

Bench-Scale Fermentation Laboratory

Bench-scale process development capabilities for the conversion of biomass to sugars, fuels, and chemicals

NREL's bench-scale fermentation laboratory is home to a number of traditional fermentors, ranging in size from 500 mL to 5 L, and one high-solids bioreactor.

NREL's bench-scale fermentation laboratory provides:

- Fermentation systems with pH, temperature, and dissolved oxygen control
- Data acquisition and recipe control for the Biostat Q and Q-Plus systems
- CO₂ and redox measurement capabilities
- At-line analytical equipment capable of monitoring glucose, xylose, ethanol, ammonium, and potassium ion with flexibility to measure other compounds
- Custom-built bioreactor for high-solid lignocellulosic biomass slurries (>10% insoluble solids).

Bench-scale fermentation applications include:

- Enzymatic hydrolysis and fermentation testing
- Microorganism evaluation and development
- Aerobic and heterotrophic algal process development.



NREL uses these 1-L Braun Q fermentors to study the fermentation performance of different microorganisms, such as *Zymomonas mobilis*. Photo by Patrick Corkery, NREL/PIX 16368

Equipment Type	Quantity
500-mL small-scale Sartorius Biostat Q-Plus fermentor	15
1-L Braun Biostat Q fermentor	8
New Brunswick Bioflo 3000 fermentor with 1 L to 5 L interchangeable vessels	4
4-L high-solids bioreactor	1

Applications

Enzymatic hydrolysis and fermentation testing

- Different enzyme mixtures
- Pretreated lignocellulosic feedstocks at low and high solid concentrations
- Aerobic and micro-aerophilic cultivation processes.

Microorganism evaluation and development

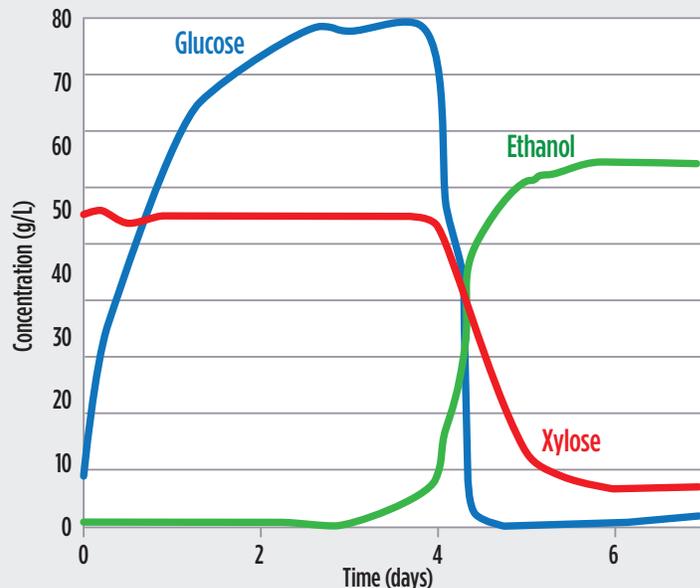
- Evaluating microorganisms for production of biofuels and bioproducts
- Producing inhibitor-resistant and high-product-tolerant microorganisms for biofuels production that improve conversion yields.

Aerobic and heterotrophic algal process development

- Studying the effect of the environment on algae growth and lipid production
- Using algae residue as a feedstock for biofuels production.



The 500-mL Biostat Q-Plus fermentors are used for small-scale fermentation testing. Photo by Cindy Gerik, NREL/PIX 19431



Glucose, xylose, and ethanol concentrations during enzymatic hydrolysis and fermentation of pretreated corn stover at 20% total solids. Figure by NREL

Associated publications

Humbird, D., et al. (2010). "Economic Impact of Total Solids Loading on Enzymatic Hydrolysis of Dilute-Acid Pretreated Corn Stover." *Biotechnol. Prog.* (26); pp. 1245-1251.

Mohagheghi, A.; Schell, D.J. (2010). "Impact of Recycling Stillage on Conversion of Dilute Sulfuric Acid Pretreated Corn Stover to Ethanol." *Biotechnol. Bioeng.* (105); pp. 992-996.

Dutta, A., et al. (2010). "An Economic Comparison of Different Fermentation Configurations to Convert Corn Stover to Ethanol Using *Z. mobilis* and *Saccharomyces*." *Biotechnol. Prog.* (26); pp. 64-72.

Hodge, D.B, et al. (2009). "Model-Based Fed-Batch for High-Solids Enzymatic Cellulose Hydrolysis." *Appl. Biochem. Biotechnol.* (152); pp. 88-107.

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