Overview

Pennsylvania is the birthplace of the modern petroleum and natural industry. On August 27, 1859, along the banks of Oil Creek near Titusville Pennsylvania, Edwin L. Drake completed a 69.5' deep oil well that quickly stimulated a boom for the industry. Today, society uses petroleum and natural gas to produce a myriad of products ranging from transportation fuels and petrochemicals, to heating fuel for homes and businesses, and electricity. Over 3,000 products are manufactured from petroleum.

The EMS Energy Institute brings together diverse expertise in the areas of reservoir characterization, petroleum and natural gas extraction, processing, and utilization. Laboratory facilities and industry-driven consortia include the gas flooding industrial affiliate program, the center for quantitative x-ray CT imaging, the stripper well consortium, the center for geomechanics, geochemicals and geohazards, the 3S well stimulation laboratory, and the unconventional gas resources consortium.

Penn State is a leader in petroleum and natural gas engineering. Penn State’s petroleum and natural gas program is the longest running in the U.S. and is the only program in the northeast that offers a Ph.D. program in petroleum and natural gas engineering.

Research Activities

The EMS Energy Institute has an active research presence on the characterization, extraction, and transportation of petroleum and natural gas resources. Examples include:

- Gas flooding and surfactant flooding for enhanced oil recovery
- Microbe and CO₂-enhanced oil recovery
- New generation reservoir engineering analysis tools for performance prediction of unconventional natural gas reservoirs
- Well test analysis in ultra-tight and double porosity systems
- Performance prediction of shale gas and oil reservoirs using artificial expert systems (ANN)
- Hydrocarbon recovery from mineral matter
- ANN-based field development tools
- Fluid flow modeling and experiments in coalbed methane reservoirs systems
- Trapping and leakage mechanisms during geologic carbon storage
- Digital rock physics and pore-scale transport mechanisms in reservoir environments
- Hydraulic fracturing technology
- Simulation of complex, multi-lateral well configurations
- Paradoxical behavior and maldistribution in natural gas transportation systems
- Salting/scale mechanisms, diagnosis, and solutions

Consortia & Centers

Stripper Well Consortium

The Stripper Well Consortium (SWC) is an industrial consortium, focused on developing, demonstrating, and commercializing technologies that will improve the production performance of the nation’s natural gas and petroleum stripper wells. The EMS Energy Institute worked with the U.S. Department of Energy’s National Energy Technology Laboratory and the stripper well industry to secure the necessary funding needed to launch this initiative. Learn more about the SWC by visiting its website, www.energy.psu.edu/swc.
The Center for Geomechanics, Geofluids, and Geohazards

The Center for Geomechanics, Geofluids, and Geohazards (G3 Center) promotes interdisciplinary research in subsurface science and engineering with application to conventional and unconventional reservoirs (gas shales, coalbed reservoirs, geothermal reservoirs, and CO₂ sequestration) and to natural processes (earthquake physics, basin evolution, and volcano dynamics).

The Center focuses on broad aspects of reservoir behavior from nanoscale to reservoir scale, from timescales of basin evolution to those of reservoir production and encompassing observational, experimental and analytical geomechanics. Recent projects relate to understanding the evolution of complex induced hydraulic fracture networks; shale ductility and hydraulic fracturing; coal-gas and shale-gas interactions, including enhanced gas recovery, complex coupled HPHT physicochemical interactions in hydrocarbon and geothermal reservoirs, dynamic stressing for permeability evolution, modeling of poroelastic effects on wellbore failure, and coupled evolution of permeability, pore pressure, and deformation in both mudrocks and sands. For more information about the G3 Center visit g3.ems.psu.edu.

3S Laboratory for Petroleum Research in Well Stimulation

The mission of the reservoir Simulation, Stimulation and Strategy Laboratory (3S Lab) is to build new knowledge and develop new technologies for evaluation and stimulation of low-permeability reservoirs (ultra-tight gas, shale gas, and shale oil) and to educate future engineers and leaders in petroleum and the broader energy area.

The 3S Laboratory combines industrial and academic resources to solve engineering problems facing the oil and gas industry. The major areas of research include laboratory evaluation of fracture fluids, proppants, additives, and flowback fluids; numerical simulation of hydraulic fracture propagation; fluid cleanup; and long-term oil/gas recovery in low-permeability reservoirs. More information can be found at 3s.ems.psu.edu.

Center for Quantitative Imaging

The Center for Quantitative Imaging (CQI) combines state-of-the-art X-ray Computed Tomography (CT) and data-mining expertise to provide visual three-dimensional reconstruction of materials and processes. X-ray CT is a method for mapping X-ray absorption, which can be converted to maps of density, porosity, and component concentrations. This laboratory handles samples ranging from 1mm to 600mm in diameter, and up to 2m long.

The CQI was established through a National Science Foundation Major Research Instrument Grant and by the generous support of Marathon Oil. This unique facility is used to study multiphase flow in porous media, rock structure and mineralogy, fluid saturation changes, stress-strain behavior of rock samples, and more. The CQI can provide industrial and research clients with a state-of-the-art, non-destructive imaging service that advances scientific knowledge of transport process and structural characterization of natural and synthetic samples. For more information visit www.cqi.psu.edu

Unconventional Natural Resource Consortium

The main objective of the Unconventional Natural Resources Consortium (UNRC) is to provide sustained and long-term support to cutting-edge research in the area of unconventional natural resources exploitation and development and the dissemination of research results to UNRC members. Research projects are focused in the reservoir engineering areas of unconventional natural gas resource exploration and production technology, with an emphasis in shale gas and tight gas plays and closely related areas.

The most significant volume of unconventional gas in the U.S. is found locked in three distinct plays: coalbed methane, tight sands, and gas shales. The significance of gas production from these plays continuously grows within the U.S. domestic portfolio. In Pennsylvania and the Appalachian basin, for example, estimated recoverable gas reserves have been placed within the largest in the world in the Marcellus and Utica shale plays alone. Visit www.energy.psu.edu/unrc to learn more.

Gas Flooding Industrial Affiliate Program

The goal of the Gas Flooding Program is to generate innovative research in gas flooding and closely related areas as well as recruit and train graduate students in petroleum engineering for careers in the oil industry. In addition to student recruitment and shared research outcomes, technology transfer is one of the major benefits for gas flooding members. This transfer occurs through publications as well as various toolkits provided to members, such as fluid characterization and MMP prediction spreadsheets, and novel multiphase compositional simulators.

The group’s research falls into several key areas, including gas flooding processes such as CO₂ gas flooding and rich gas flooding, thermodynamics and phase behavior, geo-chemistry, CO₂ storage, and numerical simulation of gas floods. Visit www.energy.psu.edu/gf to learn more about current gas flooding research initiatives.