

Fuel Synthesis Catalysis Laboratory

Catalytic testing for thermochemical transformations of molecules

NREL's Fuel Synthesis Catalysis Laboratory (FSCL) provides a wide range of capabilities in heterogeneous catalyst testing. Current research areas of emphasis include the transformation of biomass pyrolysis and gasification products to premium transportation fuels. Test equipment is designed for a broad range of catalysts and reactions, and can be modified to meet special requirements. The FSCL team works closely with synthetic, advanced characterization, and fuel analysis teams to derive the greatest value from every experiment.



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 19329

The FSCL includes six reactor stations for catalyst testing:

- Working pressures up to 2,000 psi (13.5 MPa)
- Working temperatures up to 1,000°C (1,800°F)
- Gaseous, liquid, and melted/vaporized solid feed sources
- Integration with process analytical
- Full suite of support equipment for proper loading, unloading, activation, and post-mortem analysis.

Automation of systems provides:

- 24/7 manned and unmanned operation
- Full product analysis via online gas chromatography and residual gas analysis
- Logging of process conditions.

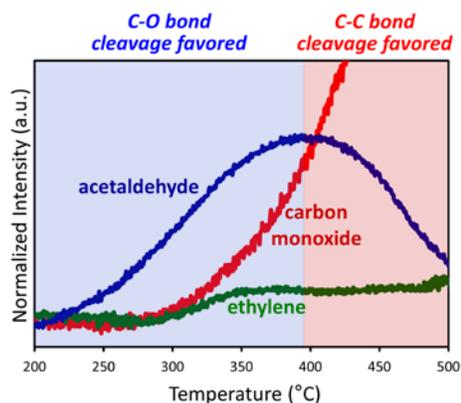
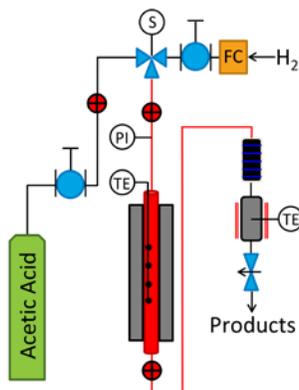
Applications include:

- Determination of best activation and operating conditions
- Catalyst screening and ranking
- Lifetime and performance testing
- Kinetic modeling support
- Simulated recycle.

Fuel Synthesis Catalyst Testing Equipment Specifications

Systems	<ul style="list-style-type: none"> • 10 and 40 mL isothermal tubular reactors • Down- and cross-flow temperature programmed reactors • Bring your own (see specifications next page)
On-line product analysis	<ul style="list-style-type: none"> • Gas chromatography and mass spectrometry • Hydrocarbons (lower detection limit [Ldl] 10 ppm) • Oxygenates (Ldl 10 ppm) • Permanent gases (Ldl 50 ppm)
Operating conditions	<ul style="list-style-type: none"> • Sample size: 100 mg–4 g (0.2–2 mL sans dilution) • Gas flow: 5–500 sccm • Pressure: Ambient to 2,000 psi • Temperature: Ambient to 1,000°C • Gases: CO/H₂/Ar/He/N₂/CO₂/CH₄/H₂S/NH₃/custom single component or custom blended on-site • Liquids: Any of reasonable viscosity • Solids: Any with measurable vapor pressure at or below 300°C
Catalysts (solid)	<ul style="list-style-type: none"> • Metals • Carbides, nitrides, phosphides, and sulfides • Aluminosilicates and zeolites • Oxides
Mass/atomic balances	<ul style="list-style-type: none"> • ± 3% within closure is typical

Representative system, sample trace, and data interpretation for temperature programmed reaction over a carbide-type catalyst.
 Figure by Joshua Schaidle, NREL



Applications

Catalyst screening and performance evaluation

- Efficient screening of catalyst performance at steady state
- Transient and temperature correlated analyses
- 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 designed for negligible temperature and concentration gradients to provide high-quality data for kinetic modeling
- State-of-the-art analytical systems provide rigorous and accurate product analysis across a full range of reactant conversion.

Use of biomass-derived syngas made in NREL's bench-scale gasifier, tar reformer, and acid gas scrubber

- Compare catalyst performance in bottled vs. "real" syngas
- Evaluate a fully integrated process at an economical scale before up-sizing.

Bring your own system

- Supply your own reactor system and catalyst for testing (within 30" x 50" base dimensions x 7' high)
- Up to 70A of 120V and 30A of 208V single-phase power available
- Connect into control system using 24, 12, and 5 VDC field devices
- Up to 12 heated zones + 1 3-zone furnace + 1 5-zone furnace and 60 temperature measurements per reactor bay
- Hookups to high- and low-pressure gases, biomass derived syngas, and house utilities.

For more information, contact:

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| • Jesse Hensley
303-384-7914
Jesse.Hensley@nrel.gov | • Joshua Schaidle
303-384-7823
Joshua.Schaidle@nrel.gov |
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