Pyro processing systems
Technology at work for you
Features and capabilities

An extensive product offering based on our core technologies and designs
Contents

• Metso introduction
• Pyro introduction
• Pyro products features and benefits
• Pyro process research and test center
• Services business line
• Conclusion
Metso Corporation

Metso is a worldwide recognized supplier of sustainable technology and services for the mining and construction, power generation, oil and gas, recycling, as well as pulp and paper industries.

- 30,000 employees in over 50 countries
- 7.5 billion EUR 2012 net sales
- Shares listed on NASDAQ OMX Helsinki Ltd
Worldwide sustainable technology and services

Metso Mining and Construction

Crushing and screening equipment business line

- Jaw crushers
- Cone crushers
- Impact crushers
- Screens, feeders, and scalpers
- Track mounted mobile crushers and screens
- Wheel mounted crushers and screens
- Equipment and plant automation

Minerals processing solutions business line

- Mining crushers
- Mining screens
- Grinding mills
- Process equipment
- Bulk material handling
- Pyro processing
- Systems
- Technology development
- Equipment and plant automation

Services business line

- Wear and spare parts
- Engineered-to-order (ETO) parts
- Repairs
- Life cycle services
- Process technology and innovation
- Materials technology
- Pumps
Metso MAC history – where we came from
Pyro processing systems

Product line introduction
Pyro processing systems

Introduction

The pyro processing group designs, engineers, manufactures, and markets systems and equipment which increase the intrinsic values of ores, minerals, wastes, and related materials by changing their mechanical and/or chemical properties through the application of heat.

• Our capabilities emerge from the core technologies and technical experience of:
  - Allis-Chalmers
  - Armstrong-Holland
  - Kennedy Van Saun (KVS)
  - MPSI-Harding
  - Pyrotherm
  - Stansteel
Pyro processing systems
Global product center located in Danville, Pennsylvania, USA

• Completely localized engineering company within a large global company, focused on the design of processing plants (systems) worldwide, consisting of approximately 130 employees focused on the following disciplines:
  - Sales and proposals
  - Project management (experience on projects up to €100 million)
  - Supply chain management (purchasing, logistics, quality assurance)
  - Engineering and drafting (process, civil, mechanical, electrical)
  - Process research and test center
  - Field services
  - Spare parts
  - Finance and administration
Pyro processing systems

Product offering

- Rotary kilns
- Dryers and coolers
- Indirect kiln systems
- Iron ore pelletizing systems
- Lime calcining systems
- Lime hydration systems
- Petroleum coke calciners
- Waste processing systems
- Specialty calcining systems
Dryers and coolers

Features and benefits
Dryers and coolers

Introduction

Drying is the removal of moisture from materials, and can be the beginning, intermediate, or final phase in the material processing.

Cooling is the reduction of material temperature, normally the final phase in the material processing.

- Efficient drying and cooling systems are critical to successful process design and implementation
- Metso’s range of thermal drying and cooling systems includes:
  - Fluid bed
  - Holo-Flite® processor
  - Rotary systems
## Dryers and coolers

### Materials processed

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<thead>
<tr>
<th>Agriculture &amp; Food</th>
<th>Chemicals &amp; Minerals</th>
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Fluid bed
Features and benefits
Fluid bed

Introduction

- Stationary single chamber unit for cooling and drying applications
- Utilizes fluidizing air for homogenous mixing and drying of particles
- Ideal for drying of fine materials (8 mm and below) to low moisture content (<0.5%) product
- Capacities ranging from 0.5 tons per hour to 550 tons per hour in a single unit
Fluid bed

Principles of operation

• A stationary cylindrical vessel (expansion chamber and windbox) separated by a horizontal perforated plate (fluoplate)
• Fans deliver heated forced air through combustion chamber and windbox up through the fluoplate
• Material is introduced onto the fluoplate which is then fluidized
• Product discharges over a weir and onto material handling equipment
Fluid bed
System overview

- Cyclones
- Dust Collector
- Exhaust stack
- Exhaust fan
- Fluidizing air fan
- Combustion air fan
- Burner system
- Combustion chamber
- Stationary dryer unit
Fluid bed

System advantages

• All particles are surrounded by fluidizing air, creating the optimal method of heat transfer
• Excellent heat transfer results with minimal fuel consumption
• Maintenance is practically non-existent, there are no moving parts
• A well agitated and mixed bed ensures the absence of hot or cold spots in the fluid bed producing consistent product quality
• Can withstand significant rate, moisture, and temperature fluctuations in feed material
• Simple to control
# Fluid bed

## Reference projects*

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<th>Process Type</th>
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*Partial installation list
Fluid bed

Featured product

• 120 MTPH Dryer and Cooler
  - **Client:** Multiplex Bateman Joint Venture
  - **Location:** Mozambique
  - **Feed Material:** Ilmenite
  - **Feed Moisture:** 8%
  - **Product Moisture:** < 0.2%
  - **Fuel:** Fuel Oil
  - **Metso Scope:** Design and supply of fluid bed dryer, fluid bed cooler, dryer firing system, dust collector, fans, and controls

• Equipment Specifications
  - Dryer 4.5 m diameter
  - Cooler 1.6 m diameter x 6.6 m long
Holo-Flite® processors

Features and benefits
Holo-Flite® processors

Introduction

• Indirect heat exchanger for heating, cooling, and drying applications

• Utilizes heat transfer media (water/glycol, steam, or thermal fluid) in screws and trough

• Proven design with numerous installations worldwide, heating up to 288°C and cooling feed temperatures from 1200°C

• Capacities ranging from 0.5 tons per hour to 50 tons per hour in a single unit
Holo-Flite® processors

Principle of operation – heat transfer fluid flow pattern

- **Self-Supporting Rotary Joint**: Allows screw to rotate while providing a seal to stationary piping.
- **Front Flight**: Conveys material continuously through the Holo-Flite® Processor.
- **Block Plate**: Prevents intermixing of inlet and outlet heat transfer agent.
- **Hollow Stem Pipe**: Seamless, heavy-walled pipe.
- **Back Flight**: The jacketed portion of the flight allows the heat transfer agent to circulate through the flights.

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- **Guide**: 
- **Seal Ring**: 
- **Spring**: 
- **Siphon Tube**: Allows inlet and outlet heat transfer agent to move through the same end of the screw.
- **Outer Twin Pad Wrap**: Wrapped around the stempipe. Flights are welded to this wrap, allowing them to expand and contract independently of the stempipe. The Holo-Flite® Processor is the only machine with this patented feature.
- **Shaft**: Extends through the trough housing and is supported by bearings.
Holo-Flite® processors

System overview
Holo-Flite® processors

System advantages

• Material in a contained environment
• Efficient recycling of heat transfer media through rotating screws
• Simple to control
• Variable speeds
• Long life/high availability
• Minimal space requirements
• Low energy consumption
• Nominal dust generation
• Low maintenance
• Easily accessible
## Holo-Flite® processors

### Reference projects*

<table>
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<tr>
<th>Client</th>
<th>Location</th>
<th>Application</th>
<th>Process Type</th>
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<td>Collahuasi</td>
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<td>Moly Disulfide</td>
<td>Dryer</td>
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</tbody>
</table>

*Partial installation list
Holo-Flite® processors

Featured project

• 3.6 MTPH Dryer
  - **Client**: Anglo American
  - **Location**: Chile
  - **Feed Material**: Molybdenum Concentrate
  - **Feed Moisture**: 18%
  - **Product Moisture**: 4%
  - **Heating Agent**: Hot Oil
  - **Metso Scope**: Design and supply of Holo-flite®, motors, drive, thermal fluid heating system

• Model D2418-6 Specifications:
  - Dual intermeshing screws
  - Screws 5.5 m long x 610 mm diameter
  - Screw operational speed 0.7 RPM
Rotary dryers and coolers

Features and benefits
Rotary dryers and coolers

Introduction

• Direct heat exchanger for drying and cooling applications
• Utilizes air as heat transfer media
• Parallel flow
• Counter current flow
• Maximized convective heat transfer
• Proven design with numerous applications installed worldwide
• Expertise with capacities of 250 tons per hour and higher in a single unit
Rotary dryers and coolers

Principles of operation

• Main component is a horizontal rotating cylindrical vessel
• Dryers include separate air heater at one end
• Fans induce heated air through combustion chamber and dryer
• Material is introduced via feed pipe
• Internal lifters cascade material through air stream as vessel rotates
• Product discharges through stationary hood onto product conveyor
Rotary dryers and coolers

Overview – direct fired rotary dryer
Rotary dryers and coolers

System overview

- Rotary shell and drive gear system
- Internal lifters
- Combustion system
- Instrumentation and control system
- Off-gas handling system
- Process fans
- Feed and product handling equipment
Rotary dryers and coolers

System advantages

- High reliability
- High thermal efficiency
- Low power consumption
- Optimized dryer internals based on proprietary designs
- Suitable for a wide range of materials
- Capable of processing fine or coarse materials
# Rotary dryers and coolers

## Reference projects*

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*Partial installation list
Rotary dryers and coolers

Featured product

• 250 MTPH Rotary Dryer
  - **Client:** Xstrata – Falconbridge
  - **Location:** Dominican Republic
  - **Feed Material:** Nickel laterite ore
  - **Feed Moisture:** 30%
  - **Product Moisture:** 20%
  - **Fuel:** Naptha
  - **Metso Scope:** Design and supply of rotary dryer including internals, control system, field advisory services, and commissioning

• Equipment Specifications
  - Dryer 3.65 m diameter x 38.40 m long
Iron ore pelletizing systems
Features and benefits
Iron ore pelletizing systems

Introduction

- Iron ore concentrate pellets are upgraded into high quality feed for both blast furnace and direct reduction furnace operations
- Metso’s range of pelletizing products includes:
  - Balling equipment
  - Grate-kiln pelletizing system
    - 54 installations worldwide
    - Capacities ranging from 3 million to 7 million tons per year per line
  - Straight grate pelletizing system
    - 44 installations worldwide
    - Capacities ranging from 0.6 million to 9 million tons per year per line
Iron ore pelletizing systems

Balling equipment

- Table feeders
- Balling discs
- Balling drums
- Roller screens
- Ball smashers
- Reciprocating conveyors
- Wide belt conveyors
- Roller classifiers
Grate-kiln iron ore pelletizing system

Features and benefits
Grate-kiln iron ore pelletizing system

Principles of operation

• Traveling grate
  - Pellets are dried and partially indurated through multiple cross flow process zones: updraft drying, downdraft drying, tempered preheat, and preheat, strengthening pellets for processing in rotary kiln
  - Average bed depth 180 mm (no hearth layer required)

• Rotary kiln
  - Final point of pellet induration in system
  - Rotation of kiln exposes entire pellet bed to heat radiating from the burner resulting in uniform pellet quality
  - Kiln burner utilizes secondary combustion air (which is hot cooler off gas) to heat material bed to nominal of 1340 °C completing the slag bonding and mineral bridging to form pellets

• Annular cooler
  - Multiple zone cooler with recuperation ducts to traveling grate
  - Recovers essentially all of the sensible heat from the pellet bed resulting in overall system energy savings
Grate-kiln iron ore pelletizing system

Major components

- Traveling Grate
- Rotary Kiln
- Preheat Fan
- Balling Area
- Electrostatic Precipitators
- Heat Recovery Ducts
- Annular Cooler
- Process Fans
Grate-kiln iron ore pelletizing system

System advantages

• Independent variable speed control of drying/preheating, induration, and cooling

• System design allows for a lower bed depth providing a uniform temperature profile, a lower pressure drop, and less power consumption

• Use of rotary kiln ensures better mixing of the pellet bed resulting in more homogeneous product

• One kiln burner providing the single source of energy for the system
  - Kiln burners have the capability to fire multiple fuel types (solid, liquid, gas)
# Grate-kiln iron ore pelletizing system

## Reference projects*

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<td>Magnetite</td>
<td>1</td>
<td>6,000,000</td>
</tr>
</tbody>
</table>

*Partial installation list
Grate-kiln iron ore pelletizing system

Featured project

- **6,000,000 MTPY Pelletizing System**
  - **Client:** LKAB
  - **Location:** Kiruna, Sweden
  - **Feed Material:** Magnetite
  - **Fuel:** Coal
  - **Metso Supply:** Complete design and equipment supply of traveling grate, rotary kiln, and annular cooler including oil burners, refractory lining, process and equipment cooling fans, duct work, lubrication and drive systems, project management, mechanical advisory, mechanical erection, and commissioning.

- **Equipment Specifications:**
  - Traveling grate 5.66 m x 70.24 m long
  - Rotary kiln 7.47 m x 6.86 m x 40 m long
  - Annular cooler 28.04 m x 3.657 m
Straight grate iron ore pelletizing system

Features and benefits
Straight grate iron ore pelletizing system

Principles of operation

• Green pellets are dried, preheated, indurated, and cooled on a continuous moving grate without intermediate transfers

• The machine is fed continuously with green pellets across the full width of the machine on top of a protective hearth layer
  - Average green pellet bed depth 350 mm
  - Average hearth layer bed depth 75 mm

• The gas flow scheme is designed to recuperate a significant amount of sensible heat from the process gas streams
  - High level heat is recuperated directly from the first cooling zone
  - Low level heat is recovered from the second cooling zone for drying pellets

• The process air introduced for pellet cooling is circulated from the cooling zone of the grate in a multi-pass manner to the other process zones to obtain thermal efficiency
Straight grate iron ore pelletizing system

System overview
Straight grate iron ore pelletizing system

System advantages

• Independent control of multiple burners provides high flexibility

• System design allows for gentle material handling (single machine with no intermediate transfers)

• Pallet cars can be maintained off line, minimizing system downtime

• Stationary refractory requires limited maintenance
Straight grate iron ore pelletizing system

Reference projects*

<table>
<thead>
<tr>
<th>Client</th>
<th>Location</th>
<th>Ore Type</th>
<th>QTY</th>
<th>Capacity Ea. (MTPY)</th>
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<tr>
<td>Essar Steel</td>
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<td>Magnetite</td>
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<tr>
<td>Iron Ore Company of Canada</td>
<td>Canada</td>
<td>Specular Hematite / Magnetite (70/30)</td>
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<tr>
<td>Samarco</td>
<td>Brazil</td>
<td>Hematite</td>
<td>2</td>
<td>6,000,000</td>
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<tr>
<td>Essar Steel</td>
<td>India</td>
<td>Hematite</td>
<td>2</td>
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<td>Hammersley Iron Pty. Ltd.</td>
<td>Australia</td>
<td>Earthy Hematite</td>
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<td>Arcelor Mittal – Quebec Cartier Mining</td>
<td>Canada</td>
<td>Specular Hematite</td>
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<td>Shougang Hierro – Marcona</td>
<td>Peru</td>
<td>Magnetite / Hematite (70/30)</td>
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<td>Ispat Mexicana S.A. de C.V.</td>
<td>Mexico</td>
<td>Hematite</td>
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<td>Hibbing Taconite</td>
<td>USA – MN</td>
<td>Magnetite</td>
<td>3</td>
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<tr>
<td>Jindal Steel &amp; Power Ltd.</td>
<td>India</td>
<td>Hematite</td>
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<tr>
<td>Jindal Steel Works – Amber River</td>
<td>India</td>
<td>Hematite</td>
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<tr>
<td>Magnetation Inc.</td>
<td>USA – IN</td>
<td>Magnetite</td>
<td>1</td>
<td>3,000,000</td>
</tr>
</tbody>
</table>

*Partial installation list
Straight grate iron ore pelletizing system

Featured project

• 4,000,000 MTPY Pelletizing System
  - **Client:** Jindal Steel Power Ltd.
  - **Location:** Barbil, India
  - **Feed Material:** Hematite
  - **Fuel:** Coal Gas / Oil
  - **Metso Supply:** Complete design and partial equipment supply of traveling grate components including pallet cars, rails, drive mechanism, burners, lubrication and drive systems, project management, mechanical advisory, and commissioning.

• Equipment Specifications:
  - Traveling grate 4.0 m x 116 m long
Iron ore pelletizing systems comparison

Grate-kiln
- Capable of firing solids, liquids, and gases
- Shallow bed depth results in lower electrical power consumption
- Three separate entities (traveling grate, kiln, cooler) acting in unison allows tighter control of residence time in each area of the process
- Single kiln burner the main source of energy for the entire system
- More consistent product quality due to dynamic bed in the kiln which exposes the entire pellet bed to the highest temperature zone

Straight grate
- Capable of firing liquids or gases (no solid fuels)
- Deeper bed depth results in higher electrical power consumption
- Single machine for entire process
- Multiple burners provide for higher process flexibility
- More variation in product quality due to stationary bed
Limestone calcining systems

Features and benefits
Limestone calcining systems

Introduction

The conversion of limestone (CaCO$_3$) to lime (CaO)

- Lime is used in steel making, water treatment, chemical processing, gold mining, and flue gas desulfurization

- Metso is the world’s leading supplier of preheater lime kiln systems, with over 125 installations worldwide

- Capacities ranging from 300 tons per day to 1,400 tons per day in a single rotary kiln system
Limestone calcining systems

Principles of operation

• Limestone feed enters the stone bin and is directed by gravity to a series of discharge chutes along the perimeter into the preheater located directly below

• Kiln exhaust gases enter the preheater, resulting in approximately 35% calcination of limestone before transference to the rotary kiln

• Preheater hydraulic rams move the material into the kiln via transfer chute

• Fully calcined lime is discharged from the rotary kiln into forced air static cooler

• Lime product is discharged from cooler via vibrating feeders to product conveyor
Limestone calcining systems

System overview

Stack
Induced Draft Fan
Baghouse
Kiln

Stone Bin
Preheater
Firing Hood
Kiln Burner
Coal Bin
Coal Mill
Cooler
Lime Discharge
Limestone calcining systems

System advantages

• Single kiln burner with capabilities to fire multiple fuels, independently or in combination

• Preheater system will result in lower total fuel consumption compared to long kiln

• Use of standard refractory shapes in system, allowing ease of maintenance

• Sloped floor in preheater allows for gentle transference of partially calcined material into rotary kiln, minimizing dust generation

• Capable of processing fine and coarse feed material
### Limestone calcining systems

#### Reference projects*

<table>
<thead>
<tr>
<th>Client</th>
<th>Location</th>
<th>Capacity (MTPD)</th>
<th>Kiln Size</th>
<th>Preheater Type</th>
<th>Preheater Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graymont – Western</td>
<td>USA – MI</td>
<td>730</td>
<td>4.57 m x 61 m long</td>
<td>Polygon</td>
<td>12 Plunger</td>
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<tr>
<td>Baoshan Iron &amp; Steel</td>
<td>China</td>
<td>1100</td>
<td>4.88 m x 70 m long</td>
<td>Polygon</td>
<td>18 Plunger</td>
</tr>
<tr>
<td>Graymont – Superior</td>
<td>USA – WI</td>
<td>590</td>
<td>3.96 m x 56 m long</td>
<td>Rectangular</td>
<td>8 Plunger</td>
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<tr>
<td>U.S. Lime &amp; Minerals</td>
<td>USA – AR</td>
<td>550</td>
<td>2.90 m x 94 m long</td>
<td>Polygon</td>
<td>12 Plunger</td>
</tr>
<tr>
<td>Taiyuan Iron &amp; Steel (TISCO)</td>
<td>China</td>
<td>1000</td>
<td>4.88 m x 70 m long</td>
<td>Polygon</td>
<td>18 Plunger</td>
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<tr>
<td>Dynatec Ambatovy</td>
<td>Madagascar</td>
<td>565</td>
<td>3.66 m x 55 m long</td>
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<tr>
<td>Graymont – Cricket Mountain</td>
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<td>Industria Nacional de Cemento S.A.</td>
<td>Chile</td>
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<tr>
<td>Novolipetsk Steel (NLMK)</td>
<td>Russia</td>
<td>800</td>
<td>4.27 m x 64 m long</td>
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<tr>
<td>Martin Marietta Magnesia Specialties, Inc.</td>
<td>USA – OH</td>
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<td>4.27 m x 98 m long</td>
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<tr>
<td>Pohang Iron &amp; Steel (POSCO)</td>
<td>South Korea</td>
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<tr>
<td>Freeport-McMoRan</td>
<td>Indonesia</td>
<td>400</td>
<td>3.66 m x 56 m long</td>
<td>Rectangular</td>
<td>8 Plunger</td>
</tr>
</tbody>
</table>

*Partial installation list
Limestone calcining systems

Featured project

• 820 MTPD Preheater Lime Calcining System
  - **Client:** Martin Marietta Magnesia Specialties, Inc.
  - **Location:** Ohio, USA
  - **Feed Material:** Dolomitic limestone
  - **Fuel:** Coal
  - **Metso Supply:** Complete design and equipment supply from stone bin inlet to cooler discharge including baghouse, ID fan, stack, structural steel, refractory, motors, instrumentation, process control system, field service, and commissioning.

• Equipment Specifications:
  - Preheater 12 plunger polygon
  - Rotary kiln 4.27 m x 98 m long
  - Cooler size 8
Lime hydration systems

Introduction

The conversion of lime (CaO) to calcium hydroxide (Ca(OH)$_2$)

- Calcium hydroxide is used in air pollution control, water treatment, chemical processing, and construction
- Technology incorporates latest industry standards while maintaining simplicity of design
- Capacities ranging from 8.5 tons per hour to 40 tons per hour in a single system
Lime hydration systems

Principles of operation

• Lime is metered to the duplex mixer via weigh belt feeder at a controlled rate

• Water is added to the duplex mixer at a controlled rate, initiating the chemical reaction of the water and lime mixture within the adjoining seasoning chamber

• Single paddle shaft mixer in the seasoning chamber simultaneously advances and mixes the water and lime to complete the chemical reaction

• Hydrated lime is discharged from the seasoning chamber to product conveyor
Lime hydration systems

System overview

- Baghouse
- Lime Feed from weigh belt feeder
- Process Water
- Duplex Mixer
- Transition Duct
- Exhaust Fan
- Lime Hydrate Product
- Seasoning Chamber
Lime hydration systems

System advantages

• Proven design of rugged construction
• Ease of control
• High reliability
• Low maintenance
## Lime hydration systems

**Reference projects***

<table>
<thead>
<tr>
<th>Client</th>
<th>Location</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andritz Environmental Solutions, Inc.</td>
<td>USA – KY</td>
<td>2 lines x 23 MTPH</td>
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<tr>
<td>U.S. Lime &amp; Minerals</td>
<td>USA – TX</td>
<td>13.61 MTPH</td>
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<tr>
<td>Mississippi Lime Co.</td>
<td>USA – SC</td>
<td>13.61 MTPH</td>
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<tr>
<td>Freeport McMoRan</td>
<td>Indonesia</td>
<td>13.5 MTPH</td>
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<tr>
<td>Industrias Votorantim, S.A.</td>
<td>Brazil</td>
<td>2 lines x 30 MTPH</td>
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<tr>
<td>Falco Lime, Inc.</td>
<td>USA – MS</td>
<td>27.22 MTPH</td>
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<tr>
<td>Minera del Norte</td>
<td>Mexico</td>
<td>18.14 MTPH</td>
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<tr>
<td>Itau de Minas</td>
<td>Brazil</td>
<td>27.22 MTPH</td>
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<tr>
<td>Union Lime</td>
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<td>12 MTPH</td>
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<tr>
<td>Graymont</td>
<td>Canada</td>
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<tr>
<td>Hitachi</td>
<td>Japan</td>
<td>15 MTPH</td>
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</table>

*Partial installation list*
Lime hydration systems

Featured project

• Two (2) 23 MTPH Atmospheric Hydration Systems
  - **Client:** Andritz Environmental Solutions, Inc.
  - **Location:** Kentucky, USA
  - **Feed Material:** Hi-cal lime
  - **Metso Supply:** Complete design and equipment supply of duplex mixer and seasoning chamber including baghouse, fan, motors, instrumentation controls and commissioning.

• **Equipment Specifications:**
  - Duplex mixer 1.30 m x 3.10 m
  - Seasoning chamber 2.44 m x 4.27 m
Petroleum coke calcining

Features and benefits
Petroleum coke calcining

Introduction

Green petroleum coke (residue of the oil refining process) is upgraded into high quality carbon material for use in anodes in the aluminium smelting process

• Metso is the world’s leading designer of petroleum coke systems, with 60 installations worldwide, equating to an installed capacity of over 9 million tons

• Capacities ranging from 100,000 tons per year to 500,000 tons per year in a single system
Petroleum coke calcining

Principles of operation

• Green coke feed is metered from the storage bin via weigh feeder to the kiln feed pipe
• Green coke is processed in the kiln at approximately 1350°C where volatiles are removed
• Tertiary air system controls the rate of de-volatilization along the axis of the kiln
• Afterburner retention removes additional volatiles from the gas stream
• Calcined coke is discharged from the kiln to cooler and subject to direct water quenching
• Cooled product is discharged from the cooler to product conveyor
Petroleum coke calcining

System overview

- Guillotine Isolation Gate
- Green Coke Feed System
- Green Coke Feed Storage
- Kiln
- Afterburner
- Heated Off Gas Discharge
- Coke Transition
- Firing Hood
- Cooler
- Calcined Coke Discharge
Petroleum coke calcining

System advantages

• Kiln tertiary air system provides for more stable control and minimizes fuels consumption

• Proprietary afterburner design with enhanced air mixing and retention time enhances destruction of pollutants, minimizing burden on downstream gas cleaning equipment

• Direct water quenching in cooler
**Petroleum coke calcining**

**Reference projects***

<table>
<thead>
<tr>
<th>Client</th>
<th>Location</th>
<th>Quantity</th>
<th>Capacity Ea. (MTPY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum Company of America (ALCOA)</td>
<td>USA – LA</td>
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<td>Seadrift Coke</td>
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<td>Pertamina</td>
<td>Indonesia</td>
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<td>Volgogradnefte Orgsintez</td>
<td>Russia</td>
<td>2</td>
<td>100,000</td>
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<td>Fergananefte Orgsintez</td>
<td>Uzbekistan</td>
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<td>Aluminum Company of Bahrain (ALBA)</td>
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<tr>
<td>Petrocoque, S.A.</td>
<td>Brazil</td>
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<td>181,000</td>
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<tr>
<td>Aluminum Company of China (CHALCO)</td>
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<td>190,000</td>
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<td>Sasol</td>
<td>South Africa</td>
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<td>Copetro, S.A.</td>
<td>Argentina</td>
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<td>Numaligarh Refinery</td>
<td>India</td>
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<td>103,000</td>
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<td>China National Offshore Oil Co. (CNOOC)</td>
<td>China</td>
<td>2</td>
<td>225,000</td>
</tr>
</tbody>
</table>

*Partial installation list*
Petroleum coke calcining

Featured project

• Two (2) 225,000 MTPY Coke Calcining Systems
  - **Client:** China National Offshore Oil Co. (CNOOC)
  - **Location:** Huizhou, China
  - **Feed Material:** Petroleum coke
  - **Fuel:** Natural gas
  - **Metso Supply:** Design and partial supply of rotary kiln, rotary cooler, and afterburner including instrumentation, process control system, field service, and commissioning.

• Equipment Specifications:
  - Rotary kiln 3.43 m x 67 m long
  - Rotary cooler 2.89 m x 24 m long
  - Cylindrical afterburner 7.01 m x 71 m long
Waste processing systems

Features and benefits
Waste processing systems

Introduction

• Metso provides rotary kiln incinerators for the destruction of industrial, medical, and hazardous wastes
• Process incorporates latest technology for environmental pollution control as well as for the recovery of valuable energy
• Metso has successfully designed and supplied over 30 installations worldwide
• Capacities ranging from 25 tons per day to 120 tons per day in a single system
Waste processing systems

Principles of operation

• Solid feed system
  - Ram loader to precisely and positively feed solids and containerized waste into the kiln

• Rotary kiln
  - Designed for excess air operation for process control and to operate in ashing mode with dry solids discharge, not wet slag that is detrimental to refractory

• Secondary chamber
  - Vertical cylinder mounted on top of discharge hood so that any slag formation in secondary can drop into the ash conveyor under the discharge hood

• Wet ash conveyor
  - Drag chain conveyor in water bath to cool ash and provide seal against air infiltration, or hoe in water bath for applications with small quantity of ash

• Waste heat boiler
  - Often follows the secondary chamber to generate low to medium pressure steam for in-plant use

• Air emissions control system
  - Custom designed to suit the waste being processed and air emissions regulations
Waste processing systems

System overview
Waste processing systems

System advantages

• Metso has vast experience in development of rotary kilns, transferring this know-how to waste incineration systems

• In-house development and programming of control system results in a reliable system presenting fewer problems during commissioning

• Metso has significant experience working with a variety of waste combinations

• Metso system operates in ashing mode (below the melting temperature of glass in the waste feed stream,) not slagging mode
  - Ashing mode uses less fuel in the kiln and allows for a simpler and less expensive refractory design

• Kiln refractories also require less maintenance than with slagging operation where there is significant risk of refractory damage
## Waste processing systems

### Reference projects*

<table>
<thead>
<tr>
<th>Client</th>
<th>Location</th>
<th>Waste Type</th>
<th>Heat Release (GJ/hour)</th>
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<tbody>
<tr>
<td>Merck &amp; Co.</td>
<td>USA – NJ</td>
<td>Biomedical</td>
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<td>Merck &amp; Co.</td>
<td>USA – PA</td>
<td>Biomedical</td>
<td>31.8</td>
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<td>International Technologies for OHM</td>
<td>USA – OK</td>
<td>Hazardous</td>
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<td>E. Young Chemical</td>
<td>South Korea</td>
<td>Industrial</td>
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<td>Chi Mei Corporation</td>
<td>Taiwan</td>
<td>Industrial</td>
<td>74.0</td>
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<tr>
<td>Anderson 2000</td>
<td>Saudi Arabia</td>
<td>Hazardous</td>
<td>48.1</td>
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<tr>
<td>Danish Waste Management</td>
<td>Israel</td>
<td>Hazardous</td>
<td>58.2</td>
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<tr>
<td>Interpro MEW Joint Venture</td>
<td>Thailand</td>
<td>Hazardous</td>
<td>44.0</td>
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<tr>
<td>Kobe Steel</td>
<td>Japan</td>
<td>Contaminated Soil</td>
<td>15.0</td>
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<tr>
<td>China Tianchen Chemical Shanghai Chemical Industrial Park (SCIP)</td>
<td>China</td>
<td>Hazardous</td>
<td>64.0</td>
</tr>
</tbody>
</table>

*Partial installation list
Waste processing systems

Featured project

• Two (2) 110 MTPD Industrial Waste Incineration Systems
  - **Client:** China Tianchen Chemical (SCIP)
  - **Location:** Shanghai, China
  - **Feed Material:** Hazardous Industrial Waste
  - **Fuel:** Oil
  - **Metso Supply:** Complete design and equipment supply of two identical process lines, each with multi-part feed system, rotary kiln, secondary chamber, wet ash handling system, water tube waste heat boiler, complex emissions control system, process control system, erection advisors, commissioning
Specialty processing systems
Features and benefits
Specialty processing systems

Introduction

Metso has designed numerous specialty processing systems incorporating the use of rotary kiln technology

• These systems have utilized both direct and indirect fired rotary kilns to process a variety of materials including:
  - Specialty minerals (bauxite, lithium ore)
  - Soil decontamination
  - Lightweight aggregates
  - Tire pyrolysis
  - Carbon regeneration
Specialty processing systems

Indirect fired rotary kiln

• Used when material being processed cannot come into contact with combustion or process gases
• Shell made from stainless steel or other high temperature material
• Burners positioned outside shell along kiln axis
• Limited on size and material temperature
Specialty processing systems

Carbon regeneration indirect kiln system

• Activated carbon is used in numerous industries (primarily gold processing) as an absorber of contaminants
  - It is necessary to regenerate the carbon in order to retain absorptive properties of the carbon as close as possible to that of new fresh carbon

• Indirect fired kilns are the most common type of equipment used to regenerate activated carbon

• Metso offers indirect kilns with heat recovery for carbon regeneration

Carbon regeneration kiln at a gold processing plant
Specialty processing systems

Tire pyrolysis

• Thermo-chemically processes waste tires into:
  - Solid material, which consists principally of the original carbon black
  - Gas, which has a high thermal value and can be used to generate electricity
  - Oil, which can be used as a bunker C fuel or refined into transportation fuel or chemical by-products
  - Scrap steel

• The return of these materials to their original state is accomplished without generating waste materials. The environmental impact is:
  - Reduced landfill of scrap tires
  - Reduced oil use to generate carbon black
  - Reduction of CO\(_2\) emissions
Specialty processing systems

Ported kiln

• Incorporates use of multiple radially-spaced inlet ports along the length of the vessel by which a tertiary air is introduced

• Provides precise temperature adjustment and complete control of the atmosphere for the full length of the kiln

• Commonly used in reduction applications
Pyro processing control systems
Complete offering for plant controls

- PLC based control system design
  - Flexibility with manufacturers
  - Linked to operator interface system PCs

- Programming
- Detailed design drawings
- Instrumentation
- Motor Control Centers
- Field installation and testing
- Plant startup and commissioning
- Advanced control systems
- Optimized control systems
Rotary kiln burners

Engineered for specific job requirements

• Multi-fuel capability designed to handle solid, liquid, and gas separately or in combination

• Complete fuel flow and flame shape control with directional adjustability

• Low primary air requirement maximizes fuel efficiency

• Sturdy, rugged construction for high temperature combustion utilizes stainless steel materials for blast pipe, internals, and fuel nozzles

• Burner ratings up to 315 GJ/hr
Rotary kiln end seals

Metso Goodeal® and Superdeal™ seals

• Low leakage reduces fuel consumption
• Average of 10% fuel savings on most retrofitted systems
• Can be retrofitted on all types of kilns
• Low maintenance
• Self adjusting
• Multiple mounting arrangements
• Metso patented design
• Over 500 installations worldwide
Rotary kiln end seals

Metso Superdeal™ Seal

Metso Goodeal® Seal
Laboratory equipment

Metso, Marcy® and Morse® Brands

Complete line of high quality laboratory and pilot plant products for sample preparation and size reduction. Available for industrial and academic applications.

Marcy® Cone Crusher
Reduces 0.5" feed to < 10 mesh in a single pass. Two sizes available.

Morse® Jaw Crusher
Built to meet the demands of pilot plant operations. Four sizes available.

Marcy® Double Roll Crusher
For intermediate crushing of any material. Two sizes available.

Marcy® Pulp Density Scale
Direct reading scale determines specific gravities of pulps, liquids, and dry solids.

Metso D12 Flotation Machine
Complete with agitator and scrubber.
Process research and test center

Features and benefits
Process research and test center

Introduction

Fully equipped test facility with the capabilities to perform complex material and process tests and evaluations and simulate commercial flow sheets.

Performs necessary test work for sizing and design of commercial equipment using bench, batch, and continuous pilot plant scale testing.

Available test equipment

- Muffle furnaces
- Batch rotary kiln (small/large)
- Indirect batch and continuous kilns
- Pan pelletizers
- Pot-grate furnace
- Fluid bed
- Holo-Flite®

Materials processed

- Coal
- Tires
- Kaolin
- Iron Ore
- Gold Ore
- Diatomite
- Aluminum Dross
- Zinc Waste
- Aluminum Hydroxide
- Activated Carbon
- Oil Shale
- Waste Metals
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Cold and hot fluidization feasibility

• Purpose
  - Cold testing to collect material fluidizing velocity data that can be used for process sizing of commercial scale fluid bed systems
  - Hot testing to determine if a Metso fluid bed is suitable for the process application and to collect material operational characteristics

• Material required
  - Cold testing minimum of 25–50 lbs (9–11 kg) or 5 gal (19 L)
  - Hot testing minimum of (1) 55 gal (208 L) drum
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Holo-Flite®

- **Purpose**
  - Determines if the material can be processed successfully in the Holo-Flite® processor
  - Develops scale-up factors for actual process conditions

- **Material required**
  - Feasibility test: 25–50 lbs (9–11 kg)
  - Extended feasibility test: 20–25 gal (76–95 L) per run of 20–24 lbs (9–11 kg)
  - Production test: 5–6 55 gal (208 L) drums
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Limestone evaluation

• Purpose
  - Determines how much a particular type of stone will physically breakdown during the calcining process
  - As each style or type of calcining system is capable of handling a certain maximum amount of fines/dust, this information plays a vital role in choosing the appropriate kiln for the application

• Material required
  - 130 lbs (59 kg) of sized 1" x 3/8" (25 mm x 9.5 mm) material
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Pot grate

• **Purpose**
  - Determines how well iron ore concentrate will pelletize and develops a process cycle for a commercial iron ore pelletizing system
  - As each pellet mix is unique, it is important to evaluate the proper temperature retention time profile for a commercial unit in order to meet pellet product requirements

• **Material required**
  - 3300 lbs (1500 kg) of iron ore concentrate ground to 80% passing mesh (45 micron)
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Direct fired batch rotary kilns (Pyro)

• Purpose
  - Refractory lined and used to simulate time-temperature profiles of material
  - Heated with direct flame from propane burner
  - Maximum temperature about 1350 °C (2462 °F)

• Material required
  - Dependent upon test and material/process
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Indirect fired batch rotary kilns

• Purpose
  - Not refractory lined but rotates within enshrouding furnaces which are heated with burners
  - Used to simulate time-temperature profiles of material
  - Allows control of the atmosphere within the kiln
  - Heated with indirect flame from propane burners
  - Maximum temperature about 800 °C (1472 °F)

• Material required
  - Dependent upon test and material/process
Metso services
business line
Services and benefits
## Metso services portfolio

<table>
<thead>
<tr>
<th>Services</th>
<th>Benefits</th>
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<tr>
<td>• Advanced technologies</td>
<td>• Better process performance</td>
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<td>• Automation solutions</td>
<td>• Improved productivity</td>
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<tr>
<td>• Performance contracts</td>
<td>• Maximum plant availability and reduced downtime</td>
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<tr>
<td>• Spare and wear parts supply</td>
<td>• Reliable equipment performance</td>
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<td>• Training</td>
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<td>• Field services</td>
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<td>• Plant diagnostics and upgrades</td>
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Pyro processing parts and service

- OEM parts supply
- Re-engineered parts supply for competitor’s equipment
- Installation of new equipment
- Installation of replacement parts
- Riding ring and support roller in-place resurfacing
- Emergency repairs
- Mechanical inspections
- Process evaluations
- Maintenance planning
- Operation and maintenance seminars
- System retrofits
- Equipment alignments
- Service contracts
- Engineering studies
Pyro processing

Conclusion

• Pyro processing offers our clients custom designed systems fully developed in-house for:
  - Testing of raw materials
  - Development of process plant flowsheet
  - Design and supply of custom engineered equipment
  - Complete control system development, design, programming, and commissioning

• Completely localized engineering company within a large global company including:
  - Project management (experience on projects up to €100 million)
  - Supply chain management (purchasing, logistics, quality assurance)
  - Engineering and drafting (process, civil, mechanical, electrical)
  - Process research and test center
  - Field services
Thank you