EAF PROCESS OPTIMIZATION WITH AMIGE SMARTFURNACE SYSTEM

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Agenda

- EAF Optimization technology overview
- Electrode Regulation System
- SmartFurnace Optimization Modules
- Implementation in Yamato Steel Japan
- Implementation in Vallourec Star
Furnace Optimization

Raw Materials
- Scrap quality
- DRI/HBI Feed rate

Constraints
- Flicker
- Stability
- Harmonics
- Slag factor

Electrical energy
- Voltage
- Current

Fluxes
- Lime
- Dolo lime

Slag Control

Chemical energy
- Oxygen
- Carbon
- Natural gas

Energy losses
- Exhaust gas
- CO & CO2
- Water cooled panels

Safety
- Reactions
- Water leaks

Output
- Steel temperature
- Ppm’s and C%

Transformer, Reactor, and Substation taps

Burners & Lances
Decarburization
Furnace Optimization

SmartFurnace
EAF Optimization Control system

- GiantBoard: Monitoring Touch screen
- Computers with DigitARC PX3® screens
- SmartFurnace®: Rack-mounted server
- DigitARC PX3®
- PLC Network
- LAN
- PLC CPU & I/O Modules
- ZoloBOSS™: Off-Gas Monitoring System
- EAF
- SmartFurnace System
ELECTRODE REGULATION
DigitARC PX3 Electrode Regulator

- Dedicated controller CPU for fast close loop control
- Stability for AC & DC EAF using only electrical signals
- Diagnostic tools and automatic analysis of EAF performance
DigitARC PX3 Electrode Regulator

- High speed logging
DigitARC PX3 Electrode Regulator

- Dynamic Non Conductive Charge protection
DigitARC PX3 Electrode Regulator

- Preemptive Cave In protection
DigitARC PX3 Electrode Regulator

- Automatic electrode tests
DigitARC PX3 Electrode Regulator

- Power Quality Meter for measurement of flicker & harmonics
VM2 Remote Monitoring Service
SMARTFURNACE OPTIMIZATION
SmartFurnace Optimization system

- Graphic programming platform
- Open system
- Flexibility of a rule based expert system
SmartFurnace Modules

- **SmartARC**
  Rule based expert system to control the electrical energy input based on arc stability, scrap mix, panel temperature, etc.
SmartFurnace Modules

- SmartARC
- Oxygen Module
  - Burner/Lance Control
  - End Point control (C, Temp)
  - Foaming Slag Control
SmartFurnace Modules

- SmartARC
- Oxygen Module

PPM and temperature estimation
SmartFurnace Modules

- **SmartARC**
- **Oxygen Module**
- **Slag Module**

Real time mass balance estimates slag composition. Recommends fluxes to reach MgO saturation in slag, based on slag analysis.
SmartFurnace Modules

- SmartARC
- Oxygen Module
- Slag Module
- Off Gas Module

Closed loop control of Chemical Energy, and abnormal water vapor detection with the ZOLOScan Laser Sensor
Off Gas Sensor

- CO%, CO2%, H2O, Temperature
- In-situ System
- A non-Contact, non-extractive system
- Update rate <2 sec
- Reporting 98%
Off Gas Sensor Data
IMPLEMENTATION RESULTS
Yamato Steel

- DC Double Shaft EAF
- 120 tapped tons
- 6700 mm shell
- 102 MVA
- Maximum 120 kA and 718 VDC on the secondary
- 6 burners, 2 PC burners
- 4 Carbon Injection
- Rolled products (H & I Beams, channels, etc.)
Installation

- Project Scope
  - DigitARC PX3 DC ERS
  - SmartARC
  - Oxygen Module
  - VM2
- Installation finalized
  October 2016
Project background

- Atypical furnace with preheated scrap
- Interest in reducing consumptions
Project background

**Charged Carbon**
Grid marks @ 200 kg

**kWh/ton**
Grid marks @ 20 kWh/ton
Results*

- Kwh/Ton: 5% decrease
- P-On: 4% decrease
- Oxygen consumption: 15% decrease
- Injected Carbon: 4% decrease
- Charged Carbon: 95% decrease
- Lime: unchanged
- Dolo Lime: unchanged
- Gas/Oil: 24% increase
- Electrode consumption: 6.5% decrease
- Bottom electrode life: unchanged
- Yield: unchanged

*3 months against 3 months comparison
Vallourec Star

- AC EAF
- 100 tapped tons
- 6100 mm shell
- 78.4 MVA
- Maximum 1100V/59kA
- 4 burners
- 2 Carbon Injection
- Rolled products (H & I Beams, channels, etc.)
Installation

- Previous installation
  - DigitARC PX3 DC ERS
  - SmartARC
  - Oxygen Module
  - Slag Module
- Off Gas Module
- Abnormal Vapor Detection Module
Project background

- Safety improvement through better detection of potential water leaks in the EAF
- Operating cost reduction through process optimization
Water Vapor Detection Test

![Graph showing water vapor detection test results. The graph compares electrode spray water ON and OFF conditions.](image-url)
Water Vapor Detection
# Results

<table>
<thead>
<tr>
<th>%Change</th>
<th>100% Scrap Summary</th>
<th>Pig Iron Grade Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas</td>
<td>-3%</td>
<td>0%</td>
</tr>
<tr>
<td>Charge Carbon</td>
<td>4%</td>
<td>N/A</td>
</tr>
<tr>
<td>Foamy Carbon</td>
<td>-11%</td>
<td>0%</td>
</tr>
<tr>
<td>EAF Electrode</td>
<td>-11%</td>
<td>-11%</td>
</tr>
<tr>
<td>Aluminum</td>
<td>0%</td>
<td>-7%</td>
</tr>
<tr>
<td>EAF Electricity</td>
<td>-3%</td>
<td>-5%</td>
</tr>
<tr>
<td>Total Oxygen</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>Dissolved Oxygen at Tap</td>
<td>0%</td>
<td>-19%</td>
</tr>
<tr>
<td>Tap Temperature</td>
<td>17°F higher</td>
<td>12°F higher</td>
</tr>
<tr>
<td>FeO in Slag</td>
<td>0%</td>
<td>-4%</td>
</tr>
<tr>
<td>Average Slag Stability</td>
<td>-20%</td>
<td>-5%</td>
</tr>
<tr>
<td>Power On Time</td>
<td>-5%</td>
<td>-6%</td>
</tr>
</tbody>
</table>
Conclusion

- An intelligent system with automatic dynamic profiles has proven to improve process efficiency and standardization.
- The use of sensors and monitoring devices offers valuable process data.
- Flexible tools help adapt new optimization technologies to non-standard furnaces.
Thank you