Typical Specifications - Electrical Resistivity Test System

Test Cells:
- Maximum confining pressure: 15,000 psi (100 MPa)
- Maximum sample temperature: 300 F (150 C)
- Maximum sample size: 1.5” dia. x 3.0” (3.81 dia. x 76.2 cm)
- Optional whole core size: 4.0” dia. x 7.0” (10.16 dia. x 17.78 cm)

Sample Stack Assembly:
- Sample Diameter: 1”, 1.5” or 4” (2.54, 3.81, or 10.16 cm)
- Sample Length: 2”, 3”, or 7” (5.08, 7.62, or 17.78 cm)
- End cap material: Hastelloy C
- Porous plate breakthrough pressure: 225 psi (15 bar)

Pore Pressure/Desaturation System:
- Air-Brine with no back pressure
  - Gas reference volume: 30 cu in. (500 ml)
  - Pore pressure transducer range: 0-200 psi (0-1.4 MPa)
- Oil-Brine with back pressure control
  - Maximum pore pressure: 5,000 psi (35 MPa)
  - Differential pressure range: 200 psi (1.4 MPa)
  - VPA volume: 1.31 cu. in. (21.5 ml)
  - VPA volume resolution:
    - Encoder: 3.5 x 10^-7 ml
    - Display: .01 ml
    - Max VPA flow rate: 20 ml/min.

Electrical Resistivity Measurement:
- AC frequency range: 1 KHz to 20 MHz
- Voltage measurement accuracy: .001 V
- Phase angle measurement resolution: .01 Deg

DCI Corporation design engineers have over 25 years experience in designing and producing laboratory test systems for rock mechanics and core analysis applications. Using a combination of standard and custom-designed system components, systems can be produced to meet exact customer requirements at a reasonable cost.

Typical Tests at Simulated Reservoir Conditions

Based on proven test procedures and techniques, core samples subjected to pressure and temperature simulating reservoir conditions can be tested for a wide variety of properties including:
- Permeability
- Relative Permeability
- Electrical Resistivity
- Ultrasonic Velocity

Typical System Components

Basic elements that can be used to configure a laboratory test system:
- Test Cells. Contain the test sample and create the pressure/temperature environment to simulate reservoir conditions. Include electrical and fluid penetrations to connect to external elements in the system.
- Pressure/Temperature Control System. Controls pressure inside the test cell and test cell temperature.
- Test Sample Stack Assembly. Test sample, jacket, end caps, fluid connections, etc. required for the specific test.
- Pore Pressure/Desaturation Modules. Pumps, transducers, pressure control devices, etc. to control pore pressure in the sample or flow through the sample.
- Automated DAQ and Test Control. Signal conditioning electronics and test-specific software for data acquisition and test control.
Electrical Resistivity Test Systems

These systems are designed specifically to make electrical resistivity measurements on core samples at simulated reservoir conditions. The systems can be configured from a wide variety of standard and custom modules to meet specific testing requirements.

Test Cells
The test cell creates the pressure/temperature environment around the test sample to simulate reservoir conditions. The test sample assembly is suspended from the upper test cell closure. This upper closure provides feed-throughs into the test cell for pore lines to either end of the sample, for thermocouples to monitor temperature of the test sample assembly, and for electrical connections to the potential and current electrodes on the test assembly. Each test cell in the system can be used to conduct an independent test, at unique reservoir conditions.

Test Cell Pressure/Temperature Control System
A common pressure control cart allows each test cell in the system to be filled, pressurized, and drained separately. Each test cell has a pressure/temperature control panel. This panel allows the individual test cell to be isolated from the test of the system at the desired confining pressure. It also contains the temperature controller for the test cell heaters.

Pore Pressure Control and Sample Desaturation System
Maintaining precise differential pressure control across the sample is critical to achieving the equilibrium points necessary for accurately determining the saturation exponent (n) in electrical resistivity measurements. Several options are available to control the de-saturation pressure across the sample.

Air-brine Desaturation without Back Pressure
The simplest system uses a gas volume on the upstream side of the sample to maintain a constant pressure. The downstream side of the sample is simply open to atmosphere. A variation on this configuration places a gas/oil separator between the gas volume and the sample, allowing oil to be used as the displacing fluid in the sample.

Oil-brine Desaturation with Back Pressure
For sample temperatures above the boiling point of brine, or for tests with higher pore pressure, a back pressure control system is required. DCI’s unique VPA combines the capability of a precision digital back-pressure regulator with that of a precision automated volume measurement instrument. The VPA uses feedback from a differential pressure transducer to maintain precise differential pressure across the sample, even if upstream pressure varies during the test. In addition, the VPA measures the volume of pore fluid produced by the test sample to the nearest 0.01 cc and reports the value to the automated DAQ system. A high pressure insulating coupling (HPIC) provides electrical insulation between upstream and downstream portions of the pore pressure system.

Test Sample Assembly
The test sample assembly includes a sample end cap at each end of the core sample. One end cap includes a porous plate that is permeable to brine but not to gas (or oil) at typical test differential pressures. The end caps and core sample are enclosed in a rubber jacket which isolates the assembly from the confining fluid in the test cell. Two potential electrode wires are embedded in the rubber jacket, along the length of the core sample.

Electrical Resistivity Measurement Electronics
A common electrical resistivity measurement electronics system measures the electrical resistivity of the core sample in each test cell in the system at an operator-specified test interval. An ER-8 switch box switches the connections from the measurement system to each of up to eight test cells in the system. For systems with more that eight test cells, additional ER-8 switch boxes can be added.

Electrical resistivity measurements require that an alternating current be applied to the sample, that the current through the sample be measured, and that the voltage and phase be measured relative to ground (one sample end cap), at the other sample end cap and at the two potential electrodes along the length of the sample. These measurements allow a “2-pole” measurement from end cap to end cap, and a “4-pole” measurement between the two potential electrodes.

Automated DAQ and Test Control System
The PC-based DAQ and test control system allows the operator to define a unique test for each test cell in the system. At operator-specified intervals, the system automatically measures the electrical resistivity of the sample in the specified test cell, and records that measurement along with other test conditions (confining pressure, temperature, pore pressure, etc.). For systems where pore fluid produced is measured manually, the operator can enter volumes associated with specific electrical measurements. For systems using VPAs for measurement of pore fluid volume production, these values are read and recorded automatically. Current test status and data, as well as data history can be viewed by the operator. Data can be exported to a spreadsheet template where much of the data reduction and display is done automatically.
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