Environmental Emissions Testing for Foundry Binder Systems

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Introduction

- Currently, there are no standardized methods to measure emissions from foundry binder systems.

- Hiring an emissions testing company to perform tests independently is expensive.

- UNI Metal Casting Center is partnering with AFS to develop test protocols for measuring and recording emissions from different foundry binder systems.
Introduction

• Testing specified by this protocol includes Volatile Organic Compounds (VOC), Hazardous Air Pollutants (HAP), Carbon Monoxide (CO) and Particulate Matter (PM) including condensable particulate fractions.

• The Metal Casting Center provides the facilities required to perform the testing operations. Testing will be performed in an environment that would allow for isolation and capture of binder related emissions.

• Testing will meet standard EPA QA/QC criteria and will employ standard EPA test methods.
Objective

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• Enable collection of data from different binder systems to provide a source of the data needed for estimating emission from these systems.
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- Enable collection of data from different binder systems to provide a source of the data needed for estimating emission from these systems.
- Encourage performance and publication of emissions data.
- Encourage foundry binder manufacturers to develop new binder systems with improved environmental aspects.
Facilities
Facilities
Testing Methodologies

• EPA Testing protocols will be used to measure binder emissions. This includes Methods 1, 2, 3, 4, 5, 10, TO-15, 25A, 202, 204, 316 and 0010.

• Carbon Monoxide – Method 10

• Particulate Matter – Method 5

• Condensable Particulate Matter – Method 202
Testing Methodologies

- Formaldehyde Emissions – Method 316
- Hazardous Air Pollutants (HAP) – Method 0010
- Volatile Organic Compounds (VOC)
  - Total VOC Content – Method 25A
  - Methanol Corrected VOC – Method TO-15
Testing Methodologies
Testing Methodologies
Testing Methodologies
Testing Methodologies

![Testing Methodologies](image)
Results And Reports

- Test Reports will clearly indicate whether tests were completed in accordance with the standard protocols.

- Reports will clearly identify the products tested and will remain confidential, if desired.

- Customers will be encouraged to publish final reports to the AFS web site to create a database of emissions data for the industry.
Case Study - Overview

• Tests were conducted to determine emission characteristics of three different PUNB binder systems.

• Tests included VOC, Particulate matter, HAP’s and Carbon Monoxide.

• Pouring, cooling and shakeout tests were run for VOC, HAP’s and Carbon Monoxide.

• Pouring and cooling tests were run for particulate matter.
Case Study - Results

Chart 2
FID Response; VOC at Pouring Cooling & Shake Out

- Conventional zero adjusted
- Hybrid THC zero adjusted
- Full TEOS THC zero adjusted
Case Study - Results

Chart 3
CO Emissions at Pouring, Cooling, Shake Out

- Conventional PCS
- Hybrid PCS
- Full TEOS PCS

PPM

Time, min (Pouring at T=0)
**Case Study - Results**

**Chart 1**

**VOC and CO Emissions**

*Pouring Cooling and Shakeout Operations*  
*Lb emitted per ton metal poured*

<table>
<thead>
<tr>
<th></th>
<th>Conventional F6000/6435</th>
<th>Hybrid 8000T/6435</th>
<th>TEOS 8000T/8500T</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOC, lb/ton metal</td>
<td>6.17</td>
<td>4.46</td>
<td>3.57</td>
</tr>
<tr>
<td>VOC (methane-corrected), lb/ton metal</td>
<td>4.98</td>
<td>2.76</td>
<td>2.51</td>
</tr>
<tr>
<td>CO, lb/ton metal</td>
<td>6.43</td>
<td>5.19</td>
<td>4.74</td>
</tr>
</tbody>
</table>
Case Study - Results

Chart 6
Emissions of HAP Compounds from Pouring, Cooling & Shakeout Operations
(lb emitted/ton metal)

<table>
<thead>
<tr>
<th></th>
<th>Conventional, Ave</th>
<th>Hybrid</th>
<th>TEOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>phenol</td>
<td>3.73E-01</td>
<td>4.64E-01</td>
<td>4.83E-01</td>
</tr>
<tr>
<td>naphthalene</td>
<td>2.68E-01</td>
<td>1.06E-01</td>
<td>2.71E-02</td>
</tr>
<tr>
<td>benzene</td>
<td>1.56E-01</td>
<td>2.26E-01</td>
<td>1.25E-01</td>
</tr>
<tr>
<td>o-cresol</td>
<td>2.88E-02</td>
<td>3.27E-02</td>
<td>3.34E-02</td>
</tr>
<tr>
<td>acetonitrile</td>
<td>1.76E-02</td>
<td>5.91E-03</td>
<td>1.83E-02</td>
</tr>
<tr>
<td>formaldehyde</td>
<td>1.54E-02</td>
<td>9.99E-03</td>
<td>1.73E-02</td>
</tr>
<tr>
<td>aniline</td>
<td>6.79E-03</td>
<td>1.06E-02</td>
<td>5.37E-04</td>
</tr>
<tr>
<td>m,p-cresol</td>
<td>3.37E-03</td>
<td>3.20E-03</td>
<td>3.33E-03</td>
</tr>
</tbody>
</table>
Case Study - Results

Chart 8
Detected Common Lab Contaminants
Pouring, Cooling & Shakeout Emissions
(lb/ton metal)

<table>
<thead>
<tr>
<th></th>
<th>Conventional, Ave</th>
<th>Hybrid</th>
<th>TEOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>acetone</td>
<td>1.49E-01</td>
<td>3.22E-02</td>
<td>9.94E-02</td>
</tr>
<tr>
<td>methylene chloride</td>
<td>7.37E-02</td>
<td>2.83E-02</td>
<td>5.91E-02</td>
</tr>
<tr>
<td>hexane</td>
<td>3.90E-02</td>
<td>8.11E-03</td>
<td>1.52E-02</td>
</tr>
<tr>
<td>carbon disulfide</td>
<td>2.01E-02</td>
<td>4.59E-03</td>
<td>1.34E-02</td>
</tr>
</tbody>
</table>
Case Study - Results

Chart 9
Particulate Emissions
Pouring and Cooling Operations
lb emitted per ton metal poured

<table>
<thead>
<tr>
<th></th>
<th>Conventional</th>
<th>TEOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condensible Particulates (CPM)</td>
<td>0.9</td>
<td>0.2</td>
</tr>
<tr>
<td>Dry particulates</td>
<td>1.0</td>
<td>0.5</td>
</tr>
</tbody>
</table>
Conclusion

- The total cost for emissions testing will be roughly $\frac{1}{3}$rd lower than the cost to hire an emissions testing company. This will encourage development of reliable standard emissions testing data for foundry binders.

- In the absence of site-specific data, data from these testing protocols may reasonably be used for permitting and emissions reporting.

- Certain adjustments, such as adjusting the results proportionally to reflect the resin level of the actual operation, should be made.
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