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Electrolytic Copper Refining 2010 World Tankhouse survey

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Summary

- Introduction
- Regional trends
- Future projects
- Process technology
- Summary

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Introduction

- Eighth in a series of world and regional copper refining surveys since 1987
- Previous Surveys
  - 1987, 1991, 1995, 1999, 2001, 2003 and 2007
- The data of 58 ER plants is tabulated
- Previous survey data was included
- Timmins to be shutdown

Regional Trends

- Asia
- Europe
- Africa
- Americas

Regional Trends Asia

- Eastern (China) and Southern Asia (India) dominate copper refinery expansion
- Large multiple refining tankhouse sites include Guixi, Tongling, Kunming-YCC (China) and Tuticorin (India)
- Central Asian (Kazahkstan) refining expansion
- Japanese refineries converted from starter sheet to permanent cathode technology
- Conversion of Pasar, Philippines

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Eastern Asian ER Guixi

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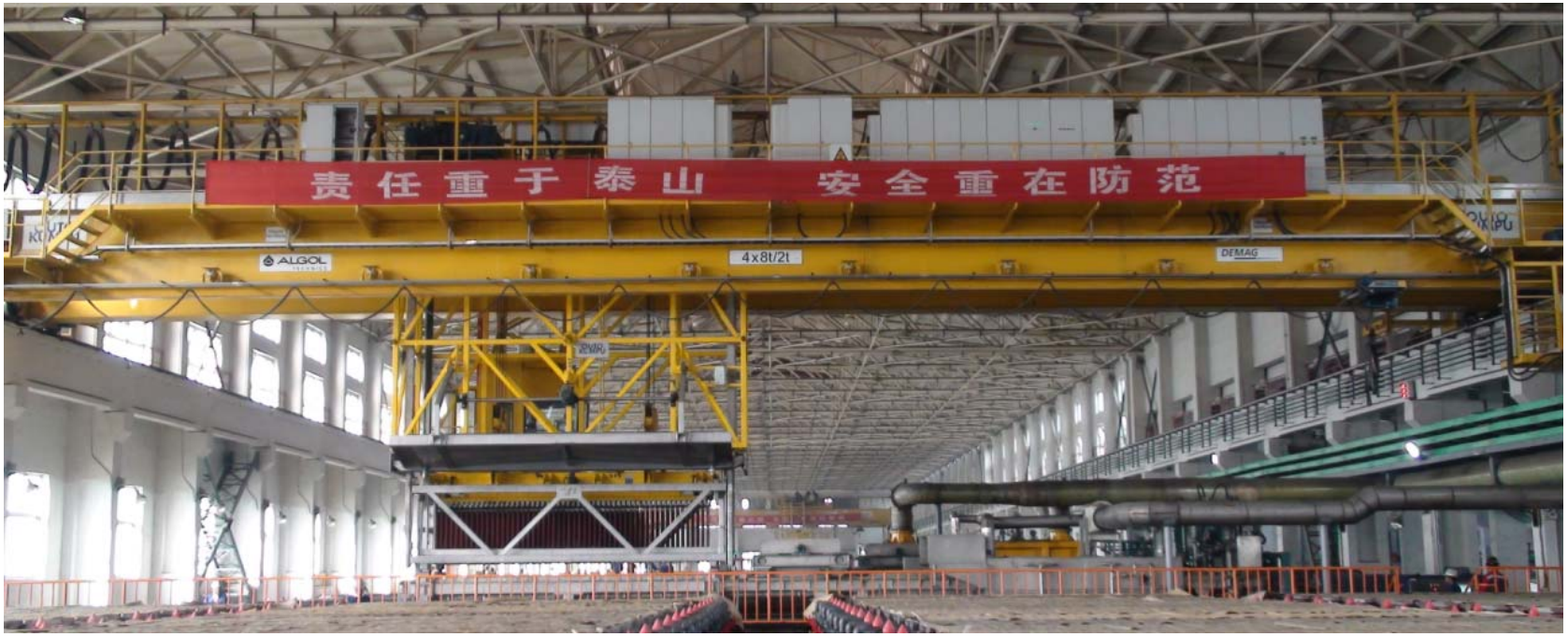
Asian ER Yanggu



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Asian ER Jinlong

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Regional trends Europe

- Large refineries being modernized with PC cells (NA)
- Permanent cathode conversion and modernization (Pirdorp and Pori)
- Consolidation of NA and Belgian copper refineries to form Aurubis, now Europe's largest refiner
- Other major European refiners include Boliden, Atlantic Copper (FMI) and KHGM (Poland)
- KHGM is still the largest starter sheet refinery operation

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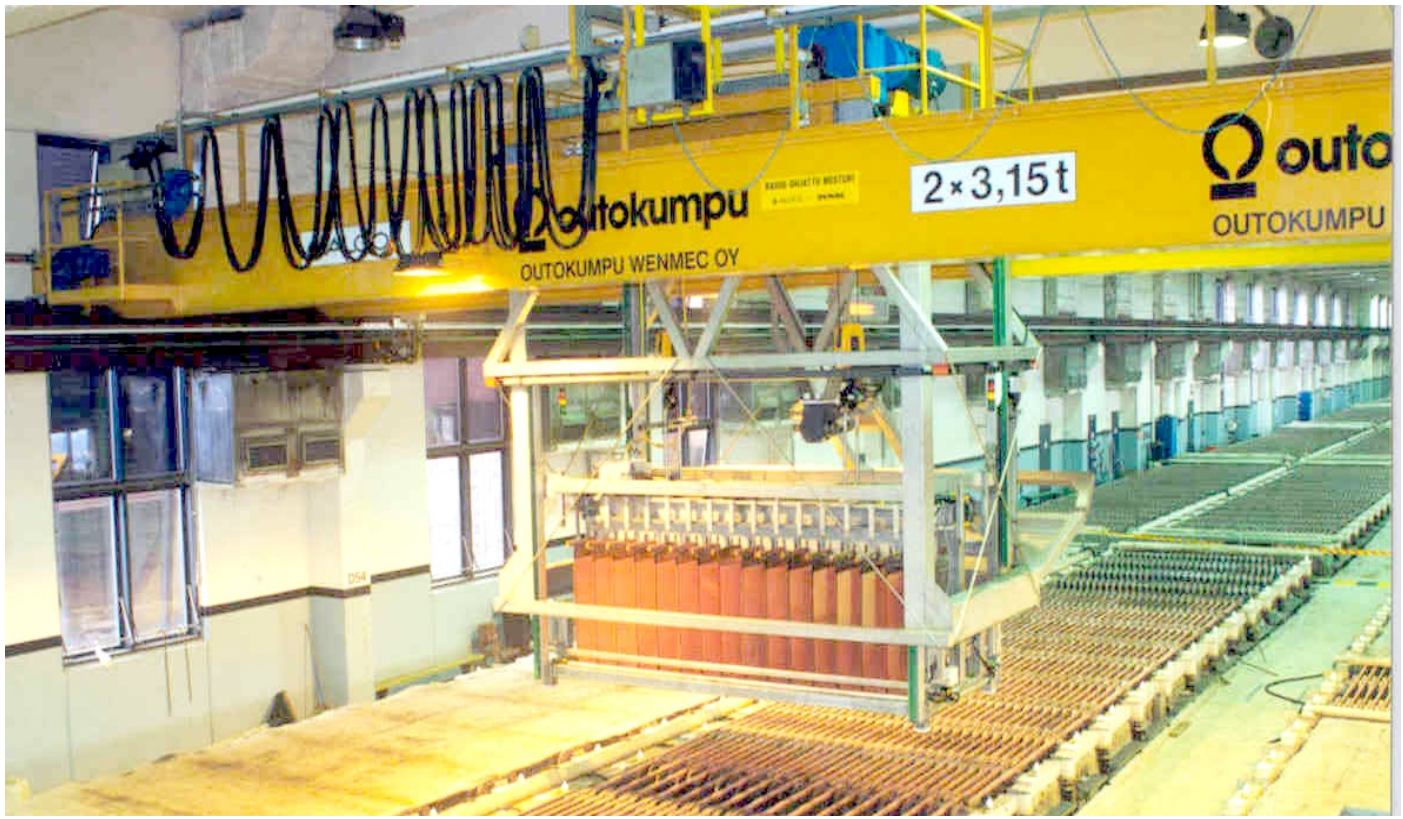
European ER Pori



Africa

- Large ER capacity in Zambia and not so in DRC
- Large ER tankhouses in Zambia being modernized with polymer concrete cells and new electrode handling machines
- ER tankhouse studies for northern Africa

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Regional trends Americas

- No new refining capacity
- But a lot of mill capacity in the pipeline for Chile and Peru leading to increasing Pacific concentrate trade
- Major refining locations include:
  - Codelco Norte, Chile
  - Las Ventanas, Chile

Process Technology

- Cathode Technology
- Automatic Cranes
- Electrolytic Cells
- Electrode contact system
- Automated cell voltage monitoring
- Summary

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Permanent Cathode Technology

- Over 40% of the respondents use permanent cathode technology as per previous surveys
- First developed by CRL and MESCO in late 70's
- Isa Process and Kidd Process are now supplied by one source Xstrata technologies (XT)
- Outotec is a ER permanent cathode technology supplier
- Ionic of Canada is pioneering robotic high speed electrode handling machines
- Stripping machine technology suppliers include:
  - MESCO (XT)
  - Outotec (Wenmec)
  - Ionic (XT)

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Stripping Machine

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Robotic cathode stripping machine

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Anode Preparation Machines

- 80% of refineries surveyed used an anode preparation machine
  - Weighing
  - Straightening
  - Lug machining
- Robotic anode preparation machines are being developed and installed
  - Metallo Chimique, Belgium
  - Zijin, China
  - Daye, China

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Robotic Anode machine

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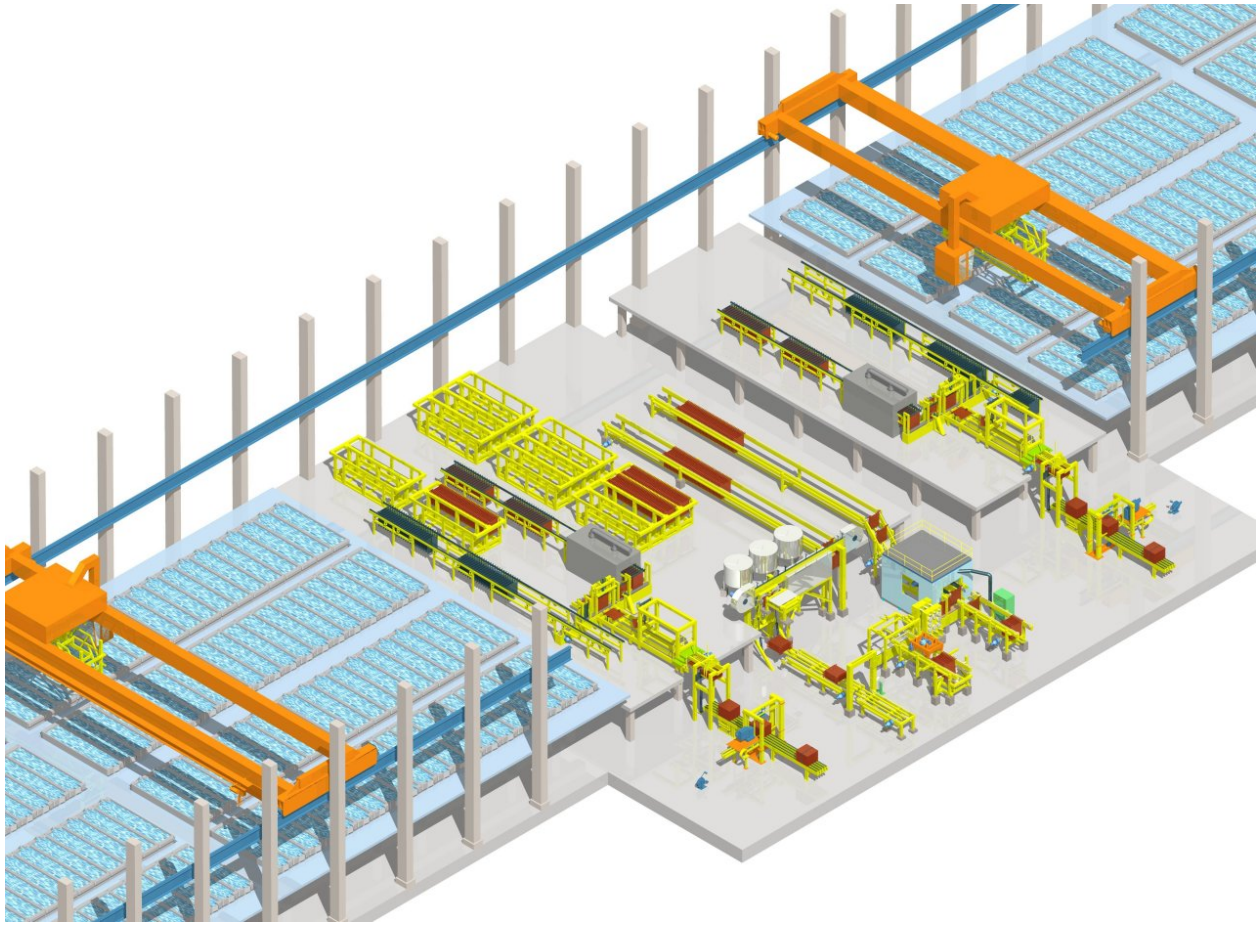
ER Electrode Handling



Electrodes

- Electrode design trends include:
  - Higher energy efficiency with designs that include more copper in/on cathode plate hanger bar
  - Electrode tracking for process control
  - Hooks on electrodes (cast for anodes) for automated crane and rapid pick up (Outotec)

Automatic Cranes

- First ER Copper automated crane application was Kunz at Brixlegg in mid 80's
- These cranes give precise location of electrodes in the cells and can increase current and time efficiency (speed)
- cranes use cone or laser method of cell location
- Suppliers in Copper EW include Kunz, Femont and Outotec
- Synchronization of stripping machines and cranes that improves time efficiency

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Automated cranes

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Crane and stripping machine synchronization

Electrolytic Cells

- Over two thirds of surveyed ER plants use Polymer concrete (PC) cells
- Many ER tank houses retrofitting PC cells in Europe
- New capacity in China and India are installing PC cells
- New cell developments include:
  - Longer cell length to minimize tankhouse footprint
  - Higher cell flows
  - Automatic crane locating devices
- Remaining older refineries use lined cells
  - Antimonial lead
  - PVC paraliners

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PC cells CRL

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Electrode contact systems

- Typical designs include:
  - Dogbone bar
  - Copper in busbar for current distribution
- Latest designs include:
  - Double double contact systems
  - Anode and cathode equalizer bars
  - Outotec ER design

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Online cell Voltage Monitoring

- Recent trend is to install online cell voltage Monitoring (CVM)
  - Cell voltage and temperature
  - Wireless
- Originally developed for electrorefining tankhouses in 70's but not wireless
- MIPAC of Australia also a supplier

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Automated online cell voltage and temperature monitoring

ER Development Summary

- More electrode handling automation including robots
  - Cathode Stripping machines
  - Anode handling machines
  - Larger capacity
  - Cranes
- Longer cells
  - More integrated automated ER tankhouse design with cell
- Higher current density operation
- Wireless ER cell voltage monitoring