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Hydraulic Fracture Testing

Accurate simulations that ensure fractures are not left to chance

At the TerraTek* Geomechanics Laboratory Center of Excellence, laboratory-scale hydraulic fracturing experiments provide a realistic simulation of conditions that are typically encountered in the field. This continually refined service is recognized as one of the leading providers of testing expertise and capability.

POLYAXIAL CELLS

As part of its Drilling and Completions Laboratory, the TerraTek center has polyaxial test systems designed for use in hydraulic fracturing, perforating, and acidizing experiments. Two polyaxial cell sizes are used:

- Large—tests blocks up to 30 × 30 × 36 in.
- Medium—tests blocks up to 11 × 11 × 15 in.

These test cells are able to apply three principal stresses independently, along with pore pressure, to simulate in situ stress conditions.

TESTING SAMPLES

Testing can include perforated and openhole completions, as well as simulated borehole geometries including vertical, inclined (both vertical and azimuthal deviation), and horizontal wellbores. Almost any fluid may be run in the test cells; the TerraTek center has run fluids ranging from water to 1×10^6 centipoise fluids. Proppants, lost circulation materials, weighting agents, and other additives may also be included in the fluids as specified by testing requirements.

Acidizing experiments can also be performed in both of the test cells. Post-test analysis of the wormholes produced is accomplished with computerized axial tomography (CAT) scanning of the blocks, along with visual imaging using a borescope.

Testing is performed in samples of outcrop rocks that are selected to be representative of typical formations encountered when exploring for oil and gas. The TerraTek laboratory has identified a variety of different sandstones, carbonates, and shales with a wide range of mechanical properties and mineralogy for use in these tests.

Block broken open to reveal hydraulic fracture surface; from experiment by Casas et al.

System Specification	Maximum Value
Large polyaxial stress frame	
Vertical stress	8,000 psi [55 MPa] (using flatjacks) or 4,600 psi [32 MPa] (using actuators)
Horizontal stress	8,000 psi [55 MPa]
Difference in vertical stress	2,000 psi [14 MPa] (with one axis at maximum vertical stress)
Temperature	135 degF [57.2 degC] at the block
Medium polyaxial stress frame	
Vertical stress	4,600 psi [55 MPa]
Horizontal stress	3,000 psi [21 MPa]
Temperature	165 degF [73.9 degC] at the block
Injection system	
Injection pressure	12,000 psi [83 MPa]
Injection flow rate	2.6E–04 to 3.9 galUS/min [1 mL/min to 15 L/min]
Injection volume	0.8 galUS [3 L]
Pore fluid pump	
Pressure	3,000 psi [21 MPa]
Flow rate	0.6 galUS/min [2.2 L/min]

Testing specifications.

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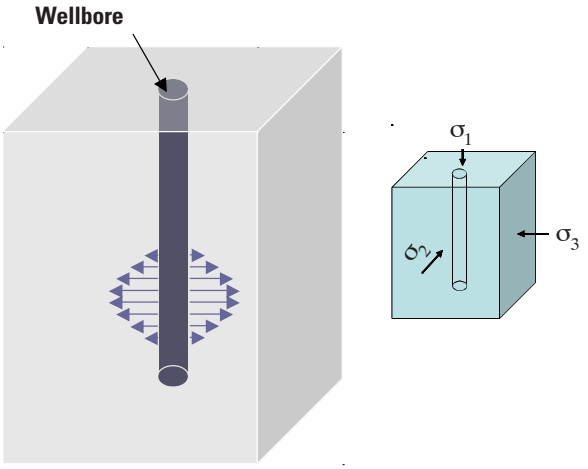
FIELD STUDIES

One TerraTek experiment studied the effects of fracturing across discontinuities. This study concluded that the test produced similar fracture growth to field conditions in the artificially produced discontinuities. The planar growth of the fracture was consistent with predicted trends obtained from 3D modeling, even as they propagated across rock-like discontinuities (Casas et al., 2006).

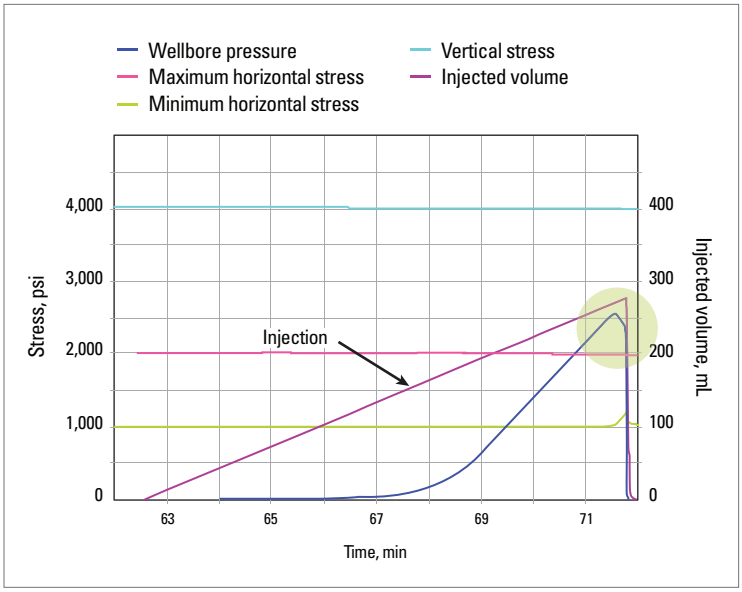


General setup of polyaxial block test for hydraulic fracturing and acidizing experiments.

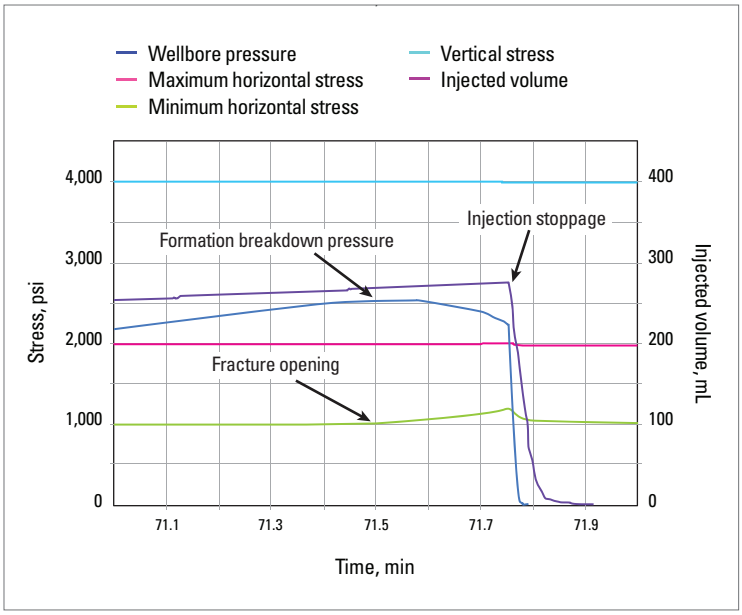
The TerraTek laboratory is developing microseismic monitoring techniques for use in the polyaxial block tests. Monitoring the microseismic events produced during hydraulic fracturing identifies the initiation and propagation of the fracture in real time. Postprocessing of the microseismic data provides valuable information by localizing the microseismic events and correlating those events with the actual fracture surface produced.

Other studies performed in the TerraTek polyaxial test cells include

- cuttings reinjection by Guo et al. (2006) and and DEA Project 81
- fracture propagation during water injection by Suárez-Rivera et al. (2002)
- propellant fracturing by Wieland (2006).



Typical hydraulic fracturing test results.



Detail of fracture initiation and growth.

References

Casas, L. et al.: "Laboratory Hydraulic Fracturing Test on a Rock With Artificial Discontinuities," paper SPE 103617 presented at the SPE Annual Technical Conference and Exhibition, San Antonio, Texas, USA (September 24–27, 2006).

Guo, Q. et al.: "Assurance Increased for Drill Cuttings Re-Injection in the Panuke Field Canada: Case Study of Improved Design," paper SPE 59118 presented at the IADC/SPE Drilling Conference, New Orleans, Louisiana, USA (February 23–25, 2000).

Suárez-Rivera et al.: "An Experimental Investigation of Fracture Propagation During Water Injection," paper SPE 73740 presented at the International Symposium and Exhibition on Formation Damage Control, Lafayette, Louisiana, USA (February 20–21, 2002).

Wieland, C.W. et al.: "Results of a Laboratory Propellant Fracturing Test in a Colton Sandstone Block," paper SPE 102907 presented at the SPE Annual Technical Conference and Exhibition, San Antonio, Texas, USA (September 24–27, 2006).

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