Foundry Sand: A Recipe for Beneficial Use

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Outline

- Profile of the Foundry Industry
- Foundry By-Products
- Opportunities for Beneficial Use
- Conclusions
Profile of the Foundry Industry

- 2,800 Operating Foundries
  - 1,000 Ferrous Foundries
  - 1,800 Nonferrous Foundries
- Employ more than 220,000 people
- 80% are small operations (less than 100 employees)
- $27 Billion in shipments in 2001
- Operating at 76% of capacity

Source: AFS
What is a metal casting?

- A casting is a metal part formed by pouring molten metal into a sand mold or metal die. The mold or die is comprised of two halves that, when mated together, form a cavity into which the molten metal is poured. The mold or die form the external surface of the casting. If an internal cavity is required in the casting, a core is placed inside the mold cavity.

After the metal solidifies, the mold is broken, the cores removed and the part is readied for finishing operations. The sand is then remolded and used again.

Source: AFS
## Profile of the Foundry Industry

### Ferrous Metals
- Cast Iron
  - Gray Iron
  - Ductile Iron
  - Malleable Iron
  - Compacted Graphite Iron
- Cast Steel
  - Carbon & Low Alloy
  - Corrosion Resistant
  - Heat Resistant
  - Manganese

### Non Ferrous Metals
- Cast Aluminum
- Cast Copper Alloy
  - Brass
  - Bronze
- Zinc
- Magnesium
- Titanium
- Nickel
- Cobalt
- Tin

*Source: AFS*
Profile of the Foundry Industry

Casting Shipment Mix for 2001

- 39% Gray Iron
- 30% Ductile Iron
- 14% Aluminum
- 9% Steel
- 2% Copper
- 1% Malleable Iron
- 5% Other

Source: AFS / Stratecast, Inc.
Profile of the Foundry Industry

Top Ten Foundry States for 2001

Other States - 19%

Source: AFS / Stratecast, Inc.
Profile of the Foundry Industry

Major Casting End-Use Markets for 2001

- 33% Cars & Light Trucks
- 15% Pipe & Fittings
- 6% Construction / Mining / Oil Field
- 6% Railroad
- 5% Internal Combustion Engines
- 5% Valves
- 3% Special Industry Machinery
- 3% Farm Machinery
- 3% Municipal
- 3% Pumps & Compressors
- 17% Other

Source: AFS / Stratecast, Inc.
Profile of the Foundry Industry

- **1980's**
  - Recession, Increased Regulation, etc.
  - 1,000 foundries close (3,000 plant level)

- **1990's**
  - Strong Economy, Growth in Automotive Industry
  - Increase in foundry production

- **2000's**
  - Significant Foreign Competition (China, Brazil, India)
  - Hardest hit are municipal, malleable iron fittings, diesel engine and machine tool castings

Source: AFS
Profile of the Foundry Industry

- Chrysler Minivan Crossmember
- Redesign of a steel weldment
- Aluminum permanent mold casting
- 14 lb. Weight savings
- Casting adds mounts for ABS, brake junction block assembly, leak detection pump, power steering pump cooler and others

Source: AFS
Profile of the Foundry Industry

- **Aluminum Cylinder Block** for GM's New Vortec 4200 SUV Engine

- **Cast using the Lost Foam process**

- **Polystyrene pattern is produced and replaced with molten metal to form the casting**

Source: AFS
Profile of the Foundry Industry

- Ice Cleat for the M1 Abrams Tank
- Steel casting from green sand mold
- Redesigned from a steel forging
- Casting must withstand temperatures to -40° F

Source: AFS
Profile of the Foundry Industry

- Military Truck Hitch Housing
- Redesign of a 35-piece fabricated steel assembly
- Steel casting using the green sand molds
- Casting reduced components to 10, weighs less, installs faster, is more durable and costs less

Source: AFS
Profile of the Foundry Industry

- Air Scoop for Combine
- Ductile iron casting (top) replaced steel weldment (below)
- Casting offered customer a 40% savings

Source: AFS
Profile of the Foundry Industry

- Silicon Bronze Statue is actually an investment casting
- Statue weighs 2,000 lbs. and is 12 feet tall

Source: AFS
Green Sand Recipe

- 80 - 85% Silica Sand
- 8 - 10% Bentonite Clay
- 3.5 - 6% Sea Coal (ground bituminous coal)
- 3 - 4% Water
- Other Minor Components
- Mix ingredients well in a muller
- Transport mix to mold making area
Foundry By-Products

**INPUTS**
- Core & Mold Materials
  - Sand
  - Binders
  - Additives
- Melting Materials
  - Metallics
  - Refractories
  - Fuels
  - Fluxes
- Other Materials
  - Grinding Wheels
  - Shot
  - Abrasives
  - Etc.

**FOUNDRY**
- Internal Process
- Recycling
- Metallics
- Molding Sand
- Core Sand

**OUTPUTS**
- Castings
- By-Products
  - Foundry Sand
  - Slag
- Wastes
  - Refractories
  - Dusts
  - Abrasives
  - Spent Shot
  - Etc.
Opportunities for Beneficial Use

- The Metalcasting process requires large volumes of sand for molding.
- Metalcasters use and reuse about 100 million tons of sand annually.
- Approximately 6 million tons (6%) can no longer be reused in the foundry process and is available for beneficial use.
Opportunities for Beneficial Use

- Construction - Engineered Fill / Road Subbase
- Flowable Fill (CLSM)
- Fine aggregate for asphalt pavement
- Cement Manufacturing
- Precast Concrete Products
- Potting and Specialty Soils
- Bricks and Pavers
- Landfill Daily Cover
Construction - Engineered Fill
Flowable Fill (CLSM)
Asphalt
Precast Concrete Products
Potting and Specialty Soils
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Potting Soil</th>
<th>Chemically Bonded Sand</th>
<th>Green Sand</th>
<th>Mixed Sand</th>
</tr>
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<tbody>
<tr>
<td>Arsenic</td>
<td>15.3</td>
<td>&lt;0.05</td>
<td>&lt;1.9</td>
<td>&lt;0.2</td>
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<tr>
<td>Barium</td>
<td>137</td>
<td>0.04</td>
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<td>1.93</td>
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<td>Cadmium</td>
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<tr>
<td>Chromium</td>
<td>33.3</td>
<td>&lt;0.004</td>
<td>&lt;19.6</td>
<td>&lt;2</td>
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<tr>
<td>Lead</td>
<td>16.3</td>
<td>0.28</td>
<td>&lt;2.6</td>
<td>&lt;3.41</td>
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<td>Mercury</td>
<td>0.16</td>
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<td>&lt;0.1</td>
<td>&lt;0.1</td>
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<tr>
<td>Selenium</td>
<td>3.3</td>
<td>&lt;0.05</td>
<td>&lt;0.3</td>
<td>&lt;0.35</td>
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<td>Iron</td>
<td>22,400</td>
<td>0.4</td>
<td>1,467</td>
<td>NA</td>
</tr>
</tbody>
</table>
Conclusions

- The foundry industry is an important component of US manufacturing and a significant recycler.
- Foreign competition poses a significant threat to the viability of this industry.
- 6 Million tons of foundry sand available for beneficial use annually.
- Effective beneficial use of foundry sand:
  - environmentally safe
  - conserves natural resources
  - contributes to industry sustainability
Barriers to Beneficial Use

- Wide variability between different state programs on beneficial use
- Limited self-implementation regulatory programs
- Smaller foundries cannot always afford to conduct required testing
- Typical end uses require large volumes of material
- Stigma associated with classification as a solid waste can be hard to overcome
Sources of Information

Sources of additional information:

- American Foundry Society - www.afsinc.org
- Ductile Iron Society - www.ductile.org
- FIRST - www.foundryrecycle.org
- Investment Casting Institute - www.investmentcasting.org
- Non-Ferrous Founders’ Society - www.nfs.org
- North American Die Casting Assoc. - www.diecasting.org
- Steel Founders’ Society of America - www.sfsa.org