U.S. DEPARTMENT OF ENERGY

Nuclear Energy

Pelletized Clay Mixtures with Enhanced Thermal Conductivity for Engineered Barriers in a Geologic Repository for High-Level Nuclear Waste and Spent Nuclear Fuel.

OVERVIEW

Purpose: The overarching goal of this project is to advance the current understanding of the behavior of pelletized clay mixtures intended for the isolation of high-level nuclear waste (HLW) and spent nuclear fuel (SNF). The research aims to gain a better understanding of the key features associated with the behavior of pelletized clay mixtures intended for the design of engineered barrier systems (EBS), including the degradation of this type of material when subjected to thermo-hydro-mechanical (THM) processes.

Objectives:

- Produce high-quality experimental data related to clay-pellet mixtures involving tests at different scales from microfabric/microstructural studies up to medium-scale laboratory tests.
- Upgrade THM constitutive and numerical models to study EBS under plausible conditions envisaged in the design of geological repositories for HLW/SNF.
- Develop training opportunities for graduate and undergraduate students on this topic.

IMPACT

Logical Path: Fundamental, experimental, and numerical investigations are conducted to advance current understating of the behavior of enhanced clay-pelletized mixtures subjected to high temperatures and hydration. The experimental investigation focuses on the identification of the key mechanisms associated with mass and heat transport in these types of materials. The studies associated with the imaging of inter- and intra-pellet behavior will help understand the underlying microscopic phenomena behind the observed macroscopic material behavior. The information gathered through the macro and micro experimental investigations will be used to develop/upgrade THM constitutive models for clay-pellets mixtures and their integration in a numerical code.

Outcomes: This project will improve the current understanding of HLW/SNF disposal in a generic mined geologic repository. Special attention is paid to the design of innovative clay-pellets mixtures intended for effective and safe isolation of HLW/SNF, together with their characterization and modeling. These findings will lead to the development of better models to represent the behavior of EBS based on clay-pellets materials when subjected to the typical THM processes anticipated in repositories for HLW/SNF.

DETAILS

Principal Investigator: Marcelo Sanchez

Institution: Texas A&M University.

Collaborators: Sandia National Laboratory, UPC (Barcelona, Spain), CIEMAT (Madrid, Spain)

Duration: 3 years

Total Funding Level: $ 800,000

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Workscope: : FC-4.

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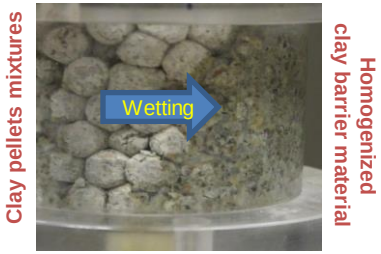
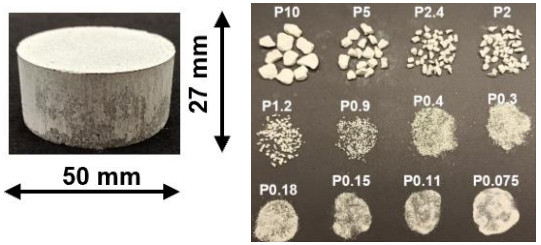
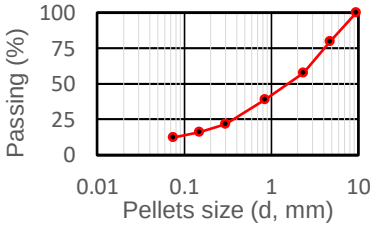


RESULTS

Results:

- Granular clay pellets have been manufactured at TAMU.
- Mx80 bentonite was compacted in cylindrical blocks 50mm diameter, 27mm height, 2.1 Mg/m^3 dry density, and 5.5% initial water content.
- The compacted samples were crushed using a jaw crusher. Sieve analysis of the pellets was conducted. The sizes range from P10 (10 mm) to P0.075 (0.075 mm).





Accomplishments:

- Manufacture of two identical swelling pressure cells and medium-scale. infiltration columns for testing clay-pellets mixtures at high temperature.
- Calibration of the sensors of the new medium-scale infiltration and heating columns.
- Training of the graduate students working in this project.