Bench and Pilot Scale Analyses to Optimize Pelletizing Performance

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– Agglomeration and Pyrometallurgy –
Pelletizing Process Evaluation

- Bench and Pilot Evaluation Processes
  - Concentrate Preparation
  - Agglomeration
  - Green Ball Assessment
  - Pellet Firing
  - Pellet Physical Quality Assessment
  - Chemical Analyses
  - Metallurgical Quality Assessment
Pelletizing Process Evaluation

**Bench Scale**
- Leaf Filter Testing
- Airplane Tire Agglomeration
  - Green Ball Quality
- Mini-Pot Furnace
  - Fired Pellet Quality

**Pilot Scale**
- Pilot Scale Disk Filters
- 3 Foot Dia. Balling Disk
  - Green Ball Quality
- Mixing
  - Muller, Standard
  - Littleford, High Intensity
- Pot Grate Furnace
  - Extension of the Mini-Pot Furnace Tests
  - Straight Grate and Grate-Kiln Furnace Simulation
Laboratory Scale Process Simulation

- Bench Scale Filtering and Agglomeration Studies
  - Additives
    - Filter Aids – Surfactants, etc.
    - Balling Additives – Fluxes, Binders, etc.
  - Ore Variability
    - Grind, Ferrous Iron, Particle Size Distribution, etc.
  - Moisture content
Laboratory Scale Process Simulation
Laboratory Scale Process Simulation

Green Ball Quality Assessment and Characterization

- Moisture
- 18” Wet Drop Number
- Green and Dry Compression Strength
- Deformation Characterization, (Stress-Strain)
- Porosity
Mini-Pot Grate Furnace Induration Studies

- Mini-pot firing cycles are representative of the drying, pre-heat and firing zones of the induration furnace.

- Firing cycles are developed to be representative of the top 1/3 of the bed.

Relative relationship to changes in green ball feed or furnace cycles.
Laboratory Scale Process Simulation

STANDARD CYCLE WITH TYPICAL MINI-POT CYCLE

TIME, MIN

Deg, °F

Mini-Pot Cycle
Laboratory Scale Process Simulation

Mini-Pot vs. Pot Grate Temperature Profile

Time

Temp (F)

- 2 G+8 F
- 6 G+2 F
- Mini-Pot Bed Temp
Laboratory Scale Process Simulation
Pilot Scale Process Simulation

- Pilot Scale Agglomeration Studies
  - Disk Filtering
  - Three Foot Diameter Balling Disk
  - Mixing
    - Littleford, High Intensity Mixing
    - Muller, Standard Mixing
  - Green Ball Quality Assessment and Characterization
Pilot Scale Process Simulation
Pilot Scale Process Simulation

- Pot Grate Furnace
  - Straight Grate and Grate-Kiln Furnace Simulation
  - Firing cycles are developed to simulate the time, airflow and temperature profiles in a pelletizing furnace
  - Fired pellet quality produced with standard plant cycles are designed to represent plant data
    - Changes in pellet quality are evident with alterations to the green ball feed, furnace cycles or residence time
- Extension of the Mini-Pot Furnace Tests
Pilot Scale Process Simulation

Typical Pot Grate Temperature Profile

Straight Grate Temperature Profile

- 2 G+14 F
- 3 Hood ASP F
- 4 G+10 F
- 5 G+6 F
- 6 G+2 F
- 7 Grate Bar F

Time (minutes): 14:24:00 to 15:21:36
Pilot Scale Process Simulation

Typical Pot Grate Temperature Profile

Grate-Kiln Pot Grate Temperature Profile

<table>
<thead>
<tr>
<th>Time</th>
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- 2 G+ 8 F
- 3 Hood ASP F
- 4 G+6 F
- 5 G+4 F
- 6 G+2 F
- 7 Grate Bar F
Pilot Scale Process Simulation

Pot Grate Furnace
Fired Pellet Quality Assessment

Physical Quality
- ASTM % +1/4” After Tumble
- Fired Pellet Compression, %-%-200 lbs., %-%-300 lbs.

Metallurgical Quality
- ISO 4695, Reducibility, (R40)
- ISO 7215, Relative Reducibility, (Gaukashin)
- ISO 4696-1, Low Temperature Disintegration, (LTD)
- ISO 4698, Fired Pellet Swelling
- Porosity
Fired Pellet Quality Assessment
Chemistry Evaluation

- Inductively coupled Plasma Spectroscopy (ICP)
- Iron Assay by Titration
Process Simulation Applications

- Low Level Limestone Addition to Enhance Fired Pellet Quality and Blast furnace Performance
- Change Pellet Chemistry to meet Blast Furnace Specifications
  - Changing Mn, MgO, SiO₂ content
  - Increased C/S ratio, by changing flux stone addition
- Furnace Modifications
  - Pre-heat burners
  - Drying, pre-heat or firing zone changes to compensate for chemistry changes or ore changes
Conclusions

Process changes on induration furnaces requires considerable down-time with a great amount of risk. Effectively evaluating these changes in a laboratory setting is required to reduce costs and minimize the risk. Filtering, balling and furnace testing have proven themselves capable of simulating operating conditions and fired pellet quality on both the bench and pilot scale. When used in conjunction with proper laboratory evaluation techniques, they can effectively be used to investigate process changes.