The stirred batch reactor is used for catalytic processing development in PNNL's biobased products work.

includes high-pressure catalytic reactor rooms for hydrogenation and other chemical processing, bioprocessing labs for developing and engineering fungal fermentations, wet chemical labs that support the synthesis and preparation of catalysts and feedstocks and the Combinatorial Catalysis Research Laboratory, which houses state-of-the-art rapid-throughput catalyst discovery instrumentation. BSEL also has a 2,500-square-foot high-bay facility that enables integration and scale-up of the various steps involved in bioproduct manufacturing processes.

Our work also utilizes the extensive instrumentation located in W.R. Wiley Environmental Molecular Sciences Laboratory, a DOE user facility on the PNNL campus. The facility houses state-of-the-art instruments which provide detailed information about catalysts and which assist with detailed studies of proteomics and metabolomics of biological species. Examples include nuclear magnetic resonance and electron paramagnetic resonance instruments to help users understand the molecular structure and fundamental processes needed to advance biomass science.

Pacific Northwest NATIONAL LABORATORY | U.S. DEPARTMENT OF ENERGY

The science of going green

PNNL scientist Doug Elliott, in partnership with DOE, the National Renewable Energy Laboratory, the New York State Energy Research and Development Authority and Biofine Renewables, received a Presidential Green Chemistry Award in 1999 for developing a catalytic process for converting cellulosic biomass to chemicals. Biofine Renewables now operates a biofuel plant in Italy that uses a process developed during that project to convert cellulose to levulinic acid.

Collaborations

PNNL is collaborating with national and regional universities, including Washington State University and Oregon State University. We also have active collaborations with other national laboratories, such as the National Renewable Energy Laboratory, Idaho National Laboratory, Oak Ridge National Laboratory, and Argonne National Laboratory, and member organizations of the Joint Genome Institute.

The Laboratory also is partnering with industry to advance commercialization opportunities for biofuels and bio-based products. Our partnerships include industries in the petroleum, chemical, biotechnology, agriculture and forestry sectors.

About PNNL

PNNL's biomass conversion work is an important element in a wider portfolio of research and development work funded by DOE, other federal agencies and the private sector. PNNL is a Department of Energy Office of Science national laboratory where interdisciplinary teams advance science and technology and deliver solutions to America's most intractable problems in energy, national security and the environment. PNNL employs 4,000 staff, has a $855 million annual budget, and has been managed by Ohio-based Battelle since the lab's inception in 1965.

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PNNL-SA-61684

Biomass Conversion

Pacific Northwest NATIONAL LABORATORY

delivering fuel and product options for the future

Biofuels have the potential to address some of our nation's most significant energy challenges: reducing both our reliance on imported oil and our carbon footprint.

Pacific Northwest National Laboratory (PNNL) is helping drive our nation's shift from petroleum to biobased fuels by advancing the science and technology of biomass conversion. As part of the Pacific Northwest community, our research also supports regional biofuel efforts. An additional research focus is using biomass to produce chemical products.

Biobased products and catalysis research is helping PNNL deliver technologies to private industry and government customers to reduce reliance on foreign oil.

Biofuels

Our primary focus is developing the scientific and engineering foundations for converting cellulosic biomass to next-generation biofuels that are more efficient to produce and have the potential to better use the existing fuel infrastructure.

PNNL researchers are working with advanced biotechnology and thermal gasification routes to produce ethanol, and also are using gasification and pyrolysis processes to develop the next generation of hydrocarbon fuels for use in gasoline, diesel and jet engines.

Chemical Products

Biobased chemical products offer an option to reduce U.S. dependence on imported oil and include the following benefits:

- improving economics for biorefineries through higher financial rates of return
- using renewable feedstocks for products that are now made from petroleum
- creating new high-value products that cannot be made from petroleum.

More than a decade ago, our researchers began developing the capability to convert biomass and its components to biobased chemical products. Conversion technologies developed at PNNL produce the intermediate "building blocks" used in some of our everyday products. PNNL works closely with industry to implement these conversion technologies.

Capabilities

Catalytic and thermal processing
A leader in thermochemical conversion processes, PNNL has been developing techniques to produce fuels and products from biomass for more than 25 years. Our experience ranges from developing biomass gasification and liquefaction processes to developing catalytic approaches for producing transportation fuels. PNNL researchers have extensive experience in the conversion of biomass for energy uses, such as

- thermochemical gasification or pyrolysis of biomass for producing syngas or biocrude
- catalytic conversion of syngas or bio-oils to finished transportation fuels
- catalytic conversion of organic acids to fuel additives.

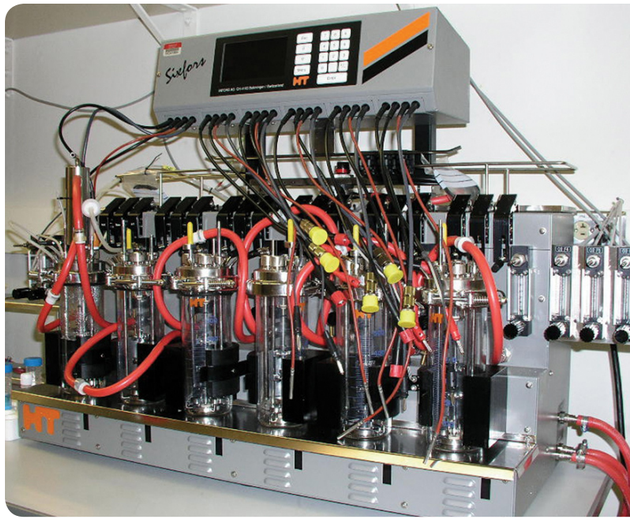
PNNL researchers are experts in formulating, synthesizing and testing catalysts for chemical and fuel production applications. Their efforts led to the development of an innovative catalytic gasification concept using high-pressure liquid water for low-temperature gasification. This concept, which converts wet organic residues to medium-Btu fuel gas (methane and carbon dioxide) was an R&D 100 Award winner in 1989.

Biotechnology and bioprocessing
PNNL scientists are using filamentous fungi as a source of enzymes to convert lignocellulosic biomass to useful products and as highly productive bioprocess organisms to produce small molecules. Our research program encompasses fungal genomics, genetics, cell biology, strain development and bioprocess optimization.

In addition, PNNL scientists lead and collaborate on a significant number of fungal genome sequencing projects performed by the Department of Energy Joint Genome Institute. Our research focuses on translating this genomic information into functional and practical tools for studying and manipulating fungi. These tools include metabolic models, proteomics and molecular biology methods for discovering and manipulating specific gene targets in fungi to accelerate development of optimal production systems. Our fermentation facility allows development and scale-up of these processes to make fuels, chemicals and enzymes.

Sustainability

Using biomass resources to produce fuels and chemicals requires sustainable practices for managing carbon emissions and water use. PNNL has strong carbon management programs that include developing techniques for sequestering carbon dioxide and global climate modeling that integrates the interplay between humans, climate technology and economics. Our researchers also are working on approaches that will enable the sustainable use of water resources for biomass production, reduce water use for unconventional hydrocarbon production, such as oil shale and tar sand, and improve the treatment and containment of contaminated water. PNNL scientists are actively involved in solving climate issues at the international level. Twenty PNNL researchers were recognized recently for their contributions to the Nobel Peace Prize won by the Intergovernmental Panel on Climate Change in 2007 for its authoritative assessments of the state of the global climate, the impacts associated with climate change, and the set of technological, institutional and policy options available to mitigate and adapt to climate change.



A group of six small fermentors allows researchers to grow quantities of fungi under the same conditions or to test multiple parameters simultaneously, vastly increasing the speed of conducting fungal experiments.

PNNL also is partnering with industry to advance commercialization opportunities for biofuels and biobased products. Our partnerships include entities in the petroleum, chemical, biotechnology, agriculture and forestry industries.

Unique Facilities

The new Bioproducts Sciences and Engineering Laboratory (BSEL) facilitates a close scientific and engineering collaboration between PNNL and Washington State University. BSEL houses PNNL's biomass program and is located on the campus at Washington State University Tri-Cities. BSEL

PNNL's biomass program is housed in the recently constructed Bioproducts, Sciences, and Engineering Laboratory (BSEL) on the campus of Washington State University Tri-Cities.