The idea of reducing seacoal use to control metalcasting facility emissions has gone from the theoretical to the practical.

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Pride Cast Metals, Cincinnati, has overhauled its sand system in the past four years in the face of mounting environmental regulations and raw materials availability. Now, the aluminum green sand facility is producing castings with the same quality level its customers have come to expect while reducing its hazardous emissions and complying with environmental regulations.

In August 2008, Pride was visited by the Ohio Occupational Safety and Health Administra-

A Netherlands-based ferrous sand caster has improved its facility atmosphere and emissions by eliminating sea coal use in its green sand mixture.
Table 1. Reduced Emissions Using a Seacoal-Free Green Sand Mixture

<table>
<thead>
<tr>
<th>Process Sources of CO</th>
<th>CO (lbs./ton of metal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cast Iron</td>
<td>0.97</td>
</tr>
<tr>
<td>Other Process Sources (clays, etc.)</td>
<td>0.43</td>
</tr>
<tr>
<td>Total of Iron and Other Sources</td>
<td>1.4</td>
</tr>
<tr>
<td>Phenolic Urethane Cores in Green Sand (no seacoal)</td>
<td>1.82-2.05</td>
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<tr>
<td>Phenolic Urethane Cores in Green Sand (with seacoal)</td>
<td>4.25-4.73</td>
</tr>
<tr>
<td>Green Sand Molds with Seacoal (no cores)</td>
<td>5.53-5.60</td>
</tr>
<tr>
<td>Green Sand Molds with Graphite Parting (no cores or seacoal)</td>
<td>1.35-2.75</td>
</tr>
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The administration intended to determine the potential exposure of the metalcasting facility workers to hazardous emissions. Individuals were fitted with personal sampling pumps to determine their actual exposures.

To Pride's surprise, OSHA measured for coal tar pitch volatiles emissions. Unaware of the maximum allowable level of this byproduct of heating coal tar, the metalcasting facility thought its results would be acceptable. Its test values were above the allowable level.

In response to the failed test, Pride began the process of converting to a sand mixture containing no carbon. The new mixture has had little effect on the company's green sand properties.

Pride isn't the only metalcasting facility that has experimented with green sand mixtures using reduced or no seacoal, a carbonaceous material commonly used to improve mold properties. A number of facilities in Europe, including a large iron foundry in the Netherlands, also have taken up the strategy. The topic of carbon monoxide (CO) emissions in green sand facilities also has drawn the attention of industry trade groups and been discussed by numerous researchers at conferences and seminars over the past five years. With this attention, industry analysts expect a growing trend toward reduced seacoal.

**Understanding Your Emissions**

Testing performed in the Casting Emission Reduction Program (CERP) by Technikon LLC, McClellan, Calif., has been a key element in the discussion of emissions in pouring, cooling and shakeout. CO is regulated as a criteria pollutant, and emissions frequently trigger the U.S. Environmental Protection Agency's (EPA) major source thresholds for Part 70-Title V and Prevention of Significant Deterioration (PSD) before other pollutants.

The regulations requiring review under PSD went into effect in 1997. The Title V permitting program was initiated in most states during the 1990s. EPA databases and reference documents do not quantify CO emissions from metalcasting pouring, cooling and shakeout operations. Historical research has focused on hazardous air pollutants (HAPs) and their variability in response to federal and state initiatives regulating HAP emissions. During recent years, some metalcasting facilities have begun testing CO from iron green sand pouring, cooling and shakeout operations at the request of state regulatory agencies.

The CERP research has identified the sources of HAPs in an iron casting facility and demonstrated green sand molds and cores make up 90% of the emissions. Many of the CERP emissions tests have quantified CO emissions from different molding process and metals.

Metalcasting facilities installing new equipment or making modifications to existing equipment must determine the impact of the change on CO emissions and their air permitting status. Major source status under Part 70-Title V is triggered at 100 tons of CO emissions per year. Major source status under PSD is triggered at either 100 tons or 250 tons of CO emissions per year, depending on the facility's use of different types of metallic charge materials.

**Reducing Your Emissions**

Both oxygen and high temperatures are required to produce CO and carbon dioxide emissions from carbon sources. In the metalcasting process, the energy to break down organic or other carbon sources is provided by molten metal. Because different metals have different pouring temperatures and melting energy requirements, the temperature at which this occurs is variable.

Carbon sources and the avail-

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Fig. 1. A Netherlands-based ferrous facility achieved significantly reduced emissions using a seacoal-free green sand mixture.
Reducing Atmosphere

CH₄

CO₂

CO

H₂O

Reducing Atmosphere

Precipitation of Lustrous Carbon

Softening of Coal to Form Coke

Fig. 2. Seacoal reduces the wettability of molten metal by the precipitation of lustrous carbon onto the mold face, produces a reduction atmosphere inside the mold cavity for the prevention of oxidation defects, seals mold surfaces and reduces compressive stresses inside the mold.

ability of oxidation products also can be considered a variable. Research testing performed at the CERP facility (Table 1) shows green sand molds both with and without cores emit between 4.23 and 5.6 lbs. of CO per ton of metal. Test results from graphite parking, which contains little or no seacoal, are in the same range as those from inorganic core tests. Regardless of mold and core configuration, CO results remain relatively constant. Therefore, the potential sources of carbon necessary to form CO and carbon dioxide are:

- Seacoal and other carbon-based green sand mold additives.
- Molten metal.
- Organic core materials.
- Southern clays, western clays and inorganic additives.

During the CERP research testing where seacoal was present, the material contributed 56-75% of the CO emissions, depending on the mold configuration.

In order to reduce its CO emissions levels, the Netherlands-based ferrous facility eliminated the use of seacoal over a period of one year, gradually replacing the material with a blend of inorganic additives and processed carbon. The facility obtained a significant reduction in the quantity of CO found in its cooling and shakeout areas (Fig. 1). Between April 2007 and February 2011, the iron caster’s CO was reduced from approximately 40 ppm to 15 ppm. The amount of CO allowed in that part of Europe is 30 ppm.

Recent testing showed seacoal contributed 56–75% of the CO emissions, depending on the mold configuration.

Overcoming Seacoal Loss

The application of seacoal in green sand facilities has been understood for many years. It is generally accepted by metalcasting industry researchers that seacoal (Fig. 2):

- Reduces the wettability of molten metal by the precipitation of lus-