AutoLab 3000

There is growing interest in rock–fluid chemical interaction at in situ reservoir conditions. Typical triaxial systems are heated externally. If the pore fluid is heated before entering the pressure vessel, heating tapes are usually employed. This is cumbersome and produces unsatisfactory temperature control. Taking note of most core flood systems where the fluids entering the coreholder are heated in the same furnace as the test vessel, NER developed a unique triaxial apparatus, the AutoLab 3000.

The unique design of the AutoLab 3000, housing the vessel and the pore pressure intensifiers in a furnace capable of heating the system to 150°C, ensures that the fluids entering the pressure vessel are at the same temperature as the rock.

The AutoLab 3000 is a custom system ca pable of handling whole core at 100 mm (4.00 inches) in diameter and smaller at confining and pore pressures to 140 MPa (20,000 psi). Typical pore fluids commonly used in the system include brine, CO_2, gas, and oil. The output volumes of the pore pressure intensifiers range from 59 cm^3 (3.6 in^3) to 482 cm^3 (29.5 in^3). Each intensifier can be configured for automatic recycling, an important feature for fluid substitution and continuous flow experiments. The maximum force developed in a whole core system is 3,560 kN (800,000 pounds).

The AutoLab 3000 supports all the deformation, velocity, resistivity, and permeability options available for the AutoLab series. This platform incorporates a large number of high-pressure electrical feedthroughs to facilitate additional experiments such as monitoring

fluid propagation in a specimen using numerous transverse velocity and resistivity measurements or collecting and locating acoustic emissions as a core is stressed to failure.

AutoLab software controls the loading path and temperature profile during each test, stores the test data, and processes the results at the conclusion of the experiment. As an option, custom software can be developed to further process data from complex experiments.

The AutoLab electronics console, standard on all NER systems, can be expanded to incorporate a large number of temperature, velocity, and resistivity measurements. This flexibility in system design, software development, and electronics support ensures the customer of a near turnkey system to support immediate needs and provides for future development of additional more complex test protocols.

Key Features

- Deformation experiments for conventional and specialized loading paths
- Pore volume compressibility
- Servo-hydraulic control of strain rate, force, confining pressure, pore pressure, and flow rate
- Pore pressure intensifier compatible with water, brine, oil, and gas (including CO_2)
- Strain measurement with either LVDTs or strain gauges,
- Reservoir temperatures and pressures
- Integrated electronics console for servo amplifiers and signal conditioning
- Autolab software for system control and data acquisition

Coreholders for the System

PS2 Ultrasonic Transducer

These coreholders measure one compressional and two orthogonally polarized shear waves at confining pressures, pore pressures, and temperatures appropriate for each system.

Steady State Permeability

For these measurements, a constant pore pressure gradient across the sample is controlled. The pressure difference across the sample and pore fluid flow rate are used to compute permeability. This method requires two pore pressure intensifiers with automated recycling. The standard configuration is designed for permeabilities between 0.1 and 500 millidarcies.

Transient Permeability

Developed at NER, this technique measures fluid permeability at in situ conditions. The method involves the control of a complex transient in pore pressure at the upstream side of the sample while monitoring the pore pressure response at the downstream end. Permeability is computed by fitting the response to analytical solutions.

Low Permeability

Utilizing a special CO_2 holder with a small dead volume and integral pressure transducer, the standard configuration is designed for low permeability materials of 5 nanodarcies to 50 microdarcies. This option use NER's complex transient method for permeability analysis, allowing use of customizable pressure transients as well as more traditional sinusoidal oscillation and pulse decay.

Complex Electrical Impedance (Formation Factor)

Resistivity is measured as a function of frequency, stress, and temperature using both two and true four electrode techniques. NER's ZMeter impedance analysis is used to perform true four electrode measurements at frequencies between 0.02 Hz and 100 kHz.

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