the ENERGY lab

PROJECT FACTS

Carbon Sequestration

Maximization of Permanent Trapping of CO_2 and Co-contaminants in the Highest Porosity Formations of the Rock Springs Uplift (Southwest Wyoming): Experimentation and Multi-Scale Modeling

Background

The U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) is currently funding research to advance state-of-the-art technologies that address geologic storage of carbon dioxide (CO_2) in multiple formation types and across all phases of CO_2 geologic storage operations.

Geologic storage involves the injection of CO_2 into underground formations that have the ability to securely contain it over long periods of time. Research efforts are currently focused on several geologic storage formation types: several clastic and carbonate types, coal, organic rich shale, and basalt formations. These formations contain different fluids such as saline water and oil and natural gas. A principal element of DOE's Carbon Sequestration Program is Core Research and Development (R&D), and one of the R&D focus areas—geologic storage—is aimed at addressing the challenges of CO_2 storage in these formations.

Project Description

The University of Wyoming (UW) is using a combination of past and current research results to further investigate the most promising target for geologic storage of CO_2 in the state of Wyoming, the Rock Springs Uplift (RSU). Within the RSU are saline formations that are the focus of this study. Saline formations are deep sedimentary rock formations that contain brine (groundwater that is not considered potable because it contains more than 10,000 parts per million total dissolved solids) in pore spaces. Saline formations suitable for geologic storage of CO_2 are typically overlain by low-permeability rock that prevents upward movement of CO_2 by effectively sealing the top of the saline formation. Saline formations are promising geologic storage formations because they are quite extensive throughout North America thus representing an enormous potential for CO_2 geologic storage. However, much less is known about saline formations because they lack the extensive characterization data that industry has acquired through resource recovery from oil and gas reservoirs and coal seams. Therefore, there is a greater amount of uncertainty regarding the suitability of saline formations for CO_2 storage.

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PARTNERS

None

PROJECT DURATION

Start Date
10/1/2010

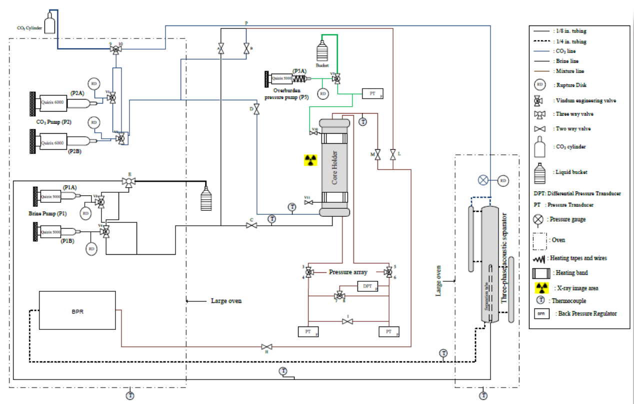
End Date
9/30/2013

COST

Total Project Value
$2,905,129

DOE/Non-DOE Share
$1,509,044 / $1,396,085

The project will include experimental and numerical modeling of the sequestration process to aid in understanding the migration and storage mechanisms related to injecting mixed supercritical CO_2 (mixed $scCO_2$) into the RSU's saline formations. Mixed $scCO_2$ is CO_2 that contains small amounts of other chemicals (sulfur compounds, nitrogen oxides, and hydrochloric acid) and exists at temperatures and pressures that give it the properties of both a gas and liquid. Capturing and storing mixed $scCO_2$ is beneficial because the CO_2 stream does not need additional purification to remove co-contaminants, which saves energy and reduces overall costs. The investigation will combine reservoir-condition core flooding experimental studies, numerical pore- and storage formation-scale modeling, and high-performance computing to investigate various large-scale storage schemes with the goal of understanding the permanent trapping characteristics for maximizing CO_2 storage in storage formations. The results of the investigation will then be used to inform reservoir-scale simulations utilizing detailed and realistic geologic models of RSU formations in order to identify schemes that maximize permanent trapping of mixed $scCO_2$ released from Wyoming coal power plants. An existing and unique experimental facility will be used to perform core flooding experiments. The chemical and physical characteristics of injected mixed $scCO_2$ must be understood in order to maximize CO_2 storage in saline storage formations.



State-of-the-art reservoir condition core-flooding system. Only two-phase configuration is shown here.

Goals/Objectives

The goal of this project is to develop a dynamic model that will aid in understanding mixed $scCO_2$ storage in the RSU. This improved understanding will help maximize CO_2 storage. This goal will be accomplished by achieving the following objectives:

- Laboratory measurement of relative permeabilities under conditions similar to those within the storage formation.
- Measurement of the delayed effects that mixed $scCO_2$ injection will have on relative permeability within the storage formation (hysteresis of permeability within the formation).
- Characterization of the ability of mixed $scCO_2$ to spread over the solid surface areas within the saline formation (the wettability of the formation).
- Development of a pore-scale model for rock samples from the RSU. The model will be validated against the permeability/wettability data obtained to provide improvements to the existing model.
- Conducting an optimization analysis of long term permanent trapping of mixed $scCO_2$ through high-resolution numerical experiments taking into account storage formation heterogeneity, saturation history, dissolution, capillary trapping, geomechanical deformation due to injection of massive quantities of mixed $scCO_2$, well location, and injection pattern.

Benefits

This research will increase the understanding of the effects of injecting mixed $scCO_2$ into deep saline aquifers. This will allow more accurate prediction of storage capacity as well as improved understanding of the effects of mixed $scCO_2$ injection on the storage formation and overlying seal. Mixed $scCO_2$ capture and storage is more efficient than other sequestration methods because it does not require additional treatment to remove co-contaminants. This reduces the energy needed for treatment and provides an overall cost savings.

Additionally, the RSU is located in the region where two coal-fired power plants produce 36 percent of the CO_2 emissions in Wyoming. The ability to utilize this formation for CO_2 storage will provide a cost-effective local mechanism for sequestering a significant amount of CO_2 from the atmosphere.