CUSTOMIZED TESTING SOLUTIONS

Testing 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. The Innovation Center is a unique facility that offers comprehensive testing options for both agglomeration and thermal processes. Our process engineers can work with you to develop a customized testing program around the answers you’re looking for. Depending on your needs, we offer testing services in four categories:

1. Feasibility/Proof of Concept - An initial, non-witnessed batch testing phase in which the possibility of creating a product is explored.

2. Proof of Product - A more in-depth batch testing phase in which more time is spent determining whether a product can be made to desired specifications.

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

4. Process/Product Optimization - An in-depth study to optimize your specific material’s characteristics and/or production parameters in an industrial setting.

TESTING EQUIPMENT

Whether you need to test a single piece of equipment, or you’re looking to try various configurations of multiple pieces, the FEECO Innovation Center is well equipped to suit small batch tests, as well as continuous process loops. Available testing equipment is listed below, with the scale of the equipment indicated by either batch (small-scale testing) or continuous (pilot-scale testing).

AGGLOMERATION

BATCH EQUIPMENT
- Disc Pelletizer
- Pin Mixers (2)
- SC Roll Compactor / Briquetter

CONTINUOUS EQUIPMENT
- Disc Pelletizers (2)
- Rotary Granulator
- Paddle Mixer/Pug Mill
- Pin Mixer
- Hammer Mill
- Rod Mill
- Prater Mill
- Rotex Screen – 2 deck
- Circular Screen
- Pipe Reactor
- Littleford Day Mixer
- Coating Drum

THERMAL

BATCH EQUIPMENT
- Rotary Klin
- Indirect Klin
- Rotary Dryer
- Flight Simulator

CONTINUOUS EQUIPMENT
- Rotary Klin
- Indirect Klin
- Rotary Dryer
- Fluid Bed Dryer, Cooler

MATERIAL HANDLING
(ALL CONTINUOUS)
- Steep Incline Conveyor
- Bucket Elevator
- Belt Conveyor
- Various Feeders

SUPPORT

BATCH EQUIPMENT
- Muffle Furnace
- Fluid Bed Sample Dryer
- Tray Oven

CONTINUOUS EQUIPMENT
- Steam Generator with Steam Tanks

ON-SITE SUPPORT

In addition to the equipment listed here, we are capable of making on-site, large-scale modifications to our facility in order to accommodate your testing needs, without the hassle of bringing in external contractors.

ADVANCED PARTICLE ANALYSIS

FEECO utilizes a 3D Dynamic Image Analysis tool to provide advanced particle analysis during testing. A number of characteristics, including size, shape, thickness, surface roughness, density, transparency, and more, can all be measured without disrupting the testing process. Results are recorded with precision accuracy in real time, with data comparison and trending available through the integrated software program. Advanced particle analysis systems are also available as part of a system purchase.
AGGLOMERATION TESTING

Agglomeration testing in the Innovation Center will tell you if your material is capable of agglomerating, as well as what equipment will be required to achieve the results you’re looking for. We can convert dusts, bulk powders, and sludges into free-flowing pellets for dust-free handling, or to improve product characteristics. We can also test a complete, continuous process with agglomeration, drying, particle sizing, and product recycle capabilities to create a highly efficient process. We can record operating data to assist in process scale-up and design a full-scale production plant.

WE CAN TEST THE FOLLOWING METHODS OF AGGLOMERATION:

**NON-PRESSURE**
- Pelletizing (Disc, Rotary Drum)
- Conditioning (Pug Mill, Pin Mixer, Rotary Drum)
- Mixing (Pug Mill, Pin Mixer, Rotary Drum)
- Coating (Rotary Drum)
- Micro Pelletizing (Pin Mixer, Disc Pelletizer)

**PRESSURE**
- Briquetting
- Compaction Granulation

QUESTIONS THAT CAN BE ANSWERED THROUGH AGGLOMERATION TESTING:
- Will my material agglomerate?
- Can agglomeration solve my material problem?
- Which method of agglomeration will best suit my material?
- What equipment configuration will be required to produce the results I’m looking for?
- What binder, if any, will work best for my material?
- Can my product be improved?
- How can I optimize my existing process?
- How much can dust/product loss be reduced?

MATERIAL CHARACTERISTICS

There are a variety of particle characteristics that can be measured and adjusted during processing to achieve a product with ideal characteristics. The following properties can be measured and fine-tuned:

- Attrition
- Bulk Density
- Compression
- Crush Strength
- Flowability
- Green/Wet Strength
- Moisture Content
- Physical Characteristics
- Particle Size Analysis
- Solubility
- Temperature
THERMAL TESTING

The Innovation Center offers testing for both high temperature applications, as well as drying processes; whether you’re looking to enhance product characteristics, test the feasibility of a new process, or improve upon an existing process, the Innovation Center is well equipped to serve your thermal testing needs.

Thermal testing in the Innovation Center allows you to test small samples of material, while simulating process conditions of a continuous, commercial size rotary unit (kiln or dryer). Testing can be conducted at both batch and pilot scale, and can also be carried out as part of a larger agglomeration or granulation process.

FEEOC gathers a multitude of data during testing, including both process data points and material characteristics to ensure the process is meeting expectations.

FLIGHT/LIFTER DESIGN & PATTERN

When it comes to drying bulk solids, flight (lifter) design and pattern are commonly customized in order to maximize drying efficiency. For this reason, it is common to test a variety of flight designs and patterns when designing a rotary dryer. The Innovation Center offers a flight simulator that can be utilized to test various configurations, confirming the most ideal design and pattern combination for the material to be processed.

PROCESS TESTS AVAILABLE

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

OPTIONAL TESTING CONDITIONS & EQUIPMENT

- Baghouse
- Combustion Chamber
- Direct- or Indirect-Fired
- Parallel (Co-Current) or Counter Current Flow
- Reducing Atmosphere
- Removable Flights, Dams, and Bed Disturbers
- Thermal Oxidizer
- Water Quench Tower
- Wet Scrubber

DATA GATHERED

- Air Volume
- Feed & Product Physical Analyses
- Burner Fuel Usage
- Drum Slope
- Emissions
- Feed Rate
- Gas Sampling & Analysis
- Residence Time
- Rotational Speed
- Screen Analysis of Feed & Product
- Temperature Profiles
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.

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

Agglomeration: Drum, Pan Pelletizer, Pin Mixer  
Drying: Rotary Drum Dryer, Fluid Bed Dryer  
Blending: Pug Mill  
Roll Compaction: Roll Compactor  

Thermal Process: Rotary Klin
**DATA IN REAL TIME**

Our system allows you to monitor, trend, and adjust various data points in real time, all from a single interface or mobile device. This includes:

- Current (Amps)
- Feed Rate
- Flow Rates/Product Flow
- Fuel Usage
- Horsepower
- System Pressure

- Temperature
- Torque
- Gas Sampling & Analysis (Oxygen, Carbon Monoxide, Nitric Oxide, Nitrogen Dioxide, Sulfur Dioxide, and combustibles discharged from various thermal processes)

**UNPARALLELED REPORTING CAPABILITIES**

A control system from Rockwell Automation provides state-of-the-art data collection and reporting capabilities. Our system allows you to select only the variables you want to report on, from the exact time frame you’re looking for. This is especially beneficial in the Innovation Center, allowing returning customers to pick up exactly where they left off.

FEECO can integrate third party equipment into your control system, giving you complete process tracking and visualization.

Secure remote access to the system provides unparalleled troubleshooting capabilities.
BENEFITS TO TESTING WITH FEECO

Testing in the FEECO Innovation Center provides an invaluable opportunity to test in a controlled environment, allowing you to gain a familiarity with your material, while reducing the chance for unforeseen problems after process scale-up. Some of the many advantages to testing in the FEECO Innovation Center include:

- **MATERIAL EXPERIENCE**: FEECO has been a pioneer in material processing since the 1950s, and has extensive knowledge around thousands of materials and material samples. This experience allows us to better understand your project on both a micro and macro level and deliver a custom processing solution that contributes to your company’s bottom line.

- **COMPLETE PROCESS KNOWLEDGE**: As experts in process design, FEECO is familiar with each aspect of a process, from agglomeration and kiln processing, to drying and cooling, allowing us to look at how the process will function as a whole, instead of each individual portion.

- **PROCESS SCALE-UP**: Once the process configuration has been defined, FEECO can aid in process scale-up, as well as manufacturing the custom equipment needed to get the job done.

- **VIRTUAL LAB**: FEECO offers a unique Virtual Lab where customers can view their material being tested in real time, without having to come to the FEECO facility.

INTERESTED IN TESTING?
It’s easy! Simply follow the steps listed below.

1. Fill out some **paperwork**
2. Send us a **sample**
3. We’ll run some **tests**
4. We’ll mail you the **results**

ON-SITE TESTING
FEECO also offers a variety of rental equipment to accommodate your in-house testing needs.
THE FEECO COMMITMENT TO QUALITY

FEECO International, Inc. was founded in 1951 as an engineering and equipment manufacturer. FEECO is recognized globally as an expert in providing industry-leading process design, a range of engineering capabilities, including everything from process development and sample generation, feasibility studies, to detailed plant engineering, as well as manufacturing to a variety of industries, including: fertilizer and agriculture, mining and minerals, power/utility, paper, chemical processing, forest products and more. As the leading manufacturer of processing and handling equipment in North America, no company in the world can move or enhance a concept from process development to production like FEECO International, Inc.

The choice to work with FEECO means a well-rounded commitment to quality. From initial feasibility testing, to engineering, manufacturing, and aftermarket services, we bring our passion for quality into everything we do. FEECO International follows ISO 9001:2015 standards and procedures.