Andritz MAERZ GmbH
COPPER DIVISION

Scrap smelting, remelting and refining – what furnace options are available for the recycler?
The ANDRITZ GROUP

Overview

Company

- ANDRITZ AG, Graz, Austria (Group headquarters).
- More than 180 production and service sites worldwide.
- Employees: ~16,500 worldwide (as of December 31, 2011).

Key figures 2011

- Order intake: 5,707 MEUR.
- Sales: 4,596 MEUR.
- Net income (incl. non-controlling interests): 231.5 MEUR.
- Equity ratio (as of December 31, 2011): 20.6%.

Products and services

Plants and services for the hydropower, pulp and paper, metals, and other specialized industries (solid/liquid separation, feed and biofuel).
Company profile
A world market leader in most business areas

<table>
<thead>
<tr>
<th>ANDRIZ Hydro</th>
<th>ANDRIZ Pulp &amp; Paper</th>
<th>ANDRIZ Metals</th>
<th>ANDRIZ Separation</th>
<th>ANDRIZ Feed &amp; Biofuel</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ 40-45% of Group’s order intake *.</td>
<td>▪ 30-35% order intake *.</td>
<td>▪ 10% of Group’s order intake *.</td>
<td>▪ 10% of Group’s order intake *.</td>
<td>▪ 5% of Group’s order intake *.</td>
</tr>
</tbody>
</table>

* Long-term average share of the Group’s total order intake
Andritz MAERZ GmbH

Overview

<table>
<thead>
<tr>
<th>Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Andritz MAERZ GmbH, Duesseldorf, Germany</td>
</tr>
<tr>
<td>• Founded in 1911 by Johannes Maerz</td>
</tr>
<tr>
<td>• Approximately 70 employees</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Business Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Furnaces for the Copper Industry</strong></td>
</tr>
<tr>
<td>• Primary Industry</td>
</tr>
<tr>
<td>• Secondary Industry</td>
</tr>
<tr>
<td>• Processing Industry</td>
</tr>
<tr>
<td><strong>Furnaces for the Steel Industry</strong></td>
</tr>
<tr>
<td>• Continuous Furnaces</td>
</tr>
<tr>
<td>• Batch-type Furnaces</td>
</tr>
<tr>
<td>• Special Application Furnaces</td>
</tr>
<tr>
<td><strong>Furnaces for the Aluminum Industry</strong></td>
</tr>
<tr>
<td>• Melting Furnaces</td>
</tr>
<tr>
<td>• Holding Furnaces</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Our Mission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use our expertise for engineering, know-how and process technology in the area of melting, refining, heating and casting technology for Steel, Copper and Aluminum plants all over the world.</td>
</tr>
</tbody>
</table>
MAERZ Copper Division Furnace Types

Handling copper from matte to cathodes

- **DRUM TYPE OR ELLIPTIC FURNACE**
  20 – 630 METRIC TONS

- **TILTING FURNACE**
  40 – 500 T

- **CATHODE SHAFT FURNACE**
  10 – 60 T/H

- **TOP BLOWN ROTARY CONVERTER**
  10 – 140 T

- **PEIRCE SMITH CONVERTER**
  100 – 400 T

- **HEARTH SHAFT FURNACE (&D TF)**
  14 – 40 T/H
Furnaces used in the copper Industry
Main Types

**PRIMARY INDUSTRY**
- TSL Furnaces
- Drum Type (Anode) Furnaces
- Peirce Smith Converters
- Top Blown Rotary Converters

**SECONDARY INDUSTRY**
- TSL Furnaces
- Peirce Smith Converters
- Tilting Reverberatory Furnaces
- Hearth-Shaft Furnaces
- Elliptical Furnaces
- Drum Type Furnaces
- Top Blown Rotary Converters
- (Reduction Shaft Furnaces)

**PROCESSING INDUSTRY**
- ASARCO Type Shaft Furnaces
- Tilting Reverberatory Furnaces
- Drum Type and Elliptical Furnaces
- Top Blown Rotary Refiners
- MAERZ “Direct-to-Wire” Technology
- MAERZ “Direct-to-Shape” Technology
Copper Production Routes

Primary Industry

Primary copper production

- Copper Concentrate
- TSL
- Flash
- Peirce Smith Converter
- Anode Furnace
- Casting Wheel
- Electro Refining
- Copper Processing
- Anode Scrap for Cooling
- Anode Slime
- TBRC

Andritz MAERZ’s Scope of Supply

= Copper Scrap for Cooling
Copper Production Routes
Secondary Industry

Secondary copper production

High/Medium Grade Copper Scrap > 90% Cu

Low Grade Copper Scrap and E-scrap

Hearth-Shaft Furnace

Tilting or Elliptical Furnace

Anode Furnace

Casting Wheel

Electro Refining

Copper Processing

Andritz MAERZ’s Scope of Supply

TBRC

Anode

Cathode

Anode Slime

TSL
Copper Production Routes

Processing Industry

<table>
<thead>
<tr>
<th>Copper Rod Production (ETP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper Cathodes</td>
</tr>
<tr>
<td>Shaft Furnace</td>
</tr>
<tr>
<td>Copper Line</td>
</tr>
<tr>
<td>ETP Copper Rod</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Copper Rod Production (ETP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper Cathodes and ≥ 99.5% Cu Scrap</td>
</tr>
<tr>
<td>Shaft Furnace</td>
</tr>
<tr>
<td>Copper and Alloys</td>
</tr>
<tr>
<td>Induction Furnace</td>
</tr>
<tr>
<td>Casting Machine</td>
</tr>
<tr>
<td>Billets</td>
</tr>
<tr>
<td>Heating Furnace</td>
</tr>
<tr>
<td>Plates</td>
</tr>
<tr>
<td>Rolling Mill</td>
</tr>
</tbody>
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Andritz MAERZ’s Scope of Supply

Copper Recycling Conference 2012
**Copper Production Routes**

**Processing Industry - MAERZ Direct-to-Product Technology**

**Direct-to-Wire or Direct-to-Shape**

MAERZ Direct-To-Wire and Direct-to-Shape Technology comprises the following production steps:

- **Target:** Fire refined copper allows the rod and shape production directly from copper scrap, using only pyrometallurgical refining without the production step of electrorefining in the tank house.

- **Motivation:** Saving of the operational and investment costs for the cathode production. E.g. Anode production and tank house operation.

![Diagram showing the production process](image)

= To be saved
# Copper Production Routes

## Processing Industry - MAERZ Direct-to-Wire Production

<table>
<thead>
<tr>
<th>FRHC and ETP Copper Rod Production for Existing and New Copper Rod Lines</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Copper Scrap</strong> ≥ 92% Cu</td>
</tr>
<tr>
<td><strong>Tilting or Elliptical Furnace</strong></td>
</tr>
<tr>
<td><strong>Hearth-Shaft Furnace</strong></td>
</tr>
<tr>
<td><strong>Refining Furnace</strong></td>
</tr>
<tr>
<td><strong>Copper Rod Line</strong></td>
</tr>
<tr>
<td><strong>FRHC or ETP</strong> Copper Rod</td>
</tr>
<tr>
<td><strong>Optional ETP Production</strong> Shaft Furnace</td>
</tr>
<tr>
<td><strong>Copper Cathodes</strong></td>
</tr>
</tbody>
</table>

### Possible copper rod qualities:

- **FRHC Rod** using only the scrap ≥ 92% Cu in the refining furnaces.
- **ETP Rod** by mixing the copper from the refining furnaces with molten copper cathodes from a shaft furnace.

= Andritz MAERZ’s Scope of Supply
# Copper Production Routes

**MAERZ Direct-to-Wire Production Setups for Different Capacities**

<table>
<thead>
<tr>
<th>Capacities</th>
<th>Setup Description</th>
</tr>
</thead>
</table>
| 20-50 t Cu per day and Furnace | MAERZ Elliptical Furnace  
  • for melting, refining and casting  
  • expandable by a second furnace for minimum investment |
| 50-350 t Cu per day and Furnace | MAERZ Tilting Furnace  
  • for flexible melting, refining and casting  
  • expandable by a second furnace |
| 240 – 1000 t Cu per day      | MAERZ Hearth-Shaft Furnace  
  • for highly efficient melting  
  • combined with two **Drum Type Furnaces** for refining and casting |
Copper Production Routes
Processing Industry - MAERZ Direct-to-Shape Production

Copper Shape Production for Existing and New Lines

- Copper Scrap ≥ 92% Cu
  - Tilting or Elliptical Furnace
  - TBRR
  - Heating Furnace
- Copper Scrap ≥ 92% Cu
  - Casting Machine
  - Rolling Mill
  - Optional for higher qualities

Andritz MAERZ’s Scope of Supply
Copper Production Routes

MAERZ Direct-to-Shape Production Setups for Different Capacities

<table>
<thead>
<tr>
<th>MAERZ Direct-to-Shape furnace setups</th>
<th>MAERZ Elliptical Furnace</th>
<th>MAERZ TBRR</th>
<th>MAERZ Tilting Furnaces</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-50 t Cu per day and Furnace</td>
<td>• Small capacities in 16-24 h cycle</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• expandable by a second furnace</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Casting furnaces possibly required</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 x 30-60 t Cu per day per batch</td>
<td>MAERZ TBRR</td>
<td>MAERZ Tilting Furnaces</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• for flexible melting, refining and casting</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Large capacity with 3 easy to handle batches per day</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50-350 t Cu per day and Furnace</td>
<td>MAERZ Tilting Furnaces</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Large capacities in 24 h cycle</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>• expandable by a second furnace</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Casting furnaces possibly required</td>
<td></td>
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</tbody>
</table>
Operational Costs

Development approach

- Cost for Cu Scrap:
  - Cu content
  - Amount of impurities
  - Type of impurities

- Cost for Production:
  - Compressed air
  - Natural gas
  - Additives
  - Refractory wear
  - Longer cycle

Scrap Quality vs. Scrap Price and Production Costs
Metallurgical Background
Finding the right slag system and optimizing the refining

<table>
<thead>
<tr>
<th>Oxidation</th>
</tr>
</thead>
<tbody>
<tr>
<td>High pressure injection of air or enriched air</td>
</tr>
<tr>
<td>Liquidus temperature and liquidus range</td>
</tr>
<tr>
<td>Solubility of impurities and Cu</td>
</tr>
<tr>
<td>Viscosity</td>
</tr>
<tr>
<td>Cu loss in slag (dissolved + entrained)</td>
</tr>
<tr>
<td>Slag amount</td>
</tr>
<tr>
<td>Refractory attack</td>
</tr>
<tr>
<td>Separation metal/slag phase</td>
</tr>
<tr>
<td>Additives (amount, price)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Deslagging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Removal of the slag containing the impurities</td>
</tr>
<tr>
<td>Degree of deslagging → use of nitrogen purging system</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>High pressure injection of reductant media</td>
</tr>
<tr>
<td>Control of furnace pressure → furnace design</td>
</tr>
</tbody>
</table>
Production Costs
Relative production costs for different furnace systems
Conclusion

- Scale effects are important for both operational and investment costs

- The matching furnace concept should take into consideration:
  - Desired production capacity?
  - Batch wise or continuous operation?
  - Plant production schedule?
  - Type of end product?
  - Grenfield or Brownfield installation?
  - Type of copper scrap available?
  - Constancy of scrap availability?
Anode Furnace Transport

200 t
Thank you for your attention
Your Contact

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Scrap Classifications

Types of Cu-Scrap – ISRI (Institute of Scrap Recycling Industries) Specifications

- **Barley** – No. 1 Cu wire, bare uncoated, unalloyed
- **Berry** – No. 1 Cu wire & cable, clean, untinned, uncoated, unalloyed
- **Birch** – No. 2 Cu wire, misc. unalloyed, min. 94% Cu (nominal 96%), free of: brass, bronze, excessive content of Pb, Sn, oil, Fe, nonmetallc, ash, soldered Cu, Cu wire from burning containing insulation, hair wire, brittle burnt wire
- **Candy** – No.1 heavy Cu, clean, unalloyed, uncoated clippings, punchings, bus bars, commutator segments and wire (min. 1/16 inch thick), free of brittle burnt wire
- **Cliff** – No. 2 Cu, misc. unalloyed Cu scrap, min. 94% Cu (nominal 96%), free of: brass, bronze, excessive content of Pb, Sn, oil, Fe, nonmetallics, ash, soldered Cu, Cu wire from burning containing insulation, hair wire, brittle burnt wire, Cu tubing with other than Cu connections or with sediments
Scrap Classifications

Types of Cu-Scrap – ISRI (Institute of Scrap Recycling Industries) Specifications

- **Clove**
  - No. 1 Cu wire nodules, bare, uncoated, unalloyed Cu wire scrap nodules, chopped or shredded, free of: Sn, Pb, Zn, Al, Fe, other metallic impurities, insulation and other foreign contamination, min. 99% Cu

- **Cobra**
  - No. 2 Cu wire nodules, unalloyed Cu wire scrap nodules, chopped or shredded, min. 97% Cu, max. 0.50% Al and 1% each of other metal or insulation

- **Cocoa**
  - Cu wire nodules, unalloyed Cu wire scrap nodules, chopped or shredded, min. 99% Cu, free of excessive insulation or other non-metallics, max. impurities: 0.05% Al, 0.01% Sb, 0.25% Sn, 0.05% Fe, 0.05% Ni
Scrap Classifications

Types of Cu-Scrap – ISRI (Institute of Scrap Recycling Industries) Specifications

- **Dream**
  - Misc. unalloyed Cu scrap, 92% Cu (min. 88%), e.g. sheet Cu, gutters, downspouts, kettles, boilers, free of burnt hair wire, Cu clad, plating racks, grindings, Cu wire from burning containing insulation, radiators, fire extinguishers, refrigerator units, electrolyte shells, screening, brasses, bronzes, excessive content of Pb, Sn, solders, oil, Fe, non-metallics, ash

- **Drink, Drove, Druid, Ebony, Eland, Elder, Elias, … , Nomad, Ocean, Pales, Pallu, Palms, Parch** → lower grade, brass, alloys
ETP Copper
Classical Process Route from Scrap to Product

Cu-Scrap for Anode Production → Tilting Furnace → Refining Slag 1st Removal Minor Elements → Best Quality Cu-Scrap

Cu-Scrap for FRHC → Anode Casting → Tankhouse → Cathode-Cu → Shaft Furnace → Cu-Products (Wire, Rod, Billets, Cakes)

2nd Removal Minor Elements → Anode-Cu → Tankhouse
FRHC Copper

Process Route without Tank House Operation?

Cu-Scrap for Anode Production → Tilting Furnace → Refining Slag total Removal Minor Elements → Best Quality Cu-Scrap → Anode Casting → Tankhouse → Cathode-Cu → Shaft Furnace → Cu-Products (Wire, Rod, Billets, Cakes)

To be – partially – replaced by Fire-Refining Concepts …
FRHC Copper
The MAERZ DTW® Process – Downstream Integration

MAERZ DTW® - Process

I. Off-line
via ingot caster

Shaft Furnace

Best Quality Cu-Scrap

Cathode-Cu

Existing Production Line

II. Directly
FRHC Cu-Products
Selected Qualities for
Wire, Rod, Billets, Cakes, Profiles etc.