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Tender specifications of Gas Hydrate Multi-Stress Permeability testing System

Gas Hydrate Multi-stress Permeameter system: A gas hydrate triaxial testing system to generate insitu stress conditions and simulate fluid flow across artificially created methane hydrate samples at different saturations.

1. **Load frame**
   Electromechanical load frame, load: ≥150 kN, stroke: >= 125 mm , position and speed control for closed-loop control of strain- stress or displacement (position, Speed range: 0,00001 to 60 mm/min; speed closed-loop controlled motor drive with low backlash for a wide speed range, high stiffness; integrated control panel with a touch-sensitive keyboard, graphic test display and 4 free analogue ports with A/D converter (interface + - 10 VDC); testing area: minimum 400x1300 mm; ethernet connection to PC for data analysis, sliding base extension set for easy movement of triaxial cells into loading area, emergency stop button and different limit stops (to be implemented in software)

2. **Load Cell**
   - External load cell, 150kN, accuracy: 0.1 % F.S, Amplifier output 0-10 V, 200 % overloading safety
   - High pressure submersible load cell, 150kN, Amplifier output 0-10 V, 200 % overloading safety

3. **Displacement Transducers**
   Linear displacement transducer, range: 0 - 50 mm, with mounting block and cable, repeatability: <0.002 mm, protection: IP 40

4. **High Pressure-Low temperature Triaxial cell**
   - Triaxial cell up to 70mm sample diameter suitable for different kind of triaxial tests and stress path tests, confining pressure：≥50 MPa, axial loading: ≥150 kN, exchangeable feed-through for (coaxial, hydraulic or multi-wire) ≥8, Sample size: exchangeable diameter up to 70mm and double height; temperature operation: range from -15°C to +40°C, accuracy: 0.1°C
   - Double-wall system for high accuracy in specimen volume measurement suitable for diameter of 50 mm
   - Set of adapter platens for 70mm and 50mm sample size for permeability and triaxial tests comprising hardened upper and lower endcaps, upper spherical endcap guidance and set of seals
   - Sample preparation kit for 70 mm dia. incl. 2-part split former for no cohesive materials, suction sleeve device for cohesive materials, O-ring stretcher, 100 filter paper, 20 membranes
   - Sample preparation kit for 50 mm dia. incl. 2-part split former for no cohesive materials, suction sleeve device for cohesive materials, O-ring stretcher, 100 filter paper, 20 membranes
   - Temperature control package for range from -15°C to +40°C, accuracy: 0.1°C including of hardware, software and internal cell temperature sensor for closed-loop control of heating, temperature insulation system

5. Internal Sensors:

- In-vessel axial-strain transducer set for specimen-diameter up to 70 mm including attachment kit for travel range of 20mm and 2 LVDT sensors, linearity: 0.1 % F.S. ; working pressure range : up to 50 MPa , working temperature range: -15°C to 40 °C
- Including electrical feed-through and quick-coupling connectors
- Submersible local circumferential strain measuring devices for specimen diameter from 50 to 70 mm includes a high accuracy LVDT transducer; measuring range: +/- 2.5 mm, resolution: +/- 0.0001 mm, working pressure range: up to 50 MPa , working temperature range: -15°C to 40 °C, Including electrical feed-through and quick-coupling connectors

6. Confining Pressure Controllers:

- Automatic stainless steel pressure and volume controller, electromechanical type, Max. pressure: ≥30 MPa, volume capacity 400 ml, closed-loop control resolution: ≥ 0.001 MPa, pressure accuracy: 0.1 % F. S , volume accuracy: 0.1%, volume accuracy: 0.0001ml (0.1 mm3)
- Twin pump with 2 independent controlled pressure outlets for inner and outer cell
- Integrated limit switch and pressure over load limits, emergency stop button,
- Integrated controller with touch panel and graphic test display including input keys
- Automatic volume measurement and volume calibration using system calibration storage function
- Ethernet and serial port with ASCII or LabView protocol
- Calibration data input via the integrated keyboard with password protection and permanent storage
- Includes integrated limit switches and pressure overload limits (safety stop)

7. Multiphase including gas control and monitoring system:

For pressurized dissolved methane in sea water/ water up to 30 MPa for hydration of sample including pressure vessel (gas-water equilibrator), pressure panel with distribution, connections, required valves, mixing and circulating unit and etc. Required for injection of dissolved methane in water into the sample and measuring and controlling the flow volume of input media to the sample. Facility shall be able to handle sea water compositions. Manufacturer must give enough technical specifications and photo for this item.

8. Two High Pressure Single Piston Pump:

- Corrosion resistant stainless-steel syringe pump, electromechanical table type with servomotor drive
- Max. pressure range: 30 MPa, pressure resolution 0.01 MPa, accuracy (standard): < 0.1 % (Temperature compensated)
- Volume (standard): 650 ml, Max. flow rate: 235 ml/min , min flow rate: 0.0001 ml/min
- Flow accuracy: 0.0002% , min. flow rate/resolution: 0.00001ml/min
- Digital volume resolution: 0.000001 ml
- Fluid temperature control system
- Graphical touch screen and keypad for standalone use
- Output serial and Ethernet interface

9. High Pressure Twin Piston Pumps:

- Corrosion resistant stainless-steel twin syringe pump, electromechanical table type with servomotor drive
- Max. pressure range: 30 MPa, pressure resolution 0.01 MPa , accuracy (standard): < 0.1 % (temperature compensated)
- Volume (standard): 2 x 650 ml, Max. flow rate: 235 ml/min , Min flow rate: 0.0001 ml/min
- Flow accuracy: 0.0002% , min. flow rate/resolution: 0.00001ml/min
- Digital volume resolution: 0.000001 ml
- Fluid temperature control system
- Graphical touch screen and keypad for standalone use
- Output serial and Ethernet interface

10. Automatic continuous flow system

Pressure system must be capable to apply automatic continuous flow including automatic valves, automated switching, high pressure fittings, software module etc.

11. Anti-clogging system.

System must be capable to counteract blockage buildup in injection ports for pore fluid at the top and bottom of the sample during the test

12. T-Profile measuring system

Measurement of T profiles or local temperatures inside sample with temperature sensors inside of the sample at different level or positions (up to 6 numbers) including the data logger

13. Coupled acoustic emission setup and seismic velocity measurement system

Acoustic emission set up along with seismic velocity measurements.
Ultrasonic system of up to 180 kHz bandwidth receiver, P and S wave velocity measurement including electronic, master signal conditioning system and control and data acquisition, software and ultrasonic adaptors for 70mm and 50mm sample size (top and bottom), pressure resistance up to 20MPa

14. Water de-airing unit

Water de-airing system to produce de-aired water with water trap, water atomizer, vacuum pump, switch panel, gauge, suction and tapping hoses; suitable for table and wall mounting, capacity 20 L.

15. Control and data acquisition software

- Fully automatic multi-channel triaxial control and data acquisition software, operating system: Windows version including different test stages e.g.:
  - consolidation stage (isotropic or anisotropic)
  - saturation stage
  - B-value check control
  - B Check, saturation ramps, isotropic consolidation
  - saturation ramps of cell pressure and back pressure
  - Standard triaxial testing: UU, CU, CD with pore pressure measurement.
  - unconsolidated - undrained with pore pressure measurement
  - consolidated - drained with pore pressure measurement

  - all shear stages (compression and extension tests for simulating all kinds of stress-paths
  - Permeability tests for samples at various hydrate saturations.
- Real-time control for all connected control axis or measuring channels
- Specialized procedure for various formation scenarios for gas hydrate tests (the manufacturer must give this information in their offer).

16. Accessories:

- The system must have an external automatic flow metering system.
- 2 temperature sensors and accessories to be connected to the inlet pressure line for measurement of temperature for inner and outer cell
- All valves, tubes connectors and accessories for tubing in the entire system
- Pump for cell fluid to fill triaxial cell and relevant fittings
- The system has to operate tests to form pure gas hydrate powders from ice for formation of gas hydrate in clays. The manufacturers have to give their own solution for this item.
- The system must have electrical resistivity measurement system at top and bottom caps and around the center.
- Complete set of O-rings and seals
- Automatic lifting system

17. Required items with applicable terms and conditions:

- **Drawing:** Manufacturer has to submit schematic drawing of the unit in details including the hydraulic and flow plan.
- **Warranty:** At least 18 months from the date of commissioning. For free replacement of defective parts, taxes and import duties are to be borne by the supplier.
- **Installation and training:** By engineer of the manufacturer at end-user site and training for at least 5 days after installation.
- **Consumables:** All equipment related consumables to be provided in advance for conducting standard number of tests for two years.
- **Service Support:** Remote assistance with same day response. Telephone/mail assistance when user has sufficient knowledge to attempt small repairs. Maximum onsite response time of 5 working days for both hardware and software related problems.
- **Delivery schedule:** Five months upon award of official order by IIT Bombay.
- **Eligibility Criteria:** A similar facility must have been supplied and functional in the last three years anywhere in India or abroad (Details in Previous Supply Order Format).