Concurrent acoustic and deformation monitoring of a hydraulic fracture in a laboratory experiment

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The results of laboratory experiments on concurrent active acoustic and deformation monitoring of a hydraulic fracture are presented. The experiments were carried out in different types of model materials made on the basis of gypsum. In one case, a homogeneous material was used, in the other case, the model material contained marble chips. Also, for comparison, reference experiments were carried out to study the passage of ultrasonic waves through a liquid-filled gap of controlled width between two precision glass plates.

The main purpose of the experiments was to study the dependence of the amplitude of the ultrasonic wave passing through the crack on its aperture. In these experiments, a pre-formed circular hydraulic fracture was used, the plane of which was perpendicular to the axis of the cylindrical specimen. A cased injection well was located along the same axis, ending at the middle of its height. The sample diameter was 104 mm and the height was 60 mm. The sample itself was located between two aluminum alloy disks equipped with piezoceramic transducers built into them, operating both in the emitter and receiver modes. Through the channel in the lower disk, the working fluid was supplied to the fracture. The sample was saturated with pore fluid through the upper disk. The entire assembly was placed in a hydraulic press providing a constant compressive force. The crack aperture varied depending on the flow rate of the fluid supplied to the center of the crack and was measured by the relative change in the distance between the disks of the assembly using inductive displacement transducers.

Based on the results of the experiments, the dependences of the amplitude of the ultrasonic wave passed through the crack were established, depending on its aperture for materials with different degrees of crack surface roughness. The results obtained will allow us to estimate the value of hydraulic fracture aperture in laboratory experiments conducted on larger samples using active acoustic monitoring.