

Active and passive acoustic monitoring of hydrofracture in laboratory experiment

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Results of laboratory hydrofracking experiments with the use of passive and active acoustic hydrofracture monitoring are presented. Experiments were conducted with the use of 3D loading unit. Depending on the values of compressive stresses along different loading axes differently oriented hydrofractures were produced. There might be fractures located along borehole as well as perpendicular to it. Piezoelectric transducers were mount in the 3D loading unit covers. They are capable of receiving acoustic emission pulses caused by internal processes in the model collector as well as ultrasonic pulses from transducers that operate as transmitters.

Solving of location problem gives spatial locations of acoustic emission sources and the instants of time of pulse emissions. Acoustic emission sources were found in the vicinity of longitudinal hydrofracture moving away from borehole during experiment. Assuming sources were located nearby fracture tip, velocity of fracture propagation was estimated.

During active acoustic monitoring transmitter sends ultrasonic pulses in certain equal time intervals. When fracture intersects transmitter-receiver line, this causes received signal change. Transmitters and receivers locations directly in the experimental unit covers result in parasitic reflections of transmitted signal complicating received waveform. The undisturbed parts of received records were selected on the basis of reflected and refracted ultrasonic waves analysis and compared with each other. The sum of amplitude squares was used as integral criterion for this comparison, that increase the sensitivity. Hydrofracture intersects several tracks transmitter-receiver during propagation giving rise the opportunity to estimate it's velocity.

Conducted experiments demonstrated both methods of acoustic monitoring allow to receive important information on hydrofracture propagation. But it should be taken into account that passive monitoring in the case of weak acoustic emission not well operates in certain model materials. Also it demands considerable computing power complicating real-time usage. Active monitoring is less dependent from model medium properties, and in certain cases with the use of received ultrasonic pulses visualization allows to observe hydrofracture position during experiment.