

# Fuel Synthesis Catalysis Laboratory

Catalytic testing for high pressure gas-to-fuels technologies

NREL's Fuel Synthesis Catalysis Laboratory provides a wide range of capabilities in high-pressure heterogeneous catalyst testing. Current research areas of emphasis are mixed alcohol and hydrocarbon synthesis from biomass-derived syngas. Many other catalyst systems can be studied by making minor system modifications.

## The lab includes four reactors for gas-to-liquids synthesis:

- Two bench-scale tubular (integral) reactors
- Two bench-scale stirred autoclave (differential) reactors.

## NREL's bench-scale high pressure reactors provide:

- 24/7 operation
- Catalyst performance data over a range of temperatures and pressures
- Robust analysis of reaction products.

## Applications include:

- Catalyst screening and ranking
- Lifetime testing
- Kinetic modeling support
- Simulated recycle.



This bench-scale fuel synthesis reactor can be used to test various catalysts over a wide range of conditions using bottled or biomass-derived syngas. *Photo by Jesse Hensley, NREL/PIX 19329*

### Fuel Synthesis Catalyst Testing Equipment Specifications

<b>Systems</b>	10 mL isothermal tubular reactor 40 mL isothermal tubular reactor 1 L stirred autoclave reactors (batch, Berty, slurry)
<b>On-line product analysis</b>	Gas chromatography Hydrocarbons (lower detection limit [ldl] 10 ppm) Oxygenates (non-acid) (ldl 10 ppm) Permanent gases (ldl 50 ppm) Sulfur-containing compounds (ldl 10 ppb)
<b>Operating conditions</b>	Sample size: 500 mg – 4 g (0.2 – 2 mL sans dilution) Gas flow: 5 – 200 g/h Pressure: 500 – 2,000 psi Temperature: 120°C – 400°C Gases: CO/H <sub>2</sub> /Ar/He/N <sub>2</sub> /CO <sub>2</sub> /CH <sub>4</sub> /H <sub>2</sub> S custom blended on-site Liquids: Any of reasonable viscosity
<b>Catalysts (solid)</b>	Metals Carbides Aluminosilicates Sulfides Size: >50 μ particles
<b>Mass/atomic balances</b>	± 3% typical

## Applications

### Catalyst screening and performance evaluation

- Efficient screening of catalyst performance at steady state
- Ranking of multiple catalyst samples.

### Medium-range catalyst lifetime testing

- Steady state operation
- Continuous catalyst testing for 1,000 to 2,000 hours or longer.

### Kinetic model development

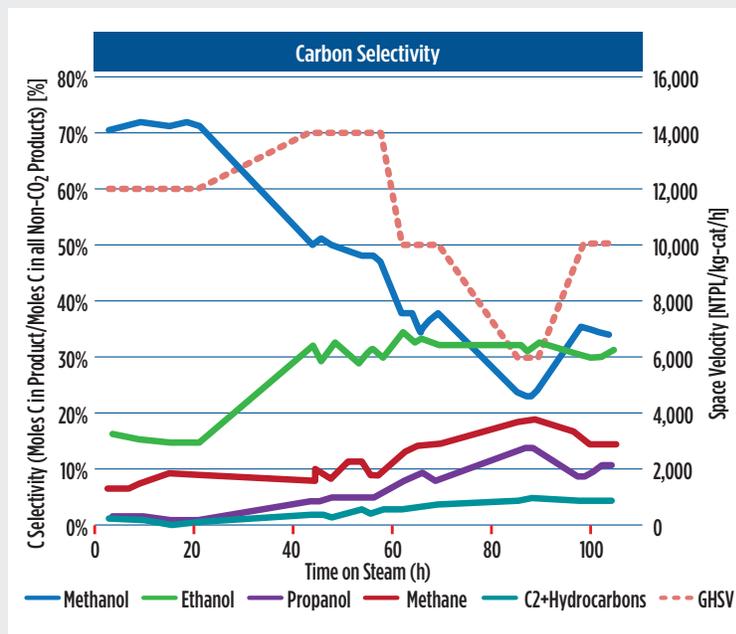
- Reactors operated with negligible temperature and concentration gradients provide high quality data for kinetic modeling
- State of the art analytical system provides rigorous and accurate product analysis from low to medium-high conversion.

### Use of biomass-derived syngas made in NREL's thermochemical process development unit (TCPDU)

- Compare catalyst performance in bottled vs. "real" syngas
- Compare bench-scale and mini-pilot-scale performance using fuel synthesis catalysis and thermochemical biorefinery pilot plant labs.

### Simulated recycle

- Recycle streams can be simulated by blending gas and vapor mixtures to match probable recycle compositions.



Sample data from a mixed alcohol catalyst operated at 325°C and 1,500 psig.  
Figure by NREL

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