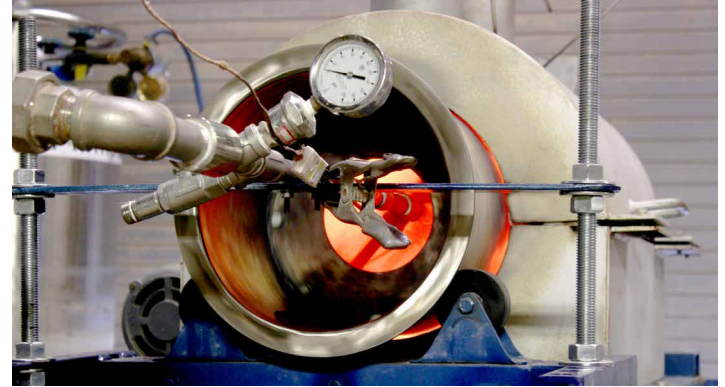


The FEECO Innovation Center offers a variety of test kilns that can simulate the conditions in continuous, commercial size kilns. Our available test kilns are described below.



18" X 24" DIRECT-FIRED BATCH KILN

Our direct-fired batch kiln is equipped with a propane burner with oxygen enrichment, variable speed drive, and both bed and gas thermocouples. A reducing atmosphere can also be used. The batch kiln is lined with 99% alumina castable refractory and can be operated to simulate either co-current or counter current flow.



10.5" X 24" INDIRECT-FIRED BATCH KILN

Our indirect-fired batch kiln is heated with a propane burner beneath the shell. Dams inside the kiln hold material within the heated zone. Two thermocouples, located near the shell in the furnace, are used to measure its temperature. Two additional thermocouples are used to measure the bed and exhaust gas temperatures. Kiln ends can be sealed and have an inlet for a purge gas and an outlet for purge gas exhaust.



30" X 20' CONTINUOUS DIRECT-FIRED PILOT KILN

Our continuous pilot kiln is equipped with a refractory brick lining, feed system, natural gas burner, and cooled screw. Adjustable dams allow for a deeper bed depth and longer residence times. The kiln can be operated in either a co-current or counter current configuration. Kiln exhaust is ducted through a thermal oxidizer (TO), quench chamber, bag filter, and ID fan.



6.5" X 84" CONTINUOUS INDIRECT-FIRED PILOT KILN

Our continuous indirect pilot kiln is divided into two electrically heated zones. Thermocouples in each zone near the shell measure temperature and control outputs from the heating elements. Both kiln speed and slope can be adjusted to alter the bed profile and residence time. Kiln exhaust is ducted through a thermal oxidizer (TO) quench chamber, bag filter, or wet scrubber and ID fan.

THE TESTING PROCESS

Testing in the Innovation Center offers a host of invaluable information, allowing you to gain critical data on your material, work out process variables, and develop a recipe for process scale-up. Our flexible setup, combined with the expertise of our process experts and our experience with hundreds of materials allows a variety of thermal tests to be expertly conducted. We also have the capabilities to incorporate additional processing, including drying and agglomeration.

COMMONLY CONDUCTED THERMAL TESTS:

- Reduction
- Heat Setting
- Catalyst Activation
- Calcination
- Sintering
- Metal Recovery
- Organic Combustion
- Desorption & Combustion
- Upgrading of Ores

We offer comprehensive testing options in four categories:

1. Feasibility/Proof of Concept

Muffle furnace testing along with Thermal Gravimetric Analysis (TGA), Differential Scanning Calorimeter (DSC), and chemical analysis to determine your specific material's chemistry and reaction to heat.

2. Proof of Product

Batch testing where it is determined whether a product can be made to the required specifications.

3. Proof of Process

A continuous testing phase that aims to establish the equipment setup and parameters required for commercial production of your specific material.

4. Process/Product Optimization

An in-depth study to optimize your specific material's characteristics and/or production parameters for an operating industrial kiln.

Optional Testing Conditions & Equipment:

- Parallel or Counter Current Flow
- Thermal Oxidizer
- Baghouse
- Wet Scrubber
- Removable Flights, Dams, and Bed Disturbers
- Data Collection & Trending System

Commonly Targeted Test Information:

- Crush Strength
- Particle Size Distribution
- Dust Generation
- Bulk Density
- Extent of Reaction (e.g. Calcination, Reduction)
- Reactivity of Product
- Exhaust Gas Composition
- Temperatures
- Baghouse Efficiency
- Thermal Oxidizer Efficiency



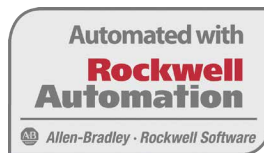
REPORTING & DATA IN REAL-TIME

Our state-of-the-art system allows you to monitor various data points, trending them, and even adjusting process variables in real-time, all from a single interface, or even from a remote device. This allows for a user to view process data and respond accordingly during production.

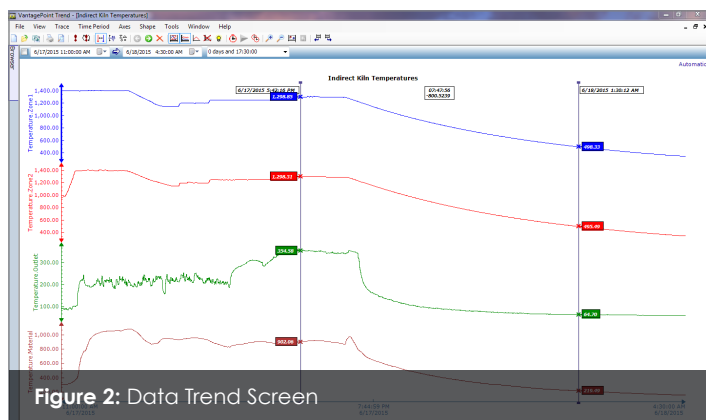
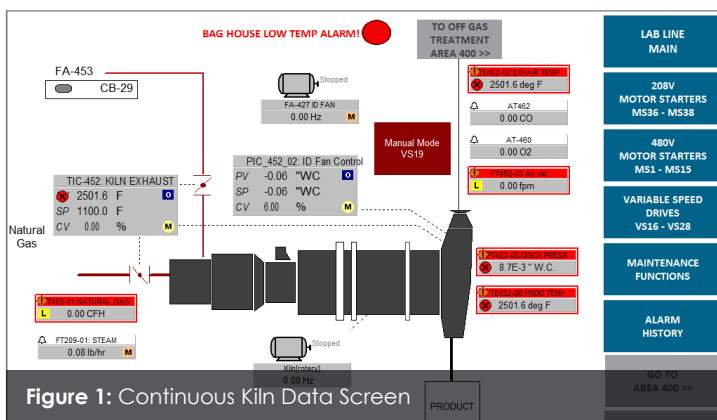
FEECO is a Rockwell Automation partner, providing integrated process control solutions, both as a service in the Innovation Center, and as part of a system purchase. FEECO and Rockwell Automation process control solutions are provided with current technology, motor control centers, programmable logic controllers, and data collection systems with advanced technologies for reporting. The Innovation Center features a Rockwell Automation MCC system, which utilizes current technologies for optimizing testing operations.

Data gathered includes:

- Burner Fuel Usage
- Drum Slope
- Emissions
- Fan Speed ^{RT}
- Feed & Product Rates ^{RT}
- Temperature (Feed end, Internal, TO, product, & exhaust gas) ^{RT}
- Heater Amps ^{RT}
- Natural Gas Flow Rates ^{RT}
- Outlet Gas Parameters
- Quench Tower Water Flow ^{RT}
- Residence Time
- Rotational Speed
- Samples: Feed, Product, & Internal Kiln
- Screen Analysis of Feed & Product
- Steam Flow ^{RT}
- System Pressures ^{RT}
- Gas Sampling & Analysis (Oxygen, Carbon Monoxide, Nitric Oxide, Nitrogen Dioxide, Sulfur Dioxide, and combustibles discharged from various thermal processes) ^{RT}



(^{RT}) indicates that the data can be tracked in real-time.



FEECO can integrate third party equipment into your control system, giving you complete process tracking and visualization. Secure remote access to the system by a Rockwell Automation expert provides unparalleled troubleshooting capabilities.

SCHEDULE A TEST

To discuss your testing needs with one of our process engineers and schedule a test, contact us today at: FEECO.com/contact

MATERIAL TRANSFORMATIONS

The FEECO Innovation Center also works extensively in helping customers to transform materials and process by-products into value-added products through agglomeration and other processing methods. The list below looks at some of the transformations FEECO has performed in recent years, as well as what processing methods were used to transform the material.

Beginning Material	Final End Product	Agglomeration	Drying	Blending	Thermal	Compaction
Sulphur Stack Emissions	Granulated Fertilizers	●	●			●
Calcium Sulfate	Fertilizer Pellets	●	●		●	
Ash (Wood, Fly)	Fertilizer Pellets	●	●			
Bentonite Clay	Cat Litter Granules	●	●			●
Calcium Chloride	Ice Melt Pellets	●	●			
Calcium Carbonate	Fertilizer Pellets	●	●			
Carbon Black Dust	De-dusted Pellets	●	●			
Cement Kiln Dust	Calcium Fertilizer Pellets	●	●			
Cell Phone Batteries	Lithium, Zinc Metal Recovery				●	
Clay	Cat Litter, Oil Dry Granules, Encapsulate Seeds	●	●	●		
Coal Dust	De-dusted Coal Pellets	●	●			●
Composts(Yard Waste)	Fertilizer Pellets	●	●	●		
Copper Dust	Metal Recovery Pellets	●	●	●		
Corn Cobs	Cat Litter, Oil Dry Pellets	●	●	●		
Clay	Proppants				●	
Dredge Sludges	Non-leaching Granules	●	●	●		
Electric Arc Furnace(EAF) Dusts	Metal Recovery	●	●	●		
Ethanol Plant Waste(DDG)	Animal Feed	●	●	●		
Foundry Dust	Metal Recovery	●	●	●		
Gold Ore Dust	Precious Metal Recovery	●	●	●		
Grain Dust	Non-explosive Pellets	●	●	●		
Gypsum Wallboard Waste	Fertilizer, Cat Litter Pellets	●	●	●		
Humate	Fertilizer Pellets	●	●	●		
Iron Oxide	Metal Recovery Pellets	●	●	●		
Lime(Waste Water Treatment Sludge)	Calcium Fertilizer Pellets	●	●	●		
Limestone	Calcium Fertilizer Pellets	●	●	●		
Talc Ore	Sterilized Baby Powder				●	
Manure – Cattle / Chicken / Hog	Fertilizer Pellets	●	●	●		
Soda Bottles	Recycled Plastic				●	
MAP Fertilizers	Fertilizer Pellets	●	●	●		
Municipal Wastes	Fertilizer, Fuel Pellets	●	●	●		
Nitrogen Fertilizers	Fertilizer Pellets	●	●	●		
NPK Blends	Fertilizer Pellets	●	●	●		●
Paper Sludge	Fertilizer, Cat Litter	●	●	●		
Petroleum Coke Dust	Fuel Pellets	●	●	●		●
Phosphates Powder	Fertilizer Pellets	●	●	●		
Potassium Chloride	Fertilizer Pellets	●	●	●		●
Saw Dust	Cat Litter, Fuel Pellets	●	●	●		●
Soy Flour	Animal Feed	●	●	●		
Steel Dusts and Sludges	Metal Recovery Pellets	●	●	●		●
Sugar	Sugar Pellets	●	●	●		
Sulphur Dust	Non-explosive Pellets	●	●	●		
Tar Sands Waste Sludge	Substitute Fuel Pellets	●	●	●		
Titanium Metal Shavings	Metal Recovery	●	●	●		
Iron Ore	Metal Recovery Pellets	●	●			
Glass Batch	Glass Blend	●	●	●		
Ceramic / Aluminum	Refractory	●	●			
Paper Sludge	Bright White Clay				●	
Gypsum	Fertilizer Pellets	●	●			
Zinc Oxide	Metal Recovery Pellets	●	●			●
Nickel Ore	Metal Recovery Pellets	●	●			
Kaolin Clay	Coating Paper	●	●			
Tungsten Oxide	Metal Recovery Pellets	●	●			●
Raw Coal	Purified Coal				●	
Bone Meal	Fertilizer	●	●			
Ammonium Sulfate	Fertilizer					●
Diatomaceous Earth	Filter Agent	●	●			
Titanium Dioxide	Pigment Pellets	●	●			●

Agglomeration: Drum, Pan Pelletizer, Pin Mixer

Drying: Rotary Drum Dryer, Fluid Bed Dryer

Blending: Ribbon Mixer, Pug Mill

Thermal Process: Rotary Kiln

Roll Compaction: Roll Compactor