the ENERGY lab

PROJECT FACTS

Carbon Sequestration

Training and Research on Probabilistic Hydro-Thermo-Mechanical Modeling of Carbon Dioxide Geological Sequestration in Fractured Porous Rocks

Background

Increased attention is being placed on research into technologies that capture and store carbon dioxide (CO_2). Carbon capture and storage (CCS) technologies offer great potential for reducing CO_2 emissions and, in turn, mitigating global climate change without adversely influencing energy use or hindering economic growth.

Deploying these technologies in commercial-scale applications requires a significantly expanded workforce trained in various CCS specialties that are currently under-represented in the United States. Education and training activities are needed to develop a future generation of geologists, scientists, and engineers who possess the skills required for implementing and deploying CCS technologies.

The U.S. Department of Energy's (DOE) National Energy Technology Laboratory (NETL) has selected 43 projects to receive more than $12.7 million in funding, the majority of which is provided by the American Recovery and Reinvestment Act (ARRA) of 2009, to conduct geologic sequestration training and support fundamental research projects for graduate and undergraduate students throughout the United States. These projects will include such critical topics as simulation and risk assessment; monitoring, verification, and accounting (MVA); geological related analytical tools; methods to interpret geophysical models; well completion and integrity for long-term CO_2 storage; and CO_2 capture.

Project Description

NETL is partnering with the Colorado School of Mines to conduct research and training to develop and validate an advanced CCS three-dimensional (3-D) probabilistic simulation and risk assessment model. CCS simulation and risk assessment is used to develop advanced numerical simulation models of the subsurface to forecast CO_2 behavior and transport; optimize site operational practices; ensure site safety; and refine site monitoring, verification, and accounting efforts. As simulation models are refined with new data, the uncertainty surrounding the identified risks decrease, thereby providing more accurate risk assessment. The 3-D models will take into account the full coupling of multiple physical processes (geomechanical, thermal, and fluid flow) and describe the effects of stochastic hydro-thermo-mechanical (HTM) parameters on the modeling of CO_2 flow and transport in fractured porous rocks. Graduate students will be hired and involved in the development and validation of the 3-D model that

CONTACTS

Sean Plasynski
Sequestration Technology Manager
National Energy Technology Laboratory
626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940
412-386-4867
sean.plasynski@netl.doe.gov

Joshua Hull
Project Manager
National Energy Technology Laboratory
3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507
304-285-0906
joshua.hull@netl.doe.gov

Marte Gutierrez
Principal Investigator
Colorado School of Mines
1600 Illinois Street
Golden, CO 80401
303-273-3468
mgutierr@mines.ed

PARTNERS

None

U.S. DEPARTMENT OF ENERGY

PROJECT DURATION

Start Date
12/01/2009

End Date
11/30/2012

COST

Total Project Value
$297,505

DOE/Non-DOE Share
$297,505/$0

Government funding for this project is provided in whole or in part through the American Recovery and Reinvestment Act.

can be used to predict the fate, movement, and storage of CO_2 in subsurface formations, and to evaluate the risk of potential leakage to the atmosphere and underground reservoirs.

The scope of the project includes:

- Formulating a rigorous procedure to couple the 3-D hydraulic, thermal, and mechanical modeling of CO_2 storage reservoirs using Biot's theory for fluid flow in deformable porous media.
- Implementing a model for 3-D hydro-mechanical behavior of fractured porous rocks with random fracture geometries based on Oda's crack tensor formulation.
- Developing a Monte Carlo-based risk assessment procedure (Figure 1) for assessing the effects of uncertainties in the predictions of the fate and movement of CO_2 in storage reservoirs and the risks associated with the potential leakage of CO_2 to the atmosphere and underground reservoirs.
- Testing and validating models using available data and case histories of geological sequestration of CO_2.

Goals/Objectives

The goal of the project is to use research projects as a means to educate and train students in the science and technology of CCS, with a focus on geologic storage. The objective of the project is to investigate an advanced CCS 3-D simulation and risk assessment model that can be used to predict the fate, movement, and storage of CO_2 in underground formations, and to evaluate the risk of potential CO_2 leakage to the atmosphere and underground aquifers.

Benefits

The overall result of the project will make a vital contribution to the scientific, technical, and institutional knowledge necessary to establish frameworks for the development of commercial-scale CCS. Further, it will provide an improved understanding of the behavior of CO_2 in storage reservoirs which will supply the basis for developing a better model that can reliably and accurately predict the different hydraulic, thermal, and geomechanical process involved in the geologic storage of CO_2. It is envisioned that the project's proposed simulation and risk assessment model will become an important tool in the planning, design, and management of future CCS projects. Additionally, the project will offer research opportunities to graduate students who will be well-trained in the skills and competencies required to implement CCS technologies on a commercial-scale.

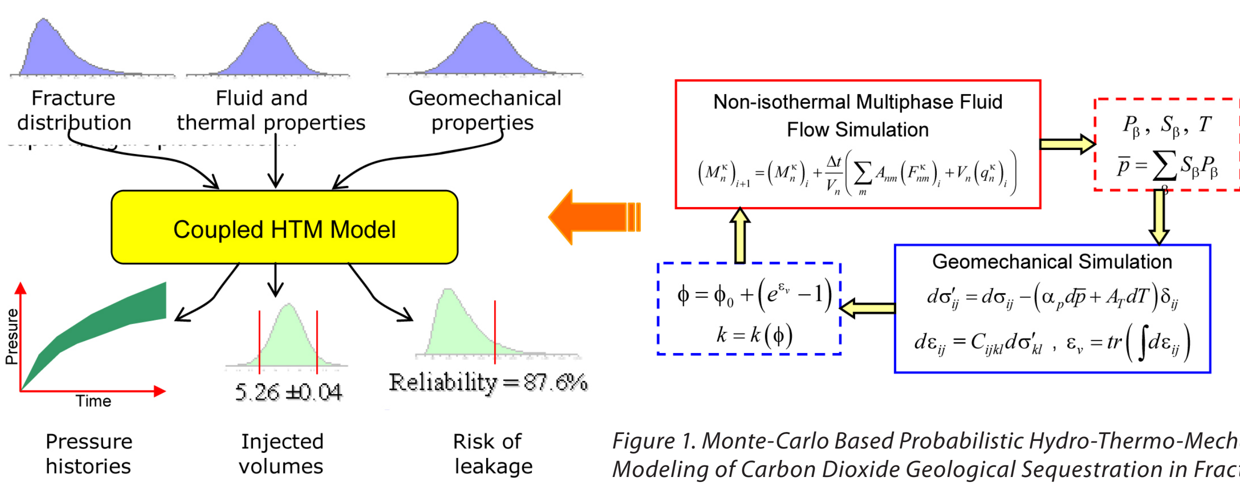

Figure 1. Monte-Carlo Based Probabilistic Hydro-Thermo-Mechanical Modeling of Carbon Dioxide Geological Sequestration in Fractured Porous Rocks.