Investigations of seismic emission and shut-in pressure behavior during micro-hydraulic fracturing of plexiglass

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The article reports the data of a lab test of longitudinal and transverse hydraulic fracturing carried out on a block made of organic glass. The average breakdown pressures in plexiglass were 21.71 ± 5.09 and 16.01 ± 4.39 MPa with a confidence level of 0.9 under longitudinal and transverse hydraulic fracturing, respectively. For the analysis of the obtained results, pressure drop graphs were used, as well as the shape and amplitude spectra of seismic impulses obtained during the formation of a crack [1].

The following features are typical for all seismograms for the longitudinal fracturing: a) since the fracture initiation and sharp drop in pressure, a short seismic impulse with 1-2 periods long is formed with the main oscillation frequency of 58–79 Hz; b) by the end of the sharp pressure drop, continuous oscillations with a frequency of 13–25 Hz and 10-12 periods long occur with a maximum amplitude higher than at the previous stage; c) in some tests, after a sharp drop in pressure, a slight increase in pressure is observed. In case of the transverse hydraulic fracturing, the first high-frequency impulse is absent, and the low-frequency one is much weaker than during the longitudinal fracturing; its onset falls at the slight rise in the pressure after its sharp decline.

Based on the propagation velocities of elastic waves in plexiglas block and the time of impulse registration, it is established that the observed low-frequency impulse is not associated with the destruction of plexiglas, and that the main seismic energy is radiated after the crack creation. The probable source of such prolonged emission is the oscillations of the crack edges when it is filled with fluid and interacting with the elastic volume of the hydraulic system of the fracturing equipment. This is evidenced by a surge in pressure after a sharp decline, as well as the nature of the observed seismic emission in tests. Research in this direction is of considerable practical interest for the development of microseismic monitoring of hydraulic fracturing process [2].

References

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