well as optimize the hydraulic fracturing in tight gas wells. In this paper the simulator has been used to study the 4 fracturing stages of a horizontal well Z in a real tight gas reservoir XYZ in the Northern German Basin. With the developed model temporal evolution of fracture geometry including fracture height, length and width, bottom hole pressure, proppant distribution, fluid leak-off, viscosity change of the injection fluid, temperature change of the injected fluids and reservoir formations, fracture conductivity have been simulated. The simulated fracturing results are comparable with the treating pressure measurement. The performance from the 1st to 4th fracturing stage becomes better and better, because of significantly larger and larger the contact surface of fractures to the reservoir (lateral and vertical).
The subsequent researches were focused on the optimization of the 3rd fracturing stage. Numerical simulations were carried out with different design parameters, including proppant type, viscosity of the injection fluid and injection time to obtain their sensitivities. The simulation results show that the influences of proppant type on fracture geometry and fracture conductivity is larger than that of viscosity of the injection fluid, while the influences of the injection time are the smallest.
In order to maximize the productivity of the above mentioned tight gas wellbore, we coupled the new developed simulator FLAC3D^{plus} with the numerical simulator TMVOCMP for the simulation of the gas production. TMVOCMP is developed by Lawrence Berkeley National Laboratory (LBNL) for three-phase non-isothermal flows of multicomponent hydrocarbon mixtures in saturated/unsaturated heterogeneous media. The linked simulator FLAC3D^{plus}/TMVOCMP considers the coupled thermo-hydro-mechanical effects. The change of stress tensor and the fracture conductivity during gas production are also taken into account. A full 3D reservoir model is generated, including the four created fractures. The from measured treating pressure derived bottom hole pressure was used as input for the stress sensitive reservoir simulation. According to the results, the simulated production rate matches well with the in-situ measured data. The gas production with hydraulic fractures from varied proppant type and injection plan will be studied with the coupled simulator in the near future. Based on that an optimized strategy for the hydraulic fracturing operation will be proposed with regard to the maximum productivity from a tight gas reservoir.