B.13 DRY INJECTION FABRIC FILTERS

B.13.1 Background

Dry injection fabric filters (DIFFs) are control devices that reduce acid gas emissions. Dry injection fabric filters consist of a sorbent injection system and a reaction chamber followed by a fabric filter. (Note: Dry injection for acid gas control may also be used in conjunction with other PM control devices—for example, an electrostatic precipitator—but is most frequently used in conjunction with a fabric filter.) To remove SO₂, HCl, and HF, dry sorbent is injected into a reaction chamber on the emission stream duct where the sorbent reacts with the acid gas in the emission stream to form salts that are subsequently removed by the fabric filter. The sorbent may include hydrated lime or sodium bicarbonate. The use of a reaction chamber promotes intimate contact and increased residence time for the acid gas and sorbent particles to react. The emission stream is then vented to a fabric filter to remove the resulting PM. Additional removal of acid gas is achieved when unreacted acid contacts the sorbent-coated bags as it flows through the fabric filter. The acid gas reduction efficiency is affected by dry sorbent injection rate, emission stream gas temperature, the residence time or reaction time between the sorbent and gas stream, the degree of turbulence, and the other parameters discussed for fabric filters in section B.1. Lower emission stream gas temperatures increase the sorbent reactivity and increase the removal of acid gas. In some applications, the emission stream may need to be cooled prior to the DIFF to avoid damage to the fabric filter and to promote reactivity. The emission gas stream can be cooled by a heat exchanger, humidification, or addition of lower temperature cooling air. The desired molar ratio of dry sorbent (calcium) to acid gas is dependent on the equipment configuration, i.e., whether there is a reaction chamber.

B.13.2 Indicators of DIFF Performance

The primary indicators for DIFF performance are outlet acid gas concentration, dry sorbent feed rate, fabric filter inlet gas temperature, and the primary indicators that are discussed in section B.1 for fabric filters. Other parameters that can indicate DIFF performance include DIFF inlet gas temperature (process exhaust temperature), exhaust gas flow rate, sorbent carrier flow rate, sorbent nozzle pressure differential, sorbent specifications, and other indicators that are discussed in section B.1 for fabric filters. Table B.13a lists these indicators and illustrates potential monitoring options for DIFF. See Table B.1 for potential monitoring options for fabric filters.

Outlet acid gas concentration. The most direct single indicator of DIFF performance in removing acid gas from the emission gas stream is the acid gas concentration at the outlet of the unit.

Sorbent feed rate. The dry sorbent feed rate is a key indicator of performance provided the sorbent is properly distributed and has good contact with the emission gas stream. The feed rate is determined based on stoichiometry with the amount of acid gas in the emission gas stream. In general, higher sorbent feed rates are indicative of higher levels of control up to a
Fabric filter inlet temperature. Most fabric filters are designed to operate within a specified temperature range based on the type of bags used. High inlet temperatures can damage the bags. However, cooling to too low a temperature may result in moisture condensation that will cause caking or blinding of the fabric filter bags or acid gas condensation that may corrode the fabric filter housing and other metal components.

Sorbent carrier gas flow rate. A minimum carrier gas flow rate will ensure that the flow and dispersion of the injected sorbent is maintained. With low carrier gas flow to the DIFF, the sorbent flow rate will decrease, causing the acid gas emissions to increase, i.e., less control of acid gas emissions.

Sorbent/carrier gas nozzle pressure differential. Nozzle pressure is a surrogate for the carrier gas flow rate. Higher pressure differentials indicate that more sorbent is being carried to the DIFF and also indicates that good dispersion of the sorbent is being achieved.

Sorbent specifications. Changes in the sorbent may affect the control efficiency of the unit. A facility should identify the sorbent brand and type or identify the adsorption properties of the sorbent.

DIFF inlet gas temperature (process exhaust temperature). For thermal processes, increases in the DIFF inlet temperature may indicate that additional cooling of the gas stream is necessary. Increases in temperature reduce the reactivity of the sorbent with the acid gas and may cause acid gas emissions to increase.

Exhaust gas flow rate. Gas flow rate affects the residence time of the gas stream in the reactor, the duct, and the fabric filter. Increases in the gas flow rate decrease the residence time, which may decrease the control efficiency. The longer the residence time, the more time the acid in the gas stream is in contact with the sorbent.

Indicators for fabric filters. See section B.1.

B.13.3 Illustrations

The following illustrations present examples of compliance assurance monitoring for Dry Injection Fabric Filters:

13b: Monitoring sorbent feed rate, fabric filter inlet temperature, and bag leak detector.

B.13.4 Bibliography
<table>
<thead>
<tr>
<th>Parameters</th>
<th>Performance indication</th>
<th>Approach No.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary Indicators of Performance</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outlet acid concentration</td>
<td>Direct measure of outlet acid concentration.</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Sorbent feed rate</td>
<td>Low feed rate may indicate insufficient alkali to react with acid gases. High feed rates above an optimum level may cause bag blinding.</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fabric filter inlet temperature</td>
<td>High temperatures can destroy the bags or shorten bag life; high temperatures indicate a need for additional cooling. Applies only to DIFF that control thermal process emissions. Too low a temperature can cause condensation that can result in bag blinding or increased corrosion of structural components.</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bag leak detector signal</td>
<td>Indicator of bag degradation or rupture. Signal is proportional to particulate loading in exhaust; in some cases, signal can be affected by changes in velocity, particle size/type, and humidity.</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Opacity/VE</td>
<td>Increased opacity/VE denotes performance degradation. COMS, opacity observations, or visible/no visible emissions.</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
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<tr>
<td><strong>Other Performance Indicators</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Sorbent/carrier gas nozzle pressure differential</td>
<td>High pressure differential indicates that more sorbent is being delivered to the unit and that good dispersion is being achieved. May be used as a surrogate for carrier gas flow rate.</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Sorbent specifications</td>
<td>Changes in the type or brand of sorbent may affect the acid reduction efficiency.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
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<tr>
<td>Sorbent carrier gas flow rate</td>
<td>Ensures that flow and dispersion of the solvent is maintained. Lower carrier gas may indicate lower sorbent feed rate and decreased acid removal.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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TABLE B-13. (Continued)

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<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIFF inlet temperature (process exhaust temperature)</td>
<td>Lower gas stream temperatures provide an increase in sorbent reactivity and an increase in acid gas removal. Increases in inlet temperature may indicate that additional cooling is necessary. Applies only to DIFF that control thermal process emissions.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fabric filter pressure differential</td>
<td>Indicator of blinding or malfunction of cleaning cycle. Sudden increase in pressure differential can indicate bag blinding; also can indicate if cleaning mechanism is operating properly.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Exhaust gas flow rate</td>
<td>Indication of residence time in control device.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

Notes: Other monitoring options for fabric filters are discussed in section B.1 for Fabric Filters.

• Approach No. 3 corresponds to 40 CFR 63, subpart EEE (Hazardous Waste Combustors)
• Approach No. 5: 40 CFR 63, subpart LL (Primary Aluminum Production).
1. APPLICABILITY

1.1 Control Technology: Dry injection fabric filter (DIFF)

1.2 Pollutants
   Primary: Sulfur dioxide (SO₂), hydrogen chloride (HCl), hydrogen fluoride (HF)
   Other:

1.3 Process/Emissions units: Combustors, kilns

2. MONITORING APPROACH DESCRIPTION

2.1 Parameters to be Monitored: Sorbent feed rate, opacity, fabric filter inlet temperature, and fabric filter pressure differential.

2.2 Rationale for Monitoring Approach
   • Sorbent feed rate: Amount of sorbent injected is based stoichiometrically on acid gas concentration; want to maximize sorbent feed rate without generating excess sorbent particulate that will overload the fabric filter.
   • Opacity or VE: An increase in opacity or changes in VE observations indicate process changes, changes in baghouse efficiency, or leaks.
   • Fabric filter inlet temperature: High temperature can damage filter bags; low temperature can cause condensation of moisture that will cause caking on the filter bags or of acid gases that will damage the unit.
   • Fabric filter pressure differential: Decrease in pressure differential indicates change in operation; increase in pressure differential indicates filter bag blinding.

2.3 Monitoring Location
   • Sorbent feed rate: Measure at sorbent injection point or sorbent weigh tank.
   • Opacity or VE: Per RM 9 (opacity) or RM 22 (VE) requirements.
   • Fabric filter inlet temperature: Measure at the fabric filter inlet duct.
   • Fabric filter pressure differential: Measure across inlet and outlet of each compartment of fabric filter.

2.4 Analytical Devices Required
   • Sorbent feed rate: Use of a scale or other weight monitor.
   • Opacity or VE: Trained observer using RM 9 or visible/no visible emissions observation techniques (RM 22-like).
   • Fabric filter inlet temperature: Thermocouple, RTD, or other temperature sensing device; see section 4.2 for additional information on devices.
   • Fabric filter pressure differential: Pressure transducers, differential pressure gauges, manometers, and other methods or alternative instrumentation, as appropriate; see section 4.3 for additional information on devices.

2.5 Data Acquisition and Measurement System Operation
   • Frequency of measurement: Hourly, or continuously on strip chart or data acquisition system; for opacity or VE, daily or as weather permits.
• Reporting units:
  – Sorbent feed rate: Pounds per hour (lb/hr).
  – Opacity or VE: Percent opacity or visible/no visible emissions.
  – Fabric filter inlet temperature: Degrees Celsius or Fahrenheit (°C or °F).
  – Fabric filter pressure differential: Inches of water column (in. w.c.).
• Recording process: Operators log data manually, or recorded automatically on strip chart or data acquisition system; observers complete opacity or VE observation forms and log into binder or electronic database as appropriate.

2.6 Data Requirements
• Baseline sorbent feed rate, opacity or VE, fabric filter inlet temperature, and fabric filter pressure differential measurements concurrent with emissions test.
• Historical plant records of sorbent feed rate, opacity observations, fabric filter inlet temperature, and fabric filter pressure differential measurements. (No data are needed if indicator is “any visible emissions.”)

2.7 Specific QA/QC Procedures: Calibrate, maintain, and operate instrumentation using procedures that take into account manufacturer’s specifications; initial training of observer per RM 9 or RM 22, semi-annual refresher training per RM 9, if applicable.

2.8 References: ________

3. COMMENTS

3.1 Data Collection Frequency: For large emission units, a measurement frequency of once per hour would not be adequate; collection of four or more data points each hour is required. (See Section 3.3.1.2.)
1. APPLICABILITY

1.1 Control Technology: Dry injection fabric filter (DIFF)
1.2 Pollutants
   Primary: Sulfur dioxide (SO₂), hydrogen chloride (HCl), hydrogen fluoride (HF)
   Other:
1.3 Process/Emissions units: Combustors, kilns

2. MONITORING APPROACH DESCRIPTION

2.1 Parameters to be Monitored: Sorbent feed rate, fabric filter inlet temperature, and PM concentration using a bag leak detector.

2.2 Rationale for Monitoring Approach
   • Sorbent feed rate: Amount of sorbent injected is based stoichiometrically on acid gas concentration; want to maximize sorbent feed rate without generating excess sorbent particulate that will overload the fabric filter.
   • Fabric filter inlet temperature: High temperature can damage filter bags; low temperature can cause condensation of moisture that will cause caking on the filter bags or of acid gases that will damage the unit.
   • PM concentration: A bag leak detector generates a signal that is proportional to the PM loading. It provides an indication of bag degradation or rupture. Operates on principles such as triboelectricity, electrostatic induction, light scattering, or light transmission.

2.3 Monitoring Location
   • Sorbent feed rate: Measure at sorbent injection point or sorbent weigh tank.
   • Fabric filter inlet temperature: Measure at the fabric filter inlet duct.
   • PM concentration: Measure at outlet of fabric filter.

2.4 Analytical Devices Required
   • Sorbent feed rate: Use of a scale or other weight monitor.
   • Fabric filter inlet temperature: Thermocouple, RTD, or other temperature sensing device; see section 4.2 for additional information on devices.
   • PM concentration: Bag leak detector and associated instrumentation.

2.5 Data Acquisition and Measurement System Operation
   • Frequency of measurement: Hourly, or continuously on strip chart or data acquisition system.
   • Reporting units:
     – Sorbent feed rate: Pounds per hour (lb/hr).
     – Fabric filter inlet temperature: Degrees Celsius or Fahrenheit (°C or °F).
     – PM concentration: Amps, volts, or percent of scale.
   • Recording process: Operators log data manually, or recorded automatically on strip chart or data acquisition system.
2.6 Data Requirements
   • Baseline sorbent feed rate, fabric filter inlet temperature, and bag leak detector
     measurements concurrent with emissions test.
   • Historical plant records of sorbent feed rate, fabric filter inlet temperature, and bag
     leak detector measurements.

2.7 Specific QA/QC Procedures: Calibrate, maintain, and operate instrumentation using
   procedures that take into account manufacturer’s specifications.

2.8 References: _

3. COMMENTS

3.1 Data Collection Frequency: For large emission units, a measurement frequency of once
   per hour would not be adequate; collection of four or more data points each hour is
   required. (See Section 3.3.1.2.)