Water hammer signatures in well dynamics

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A water hammer signal arises in hydraulic systems after the sudden change in fluid velocity. It consists of a series of pressure pulses and frequently occurs during hydraulic fracture treatment. The analysis of water hammer signatures (amplitude, period, duration, decay rate etc.) can provide additional diagnostic information on fracture geometry. In number of recent papers, the analysis is based on the resistance-capacitance-inertance (R-C-I) circuit analogy (Patzek et al., 2000; Carey et al., 2015; Hwang et al., 2017). The utility of water hammer diagnostics to determine correlations between the water hammer signature and fracture treatment conditions is discussed for a large dataset in (Iriarte et al., 2017)

In the presentation we develop a mathematical model of a wave packet formation due to rapid shut-in of water injector connected by the long conduit with a fluid-filled reservoir [1]. The simple mathematical model based on the Helmholtz resonator approach is considered. Numerical solutions of this model for different types of wellbores and boundary conditions have been obtained and comparisons between the experiments and numerical simulations have been performed. It is shown that some examples of water hammer events published in the above mentioned papers can be fully reconstructed from the fracture treatment data. In this case the main water hammer signature doesn't give any additional information about fracture dimensions comparing with other data registered on the surface during the treatment. We are focused on the problem of optimal parameters choice to provide the good accordance between numerical and experimental data for different types of wellbores.

References

[1]   Liapidevskii V.Yu., Neverov V.V., Krivtsov A.M. *Mathematical model of water hammer in a vertical well.* Siberian Electron. Math. Rep. 2018. V.15. P.1687-1696.