ABOUT

FEERO has developed a reputation as a leader in custom thermal processing solutions through helping companies around the world to develop advanced systems for a variety of applications. From process development, to sizing and design, and even manufacturing a custom rotary kiln, we can guide you through every step of the way.

What sets FEERO systems apart from our competitors is the customized solutions we offer. Our process experts work with our Innovation Center to develop a process around your material’s unique characteristics and the goals of your intended process. We then use the data gathered through testing to scale up the process and design and manufacture a custom rotary kiln for full-scale production.

COMPLETE SYSTEM CAPABILITIES
In addition to the kiln itself, FEERO can provide a complete system with all necessary support equipment, including:

- Material Handling
- Agglomeration
- Drying
- Afterburner/SCC

- Baghouse/Scrubber
- Acid Gas Removal
- Product Cooling
- Gas Cooling/Quench Tower

WHO WE WORK WITH
FEERO’s expertise has been sought by everyone from start-ups to Fortune 100 companies seeking innovative solutions in process design, engineering, and manufacturing for a variety of industries. Some of these companies include:

- xstrata nickel
- Honeywell
- SGI
- RioTinto
- The Ohio State University
- PotashCorp

COMMON MATERIALS:
- Activated Carbon
- Alumina
- Biochar
- Catalysts
- Contaminated Soil
- Electronic Waste
- Petroleum Coke
- Phosphate Ore
- Pigments
- Precious Metals
- Proppants
- Specialty Ceramics
- Specialty Chemicals
- Waste Lime Sludge
- Waste Materials
Advanced thermal processing

What makes our capabilities so valuable is that through testing in the Innovation Center, we have the ability to engineer a custom thermal processing system that fits our customers’ exact needs. This has put us on the cutting edge of the development of some of the world’s most innovative technologies.

- Mike Weinecke
  FEFCO Senior Process Engineer
**DIRECT-FIRED KILNS**

Direct-fired rotary kilns offer efficient processing for high temperature applications. A direct-fired rotary kiln heats material by passing the combustion gases through the rotary kiln. The combustion can either occur in a combustion chamber if direct flame radiation is to be avoided, or the flame can be directed down the length of the rotary kiln.

Direct-fired rotary kilns can operate in either the co-current mode, where combustion gases and solids move in the same direction, or in the counter current mode, where the gases and solids move in opposition to each other.

While all FEECO kilns are custom engineered around the material to be processed and the unique processing goals of the customer, the base of a direct-fired unit uses standard components. The 3D illustration above shows a basic rotary kiln.

**CAPACITY**

1 TPH - 50 TPH

(1 MTPH - 45 MTPH)

Maximum capacity is dependent on process variables unique to each application

**SIZE**

Up to 15’ [4.6m] diameter x 100’+ (30.5m+)

**FEATURES**

- Optimized refractory linings
- Engineered shell to eliminate distortion and misalignment due to high operating temperatures

**OPTIONAL COMPONENTS**

- Various Seal Options
- Machined Bases
- Screw Conveyor Feeder
- Automatic Gear Lubrication System
- Exhaust Gas Handling Equipment
- Ductwork
- Various Burner Configurations
- Components for increasing efficiency (flights, dams, bed disturbers, etc.)

**FUEL TYPES**

- Fuel Oil
- Natural Gas/Propane
- Waste Heat
- Biogas

**DRIVE OPTIONS**

- Chain & Sprocket
- Girth & Pinion Gear
- Friction Drive
INDIRECT-FIRED KILNS

While direct-fired kilns offer an efficient processing option, this method of processing is not always appropriate. Numerous applications exist where an indirect-fired kiln can provide more effective processing.

An indirect-fired kiln is enclosed in a furnace, which is then heated externally (as shown in the diagram above). This avoids contact between the combustion gases and the material to be processed. Indirect kilns offer three major advantages over their direct-fired counterparts:

1. When processing in a direct-fired kiln, fine materials can become entrained in the gas, and carried out to the baghouse. An indirect kiln avoids this issue, because there is minimal air moving through the drum.

2. Smaller exhaust gas treatment equipment is required, because the heating medium is kept separate.

3. The processing environment can be more tightly controlled. Processing in an indirect-fired kiln allows temperatures to be adjusted along the length of the drum, providing precise temperature control. Additionally, because there is no contact with the combustion gases, the internal processing environment can be kept inert.

CAPACITY | 200 LB/HR - 20 TPH
(91 kg/hr - 18 MTPH)

SIZE | Up to 15’ (4.6m) Diameter x 75’+ (23m+) Heated Length

FEATURES
- Heat resistant alloy shell
- Engineered shell to eliminate distortion and misalignment due to high operating temperatures
- Separate zones for temperature control
- Integrated cooling zone can be added

OPTIONAL COMPONENTS
- Various Seal Options
- Machined Bases
- Screw Conveyor Feeder
- Automatic Gear Lubrication System
- Ductwork
- Components for increasing efficiency (flights, dams, bed disturbers, etc.)
- Internal Bed Temperature Measurement

MATERIAL OPTIONS
- Carbon Steel
- Stainless Steel
- Specialty Alloys
- Cladded Steel
- AR Steel

FUEL TYPES
- Fuel Oil
- Natural Gas/Propane
- Electricity
- Waste Heat
- Biogas
DRIVE ASSEMBLY OPTIONS

A variety of drive assembly options exist, with the choice between them depending on the drive horsepower, and the overall size of the drum.

**CHAIN & SPROCKET DRIVE**
Chain and sprocket drive assemblies are reserved for smaller drums, running up to 75 horsepower (55kw). This type of arrangement is typically not suitable for larger drums running above 75 horsepower, but is ideal for smaller jobs, as it is cost-effective, and easy to run.

**GEAR & PINION DRIVE**
The gear and pinion drive assembly is best for heavy-duty applications running above 75 horsepower (55kw). While this type is more costly, it operates better in demanding applications and requires less maintenance.

**FRICITION DRIVE**
Friction drive assemblies are reserved for small applications requiring low horsepower. This is commonly seen with drums around 6’ (1.8m) and under. With a friction drive, two of the four trunnion wheels are connected by one shaft and driven by a shaft mounted reducer and motor arrangement.

Direct drive assemblies are also available.
APPLICAtIONS

Because rotary kilns use heat to cause a physical change or chemical reaction within the material, both direct- and indirect-fired kilns can be used to carry out a variety of processes. An explanation of some of the more common applications are listed below. All of these processes can be tested in the FEECO Innovation Center.

CALCINATION
Calcination refers to the process of heating a material to a temperature that will cause chemical dissociation (chemical separation). This process is used frequently in the creation of inorganic materials, for example, the dissociation of calcium carbonate to create calcium oxide and carbon dioxide.

THERMAL DESORPTION
Thermal desorption is also a separation process. This process uses heat to drive off a volatile component, such as a pesticide, from an inorganic mineral, such as sand. The component is vaporized at the increased temperature, causing a separation without combustion. In some cases, an indirect rotary kiln would be best for this application, because the volatile chemicals may be combustible. The indirect kiln will supply the heat for desorption, without the material coming into direct contact with the flame.

ORGANIC COMBUSTION
Organic combustion refers to the treatment of organic wastes with the intent of reducing mass and volume. Organic waste is treated in the kiln, leaving behind an ash with considerably less mass and volume. This allows for more efficient and effective deposit of waste materials into landfills.

SINTERING/INDURATION
Sintering is the process of heating a raw material to the point just before melting. This increases the strength of the material, and is commonly used in the proppant industry, where sand or ceramic materials are made stronger.

HEAT SETTING
Heat setting involves bonding a heat resistant core mineral with another, less heat resistant coating material. Unlike an unheated coating process, here, a rotary kiln heats the coating material to just below liquefaction point, allowing it to coat the heat resistant core more evenly and more securely. This process is commonly seen in the manufacture of roofing granules, where a mineral such as granite is coated with a colored pigment, producing a product that is both durable and aesthetically pleasing.

REDUCTION ROASTING
Reduction roasting is the removal of oxygen from a component of an ore usually by using Carbon Monoxide (CO). The CO is typically supplied by mixing a carbonaceous material such as coal or coke with the ore or by feeding it separately. Examples are the reduction roasting of a hematite containing material to produce magnetite that can be magnetically separated. In the Waelz process, zinc oxide in steel mill wastes is reduced to metallic zinc and volatilized for recovery in the off-gas system.
CUSTOMIZED TESTING SOLUTIONS

Testing in the FEECO Innovation Center allows you to test small samples of material, while simulating process conditions of a continuous, commercial size kiln. Testing can be conducted at both batch and pilot scale.

FEECO gathers a multitude of data during testing, including both process data points and material characteristics to ensure the process is meeting expectations. Solid samples can be regularly withdrawn in order to determine the material chemistry and physical properties of the material at various intervals. Depending on your needs, we offer testing 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.

AVAILABLE TESTING EQUIPMENT

A variety of testing options used to simulate continuous commercial rotary units are listed below. The kilns can be operated to heat solids up to 3000°F (1650°C), and can simulate both co-current and counter current flow (where applicable).

- **Batch Direct-Fired Kiln**
  - 18” diameter x 24”

- **Batch Indirect-Fired Kiln**
  - 10.5” diameter x 2’ heated length

- **Pilot Direct-Fired Kiln**
  - 30” diameter x 20’

- **Pilot Indirect-Fired Kiln**
  - 6.5’diameter x 84” heated length

PROCESS TESTS AVAILABLE

- Calcination
- Carbon Activation
- Catalyst Activation
- Heat Setting
- Incineration
- 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

TYPICAL DATA GATHERED

- Air Volume
- Burner Fuel Usage
- Drum Slope
- Emissions
- Feed & Product: Physical and Chemical Analyses
- Feed Rate
- Gas Sampling & Analysis
- Particle Size Analysis of Feed & Product
- Quench Tower Water Flow
- Residence Time
- Rotational Speed
- Temperature Profiles
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.

Additional capability to customize data reporting features the ability to accommodate a broad range of operational variables.

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
- Gas Sampling & Analysis
- Horsepower
- Speed
- System Pressure
- Temperature
- Torque

AUTOMATION AT ITS BEST
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 FEECO Innovation Center features a Rockwell Automation PLC/MCC system, which utilizes current technologies for optimizing testing operations.

AFTERMARKET
We are an extension of your maintenance department. From start-up and installation support, to emergency services and preventative maintenance, FEECO offers a variety of services to help keep your equipment running at its best for years to come, whether your equipment is FEECO brand or otherwise. We offer the following services:

- Installation & Start-up Support
- Spare Parts
- Field Services
  - Tire & Trunnion Wheel Grinding
  - Drum Trunnion Training
  - Alignments
  - Gear Replacement
  - Spare Parts Installation
  - Laser Alignment
  - Inspections
  - Equipment Audits
- Training Programs
- Process Optimization Engineering
- 24-Hour Emergency Service
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.