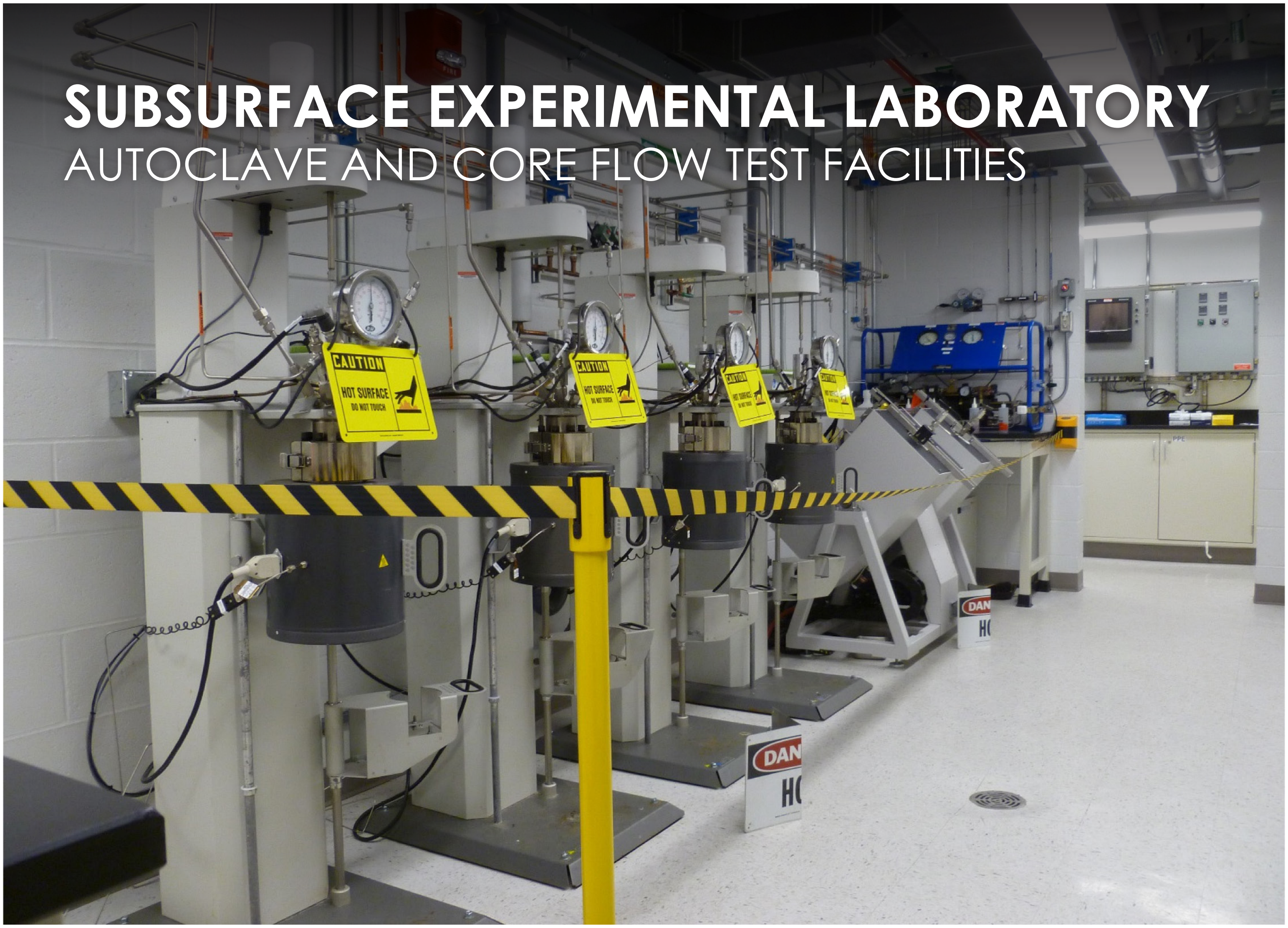
SUBSURFACE EXPERIMENTAL LABORATORY
AUTOCLAVE AND CORE FLOW TEST FACILITIES



R&D169, April 2024

NATIONAL ENERGY TECHNOLOGY LABORATORY

DESCRIPTION

Researchers at NETL study subsurface systems to better characterize and understand gas-fluid-rock and material interactions that impact environmental and resource issues related to oil, gas, and Carbon Capture and Underground Storage and Hydrogen storage development. However, studying the wide variety of subsurface environments related to hydrocarbon and CO_2 systems requires costly and technically challenging tools and techniques. As a result, NETL's Experimental Laboratory encompasses multi-functional, state-of-the-art facilities that perform a wide spectrum of geological studies. This provides an experimental basis for modeling of various subsurface phenomena and processes. This includes, but is not limited to, long-term exposure of geological samples to specific conditions such as CO_2 saturation at elevated pressure and temperature; the study of geomechanical properties and fluid behavior; and fluid-solid and fluid-fluid physical and chemical interactions. The laboratory has a wide range of tools and instrumentation to ensure a complete cycle of scientific studies. This begins with preparation of representative samples, moves through the preliminary measurements of basic properties, and culminates in the advanced investigation of the processes of interest under simulated subsurface conditions.

CAPABILITIES

The High-Pressure Immersion and Reactive Transport Facility utilizes autoclave reactors that can be equipped with various gases. The reactors have a pressure rating of 5,000 pound-force per square inch (psig) at temperatures up to 482 °F. The lab also contains a set of autoclaves for experiments at 10,000 psig and temperatures up to 662 °F in CO_2 / brine environments. Test reactors are ideally suited to investigate gas/liquid or gas/slurry interactions.

The Geological Sequestration Core Flow Facility includes two flow-through test systems with the ability to measure permeability, CO_2-enhanced oil recovery and CO_2-water-rock interaction of core samples under CO_2 sequestration conditions. Water-rock flow-through systems allow for measurement of relative permeability of various fluids to study fluid displacement in reservoir rocks under high pressure (up to 5000 psi) and temperature (up to 150 °C) conditions. These units can also be used to study flow-through fractured seal materials such as well-bore cements and caprocks. This facility also has a variety of devices used for rock characterization studies including, but not limited to, a Helium porosimeter (which measures effective porosity and grain density of a sample), both a steady state and unsteady state gas permeameter (capable of measuring gas permeabilities from .001 mD – 10 D), and a high-pressure, triaxial apparatus designed to perform petrophysical and rock mechanics experiments at reservoir conditions of overburden pressure, pore pressure and temperature (up to 20,000 psi and 120 °C).

GOALS AND OBJECTIVES

Research aimed at monitoring the long-term storage stability and integrity of CO_2 sequestered in geologic formations is one of the most pressing areas that needs to be understood if geologic sequestration is to become a significant factor in reducing greenhouse gas emissions. The most promising geologic formations under consideration for CO_2 sequestration are active and depleted oil and gas formations, brine formations and deep, unmineable carbon ore seams. Unfortunately, the long-term CO_2 storage capabilities of these formations are not well understood.

Figure 1. Six fixed-head autoclave system with PC interface.

The laboratory's goal is to better simulate the conditions found in major potential geological sequestration sites. Information obtained from laboratory testing of various rock types under a variety of controlled conditions and environments will provide information on the geotechnical effects and chemical interactions that occur when CO_2 is injected into natural rock. This information will also be used to predict potential problems that might be encountered in field-scale investigations.

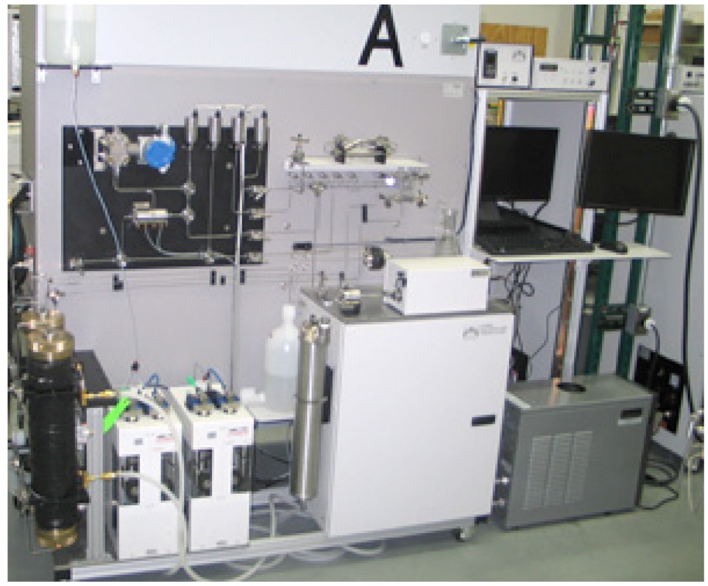


Figure 2. CFS-839Z water-rock flow-through system.

BENEFITS

To help meet a national strategic commitment to clean power generation, NETL is developing a technology base for tomorrow's highly efficient, near-zero-emissions power plants. Environmental and geosciences researchers perform laboratory-scale studies of solid, liquid and gaseous flows and their interactions. These studies are aimed at understanding the suitability of flue gases for capture and storage in industrial wastes after release from coal-fired power plants. Utilization and sequestration of greenhouse gases, such as CO_2, to mitigate global warming is a primary focus of NETL's research initiatives. The Autoclave and Geological Sequestration Core Flow Test Facilities will be instrumental in accessing the realistic potential of CO_2 geologic sequestration. Activities conducted at these test facilities will be instrumental in linking laboratory, field and modeling activities, to ensure accurate test results while optimizing resources to achieve program goals.

Figure 3. Autoclave array for studying geochemical reactions associated with Carbon Capture and Underground Storage.

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NETL is a U.S. Department of Energy (DOE) national laboratory dedicated to advancing the nation's energy future by creating innovative solutions that strengthen the security, affordability and reliability of energy systems and natural resources. With laboratories and computational capabilities at research facilities in Albany, Oregon; Morgantown, West Virginia; and Pittsburgh, Pennsylvania, NETL addresses energy challenges through implementing DOE programs across the nation and advancing energy technologies related to fossil fuels. By fostering collaborations and conducting world-class research, NETL strives to strengthen national energy security through energy technology development.

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