Foundry Optimization for Air Quality Improvement

Smith Foundry

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University of Minnesota
Driven to Discover℠
Company Background

• Specialize in low/medium production of ductile and gray iron castings

• Use sand as molds and cores to shape their castings

• Located in Minneapolis (Phillips area)
Process

Sand Preparation

Silica sand + Clay, water, and additives

Muller

Green sand
Process

Sand Preparation

Mold Making

Green sand

Cope and drag of a mold
**Process**

- Sand Preparation
- Core Making
- Mold Making

Silica sand + Chemical binders

Cores

Sand mixer
Process

Sand Preparation

Core Making

Mold Making

Mold Pouring, Cooling

Pouring and cooling
Process

- Sand Preparation
- Core Making
- Mold Making
- Mold Pouring, Cooling
- Casting Shakeout

Separator

Shakeout
Process

Sand Preparation
  \[\rightarrow\]
  Mold Making
  \[\rightarrow\]
  Core Making
  \[\rightarrow\]
  Mold Pouring, Cooling

  \[\rightarrow\]
  Casting Shakeout

  \[\rightarrow\]
  Reclaimed sand

  \[\rightarrow\]
  Spent sand

  \[\rightarrow\]
  Dust

  \[\rightarrow\]
  Disposed

  \[\rightarrow\]
  Dust-Collector

Dust bag
Process

- Sand Preparation
- Mold Making
- Core Making
- Mold Pouring, Cooling
- Casting Shakeout
- Cleaning and Finishing

Reclaimed sand

Spent sand
- Disposed
- Dust
- Dust-Collector

Dust

Castings
Incentives for Change

• OSHA regulations
• Committed to the community/neighborhood
• Employees health

• Profitability:
  • Reduce operating costs
  • Eliminate defects
  • Speed up production
Approach to the Project

• Learn the production process
• Talk to operators and employees
• Identify areas for pollution & waste reduction, and efficiency improvement
• Set up meetings with vendors & experts
  • Baseline data needed
  • Recommendations
• Quantify inputs, outputs, and costs
• Request samples & Quotes
• Test samples
Background & Solutions
1) Core Sand Binders

• Two resins are mixed with the sand
• Binding effect is activated by catalyst

• Two systems:
  • 1) Fast-cure
  • 2) Slow-cure

• Annual usage (fast-cure):
  • 3000 lb. of resins
  • 50 lb. catalyst
Why Seek Alternative Binders?

• The **conventional binders** causes:
  
  • 268 lb. VOCs
  
  • 279 lb. Carbon monoxide
  
  • 54 lb. HAPs
  
  • 80 lb. Particulate matters
  
  *(Every year)*
## Alternative Binders Reduction

- **The conventional binders** causes:
  - 268 lb. VOCs
  - 279 lb. Carbon monoxide
  - 54 lb. HAPs
  - 80 lb. Particulate matters

  (Every year)

<table>
<thead>
<tr>
<th>Alternative binders:</th>
<th>%Reduction</th>
</tr>
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<tbody>
<tr>
<td>49 lb. LESS</td>
<td>13.1%</td>
</tr>
<tr>
<td>74 lb. LESS</td>
<td>26.3%</td>
</tr>
<tr>
<td>11 lb. LESS</td>
<td>21.0%</td>
</tr>
<tr>
<td>47 lb. LESS</td>
<td>58.5%</td>
</tr>
</tbody>
</table>
# Recommendation – Sand Binders

<table>
<thead>
<tr>
<th>Pollution Reduction Option</th>
<th>Pollution Reduced</th>
<th>Implementation Cost</th>
<th>Cost Savings/Yr.</th>
<th>Payback Period</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switch to alternative binders</td>
<td>49 lb. VOCs, 74 lb. CO, 11 lb. HAPs, and 47 lb. PM</td>
<td>$0</td>
<td>$900</td>
<td>Immediate</td>
<td>Recommended</td>
</tr>
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</table>

- **Benefits:**
  - Improved air quality
  - Savings
2) Blackwater System

• **Background:**
  - Dust-collectors at shakeout and muller areas
  - The dust/sand has clay that is wasted

• **Cost of clay:**
  - $330/ton ($80,000/yr.)

• **How it works:**
  - Restores binding effect of clay
  - Replace conventional water source
Recommendation – Blackwater System

A study “Reining in Costs, Controlling Emissions” shows:
- 26-60 % Clay and coal
- 20-27 % Silica sand
- 19-70 % VOC during pouring, cooling, and shakeout

So far:
- Collected baseline data
- Sent samples of dust/sand for analysis
- Contact provider for next steps

The study by:
Rose Torielli, Fred Cannon, Robert Voigt, Penn State Univ., University Park, Pennsylvania; Timothy Considine, Univ. of Wyoming, Laramie, Wyoming; James Furness, Furness Newburge Inc., Versailles, Kentucky; John Fox, Lehigh Univ., Bethlehem, Pennsylvania; Jeff Goudzwaard, Neenah Industries Inc., Neenah, Wisconsin; and He Huang, URS Corp., Philadelphia
3) Mulling Machine

• **Currently:**
  - Mixing for 90 seconds before discharging batches

• **Problem:**
  - Under/Over mulling
  - Wasted energy
  - Wasted time

• **Opportunity:**
  - Install Mull-to-Energy system

• **How it works:**
  - Sensors tracking the energy added per batch
  - Discharge batch when energy reaches a plateau
Recommendation – “Mull-to-Energy”

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<th>Waste Reduction Option</th>
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<tr>
<td>Mull-to-Energy System</td>
<td>120,000 kWh</td>
<td>$30,000</td>
<td>$8,400</td>
<td>3.6 Yrs.</td>
<td>Recommended</td>
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• So far:
  • Traced energy by data logger
  • Contacted system provider for recommendation

• Potential Savings:
  • Energy
  • Time
  • More consistent sand molds reduce molding defects and waste
4) Optimizing Sand Handling

- **Currently:**
  - Conveying system contains many 90-degree elbows
  - Conveyed at 12-15 psi

- **Problem:**
  - Silica sand grains can fracture as low as 10 psi
  - 2% of sand breaks down to inhalable particles

- **Opportunity:**
  - Replace with sweeps to reduce conveying pressure
# Recommendation – Optimizing Sand Handling

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<td>Optimizing piping design for new Silica Sand</td>
<td>25 tons silica sand</td>
<td>$4,200</td>
<td>$1,825</td>
<td>2.3 years</td>
<td>Under review</td>
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- **Benefits:**
  - Longer sand life
  - Reduced airborne particulate
  - Less dust to be collected and disposed

- **So Far:**
  - Scanning Electron Microscopy (SEM) test of sand before and after conveying
  - Check grains fracture

- Cost Savings per year: $1,825
- Payback Period: 2.3 years
- Status: Under review
Opportunity
5) Pneumatic to Electric Tools

• Currently:
  • Compressed air grinders

• Problem:
  • Wasted energy

• Opportunity:
  • Electric tools
## Recommendation – Pneumatic to Electric

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**Status:**
- Recommend testing before switching
## Benefits Table

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<td>Blackwater system</td>
<td>60 tons clay, 250 tons silica sand, and 19% VOCs during pouring, cooling, and shakeout.</td>
<td>$250,000</td>
<td>$30,000</td>
<td>8.3 Years</td>
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Personal Benefit

• Experienced a new working environment & industry

• Interacted with people from the industry

• Reduced the gap between academic studies and real life practice

• Discovered that small changes can equal huge benefits
Any QUESTIONS?