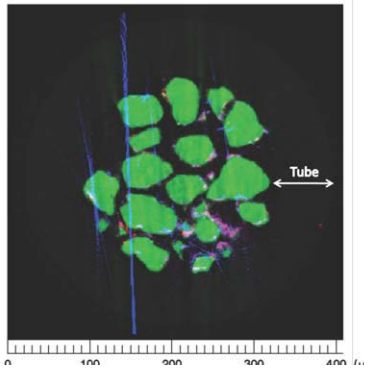
Virginia Environmentally Sustainable Technologies Laboratory



Most industrial activities generate CO_2 and these emissions are resulting in significant changes to the climate of our planet. The Virginia Environmentally Sustainable Technologies Laboratory (VESTlab) is focused on understanding engineering strategies we can use to mitigate these emissions. Our core expertise is in the complex fluid behavior that will enable the reuse, transport, and storage of CO_2 or CO_2 mixtures. In parallel, we are developing modeling tools to understand the environmental implications of deploying carbon management at large scales.

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"Developing the technical and policy knowledge needed to reduce the impacts of engineered systems on the environment."

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Efforts to mitigate the effects of climate change and to adapt to emerging conditions resulting from this change will require a new set of engineering tools. Most of the world's relevant scientific bodies have identified carbon sequestration or management as one of their top scientific priorities. We are approaching this problem via both laboratory and modeling-based research. Below are brief summaries of representative projects from VESTlab:

Interfacial properties and leakage in geologic carbon sequestration (GCS)

GCS involves the injection of CO_2 deep into the ground to keep it out of the atmosphere and it is being pursued even though it has not been demonstrated that CO_2 will stay in place. We are working to develop a fundamental understanding of how interfacial properties could impact buoyancy driven flow through porous media.

Gas expanded lubricants (GELs)

GELS are novel mixtures of CO_2 and synthetic lubricants with tunable properties (e.g. viscosity) that can be controlled in real time by adjusting the operating pressure. We invented these fluids as a way to improve the efficiency and reliability of power production in the turbines and it uses waste CO_2 as a feedstock.

Environmental implications of biofuels

Bio-sequestration using large-scale algae-to-energy facilities is being pursued to address a variety of energy independence and climate goals even though conventional biofuels have a mixed record in these areas. We are studying algae-based energy and sequestration strategies to understand the impacts of these large-scale deployments on these processes.

Transportation systems modeling

Carbon emissions from transportation systems account for over 30% of total U.S. emissions. Life cycle assessment tools are inadequate for providing deep emission reduction and so we are creating novel modeling tools to inform infrastructure management decisions to minimize costs and emissions.

RECENT RESEARCH DEVELOPMENTS

- We carried out groundbreaking work on adhesion processes in multiphase systems contacting mineral surfaces that will impact shale gas development, enhanced oil recovery, and GCS.
- Published an open-source meta-model of algae biofuel production processes for other researchers.
- Founded a new company to develop GELs.

RECENT GRANTS

- NSF - CAREER: Understanding the physicochemical and systems-level processes that would enable sustainable CO_2 sequestration in shales
- EPA – Greenhouse Gas Emissions in Pavement Management Systems
- American Chemical Society – Gas Expanded Lubricants
- NSF – A Partnership for Multiscale Experimental Study of CO_2 Leakage

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