MESA REDONDA 2010

Latest Developments in Sulphuric Acid Technology by Outotec

More out of ore
Extract of Developments in last years

- Outotec Acid Technology in brief
- OTOVent™ – Venturi Quench System
- Energy Recovery HEROS™ Process
- Drying & Absorption Towers
  - FiDi™ System – Film Distributer
  - Vertical Wire Mesh™
  - Candle Filter Plate Support System™

in Presentation Noracid
- Sulphur Combustion – New LURO2™
- Sacrificial Heat Exchanger
Outotec in brief
Operational model

Market Operations (incl. Market Areas)

Supply
- Business Infrastructure
- Strategy
- Technology Management
- Finance & Control
- Legal Affairs
- Human Capital

Shared Support Functions

Non-ferrous Solutions

Ferrous Solutions

Energy, Light Metals & Environmental Solutions

Services

Business Areas
Services

- Lifecycle service solutions and a global network of service centers for Outotec’s customers
- Services from spare parts support and delivery, site and equipment maintenance and plant audits to optimization and upgrades, project management and training.

<table>
<thead>
<tr>
<th>Expertise</th>
<th>Solutions for</th>
</tr>
</thead>
<tbody>
<tr>
<td>Component services</td>
<td>Plants</td>
</tr>
<tr>
<td>Expert services</td>
<td>Processes</td>
</tr>
<tr>
<td>Equipment upgrades</td>
<td>Processes</td>
</tr>
<tr>
<td>Operation and maintenance</td>
<td>Equipment</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Diagram:
- Develop and upgrade
- Plan and expand
- Define solution
- Implement and execute
- Research & analysis services
- Audits & Assessments
- Installation services
- Start-up services
- Component services
- Maintenance & troubleshooting services
- Shut-down services
- Training services
- Upgrade services
- Operation services
Recent acquisitions 2010

- **Millteam** maintenance services for mining companies and special expertise in grinding mill service

- **Ausmelt** complements our smelting technology portfolio

- **Larox** filtration technologies and services enable us to offer solutions for the whole value chain from mine to metal

- **Edmeston**
  - Specializing in engineering and supply of process equipment for sulfuric acid plants.
  - Unique know-how of special stainless steel grades suitable for use in highly corrosive environment.
OTOVent Quench Venturi System
Traditional Areas of Concern with Quench Towers or Quench Venturis

Areas where Hot & Dry and subsequent Cold & Wet Conditions are manifest

Gas Inlet of Quench Tower  Nozzle Area of Quench Venturi
Requirements for Improvement realized by OTOVent

1. Defined Areas for only Hot / Dry and only Cold / Wet Conditions  **AND**

2. Avoidance of Dust / Partical Deposits at Wall and In / On Acid Overflow

hot/dry condition

and

wet/cold condition
Developement of Design Features

1. Separation of Hot & Dry and Cold & Wet Areas
   Creation of an Overall Localized Even Acid Film at Wall / Bricklining above Acid Spray Nozzle Level

2. Avoid Dust & Partical Deposits on Wall
   Wall / Bricklining above Acid Spray Nozzle Level is in the Shadow of the Gas Inlet (larger inside diameter)

3. Avoid Dust & Partical Deposits In & On Acid Overflow
   Acid Overflow Channel is Conical
   - to Avoid Partical Deposits in Channel by Higher Acid Velocity at the Bottom
   - to Create an equal Film at the Overflow by Lower Velocity at Top
Flow Analysis by Fluent
Wall by Loadcase 380 / 70

Thickness of Film (m)  Temperature of Film (K)
Temperature (K) Analysis by Fluent for Loadcase 380 / 70

of Gas

of Droplets
Types of Application

Retrofit to Optimize Existing Quench Tower

Green Field Application
Excess Energy Removal

- Main blower
- Atmosphere
- Sulphur
- Combustion furnace
- Waste heat boiler
- Drying tower
- Air
- Boiler
- Combustion furnace
- Final absorber
- Intermediate absorber
- Superheater
- Economizer
- Evaporator
- Converter
- Intermediate heat exchanger
- Final absorption tower
- Product acid
- Stack
Outotec HEROS System
Recent advances - Enhanced HEROS™
IN COMPARISON TO HEROS™ WITH EARLIER DESIGN

Feed Water Preheating

Dilution Water

LP-Steam

Boiler Feed Water

Acid Cross-flow
## Outotec HEROS System – Design Philosophy

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Description</th>
<th>Related HEROS feature</th>
<th>Advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operational Flexibility</td>
<td>• Ability to vary the amount of LP steam production without altering the production of the Acid plant</td>
<td>• Controlled bypass of the venturi absorber system • IAT designed for 100% capacity</td>
<td>• LP Steam can be easily adjusted in HEROS and absorption of SO3 in IAT is ensured</td>
</tr>
<tr>
<td>Safety</td>
<td>• Minimize corrosion in case of normal operation and off-set conditions</td>
<td>• Material selection (alloy 3033) • New boiler concept • Enhanced safety concept (leak detection)</td>
<td>• Plant operation in a range of 97.5 – 99.5 % • Fast isolation of boiler • Early detection of leaks in water/steam circuit</td>
</tr>
<tr>
<td>Overall Plant Availability</td>
<td>• Failure of hot circuit must not lead to plant shutdown</td>
<td>• Separation of hot acid circuit from system by gravity • IAT design for 100 % capacity</td>
<td>• Acid and HP steam production at nominal capacity possible.</td>
</tr>
</tbody>
</table>
Outotec HEROS System
Recent advances - Enhanced HEROSTM

Shell and tube type heat exchanger (3)
Horizontal arrangement above pump tank
Mixer with water injection at inlet at (8)
Tube side boiling
Separate steam drum (1)
Forced circulation (2)
HEROS™: Application of Material

Flange: 316L
Insert: Glass / PTFE
Cover: 3033

Piping: 3033
CS / Bricks 40, 2 x 65

Sleeve

Bricklined Venturi

1. maximum reliability
2. 100% acid production even in case of boiler failure!
HEROS™ – Material Selection

Nicrofer 3033 - Excellent weldability, high ductility

Typical range of operation
Risk Mitigation

LEAKAGE / FAILURE

- Fast detection vital
- Supervision of:
  - Acid Concentration
  - Boiler Water Contamination
  - Process- and BFW-Management
  - Energy Balance

Loss prevention

- Separate drains for acid and water: fast and safely

Summary

- Can operate 97.5 – 99.5 % H2SO4 (98.5 ± 1.0 %)
- Employs proven equipment and materials of construction
- For piping and evaporator, special material 3033
- Is easy to install as a plant upgrade, revamps
HEROS™ – Layout
HEROS™ – Section
Drying & Absorption Towers
Tower - Options

- Conventional tower design
- Combined venturi + packed bed
- Integrated top heat exchanger
- Integrated venturi for large plants

Self-supporting dome
Acid exit at side
Process water addition
CONVENTIONAL TOWER DESIGN

with special attention to:

- multi-layer bricklining
- self-supporting domes
- distribution system of SX
- adequate acid mist and droplet removal
Outotec Edmeston TOWER DESIGN

with special attention to:

- SX Stainless Steel
- one-layer bricklining up to dome
- self-supporting domes
- distribution system of SX
- adequate acid mist and droplet removal with shell of 316L
SS Towers of SX and Top of 316L
SX Material by Outotec Edmeston

For

- Towers
- Pump Tanks
- Irrigation System
- Acid Coolers
- Piping

By: Roger Francis, RA® Materials and Jason Wilson, Rolled Alloys
Conventional Acid Distribution

deflector plate

nozzle

liquid trajectory

packing

Conventional Acid Distribution
Modern Acid Distribution

Stainless Steel Tower SX
3,000 t/d S-burning Plant
Optimization of Acid Distribution by Fluid Dynamic Analysis

Orifice of 80% at arm 4, orifice of 60% of radius at arm 5

Standard configuration without orifices
Comparison of Irrigation Systems

Trough System

LURGI System

Outotec FiDi™ System

Free Gas Flow Area through Irrigation System

45 to 55 %

55 to 60 %

65 to 75 %
LAB Test - FIDI™
Fluid Dynamic Analysis Vertical Wire Mesh™

Wire Mesh pressure drop 3.5 mbar
T=78°C
V=166801 Nm³/h
p(abs)=1442 mbar

Velo on xy plane, m/s
3.0 3.5 3.4 3.3 3.2 3.1 3.0 2.9 2.8
2.7 2.6 2.5 2.4 2.3 2.2 2.1 2.0 1.9
1.8 1.7 1.6 1.5 1.4 1.3 1.2 1.1 1.0

Velocity Magnitude
26 24 22 20 18 16 14 12 10 8 6 4 2

Wire Mesh Filter
Pictures of Vertical Wire Mesh™
Outotec Support™ of Candle Filter Plate

Old Design Deflection (mm) New
170 Center 3
170 Maximum 16

Dia 5.4 m - Dead weight & 250 kg / candle

Main Benefit: Due to Less in Deflection nearly no Bending at Flange / Gasket
Not mentioned Developments today

Propriety Equipment
- New Design of SS Converter
- Outotec Edmeston SX Tower without Bricks
- 2 New Designs of High Efficiency Scrubber
- Enhanced Design of Wet ESP

Process Applications
- LuRec
- Concentration Expand
- Etc.
Thank you for your attention!

www.outotec.com