Physical Modeling and Real-time Recording of Fracture Propagation in Geo-materials Using a Fracture Capture Simulator

IITM Technology Available for Licensing

Problem Statement & Unmet Need

- Controlling the fracture propagation is one of the most challenging engineering problems especially in the oil and gas sector.
- Predicting the fracture orientation becomes more complex when the **medium is non-homogeneous and anisotropic** while also possessing a non-linear material response.
- One such medium is the **porous reservoir which has high leak-off potential** whose fracturing behaviour is not clearly understood.
- Thus, a novel testing technique is adopted to simulate the ground conditions in the laboratory and study the instability characteristics of geo-materials.

Technology Category/ Market

Category - Energy, Civil engineering - Geomaterials
Applications - Energy- subsurface energy extraction, Oil and gas.

Market - Global hydraulic fracturing market is valued at USD 35.38 B in 2022 and is forecasted to reach a value of **USD 61.72 B by 2030** with a **7.20% CAGR.**

Technology

Fracture capture simulator (Fig.1) capable of **applying true anisotropic boundary stress**, injecting fluid at a predefined flow rate and viscosity while imaging fracture propagation is provided.

Pressure profiles (Fig. 2) and progression of fracture (Fig. 3) are **recorded simultaneously during fluid injection process** on specimens subjected to different boundary stresses.

The fracture initiation and evolution are **analyzed using image processing**, to provide information on fracture area/ orientation, volume change of the specimen and expansion velocities evolution with respect to time during the injection event.

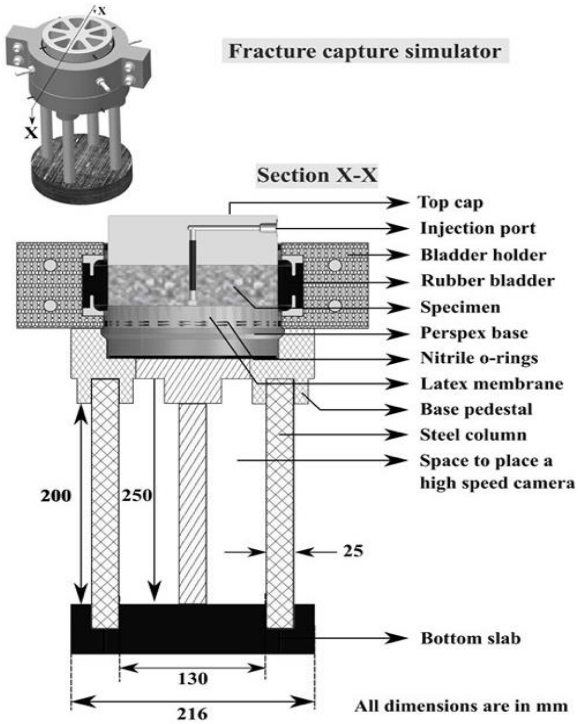

Fig. 1. Illustrates a complete sectional view of the fracture capture simulator.

Intellectual Property

- IITM IDF Ref. **2343**
- **IN 430818 - Patent Granted**

Key Features / Value Proposition

1. Applying 3D anisotropic stress field.
2. **Real-time imaging** of fracture initiation & propagation during fluid injection using imaging tools.
3. Cost efficient (compared to Neutron or CT imaging).
4. Representative specimen dimensions.

TRL (Technology Readiness Level)

TRL - 4, Experimentally validated in lab.

Research Lab

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Experimental Set-up (Fig. 4)

- Fracture capture simulator consists of **a top metal cap** which houses an injection tube through which the fracturing fluid is injected into the porous geomaterial at a predefined flow rate/ pressure.
- To apply two different horizontal stresses on the specimen, a specially designed bladder holder housing four bladders is used.
- **The bottom slab is made of transparent Perspex** where the specimen is placed, in order to capture the fracture initation and propagation.
- **The imaging setup** including the high-speed camera will be placed in-between the reaction columns to image the fracture propagation real-time after application of anisotropic stresses and injecting the fluid.
- A suite of 6 tests (3 cross-isotropic, 3 anisotropic) Fig. 3. have been performed to demonstrate that these experiments are repeatable.

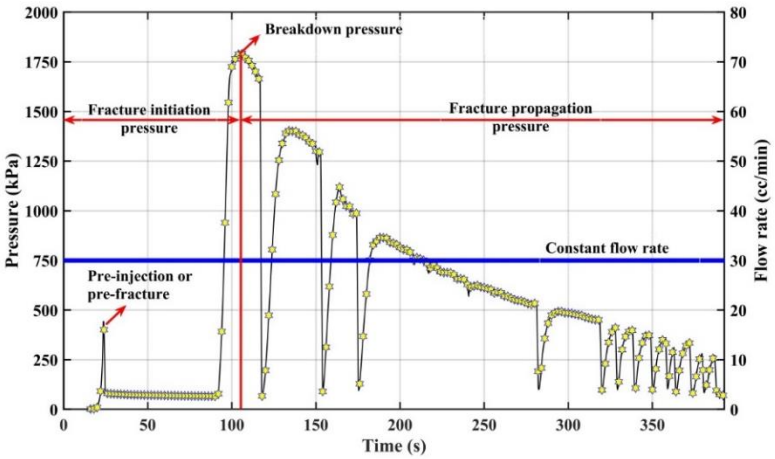

Fig. 2. A distinct pressure profile obtained during a fracture experiment after applying cross-isotropic boundary stress.

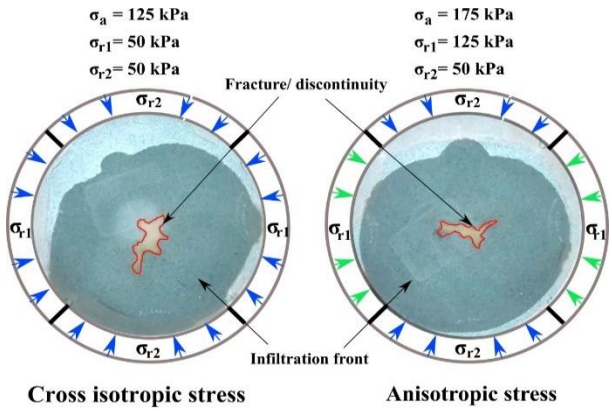

Fig. 3. Comparison of the fracture profiles obtained from cross-isotropic and anisotropic fracture tests.

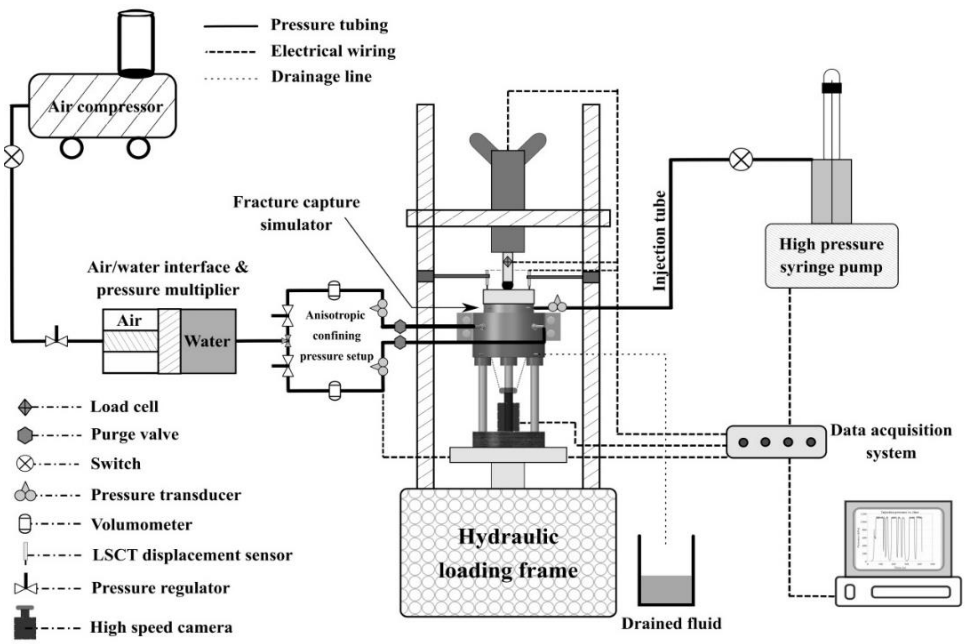

Fig. 4. Complete hydraulic fracture setup.

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