Real Time Monitoring of Selenium Species, Mercury, and Arsenic in Coal-Fired Power Plant Wastewaters

Contract Number DE-SC0020865
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Prepared for:
National Energy Technologies Laboratory
Phase I STTR Project
Highlights to Date

- Detected the Following
  - Se – 10 ppb
  - Hg – 0.03 ppb
  - As – 6.4 ppb
- Expect to Reduce These in Our Phase II Work
Team

• Energy Research Company
• Lehigh University
• Electric Power Research Institute (Phase II)
ERCo Description
ERCo

- R&D Company founded 1991
- Laser Diagnostics
- Industrial Applications
- ERCo is at the Forefront of LIBS Technology
- Formed Joint Venture, Melt Cognition, for Commercial Sales of LIBS and AIM to Metals Industry
What We Do

- Industrial Project Development
- Aluminum Industry
  - OnSpec
  - VFD Development
  - Aluminum Integrated Minimill
- Coal Fired Power Plants
  - LIBS for Coal Properties
- Fully Equipped Laser Spectroscopy Laboratory
- Expertise in Plasma Dynamics
Sample Projects
OnSpec for Molten Metals
LIBS for Coal Analysis
LIBS Installation

- 2 Systems installed side-by-side over 2 conveyors
- Systems automatically detect when coal is flowing and begin measuring
OnSpec for Glass Forming Compounds

- Los Alamos National Laboratory
- Used to control the vitrification of nuclear waste
Lehigh University – Energy Research Center

- Established in 1972, the ERC main focus has been on fossil-fuel electric power generation.
- Involved in both fundamental and applied energy research.
- Current program orientation: Power generation, energy efficiency, emissions reduction, renewable energy, carbon capture, cross-cutting technologies, water-energy nexus, energy storage.
- Name branded in the power industry and with aligned funding agencies.

Research Funding Sources:
- Electric Utility Companies, Organizations
- Equipment Manufacturers
- U.S. Department of Energy (DOE)
- U.S. Environmental Protection Agency (EPA)
- International Organizations
Instrument and Business Objectives

• Measure the following in near real time and in-situ
  • Se (IV)
  • Se (VI)
  • Total Se
  • Hg
  • As

• Meet Current and Proposed EPA Regulations

• Clean Up Wastewater Sufficiently to Minimize Instrument Maintenance.

• Application – Wastewaters
  • Coal Fired Power Plant Wastewater
  • Industrial Wastewater
  • Drinking Water
Summary of the Final Rule: VIP

- VIP for FGD Wastewater Direct Dischargers
  - *Technology Basis*: Membrane Filtration Systems
  - *Limitations*:

<table>
<thead>
<tr>
<th>Pollutant or pollutant property</th>
<th>Maximum for any 1 day</th>
<th>Average of daily values for 30 consecutive days shall not exceed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic, total (ug/L)</td>
<td>5</td>
<td>NA</td>
</tr>
<tr>
<td>Mercury, total (ng/L)</td>
<td>23</td>
<td>10</td>
</tr>
<tr>
<td>Selenium, total (ug/L)</td>
<td>10</td>
<td>NA</td>
</tr>
<tr>
<td>Nitrate/nitrite as N (mg/L)</td>
<td>2.0</td>
<td>1.2</td>
</tr>
<tr>
<td>Bromide (mg/L)</td>
<td>0.2</td>
<td>NA</td>
</tr>
<tr>
<td>TDS (mg/L)</td>
<td>306</td>
<td>149</td>
</tr>
</tbody>
</table>
Summary of the Final Rule: FGD

- FGD Wastewater BAT/PSES
  - BAT – Best Available Technology Economically Achievable
  - PSES Pretreatment Standards for Existing Sources
  - Technology Basis: Chemical Precipitation (CP) followed by Low Hydraulic Residence Time Biological Reduction (LRTR)

- Limitations:

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</tr>
</thead>
<tbody>
<tr>
<td>Arsenic, total (ug/L)</td>
<td>18</td>
<td>8</td>
</tr>
<tr>
<td>Mercury, total (ng/L)</td>
<td>103</td>
<td>34</td>
</tr>
<tr>
<td>Selenium, total (ug/L)</td>
<td>70</td>
<td>29</td>
</tr>
<tr>
<td>Nitrate/nitrite as N (mg/L)</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>
Experimental Results
<table>
<thead>
<tr>
<th></th>
<th>Achieved Measurement (ppb)</th>
<th>Achieved Concentration (ppb)</th>
<th>Actual Limits of Detection (ppb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>As</td>
<td>250</td>
<td>39</td>
<td>6.4</td>
</tr>
<tr>
<td>Hg</td>
<td>1</td>
<td>36</td>
<td>0.028</td>
</tr>
<tr>
<td>Se</td>
<td>250</td>
<td>23</td>
<td>10.0</td>
</tr>
</tbody>
</table>
Arsenic Calibration

![Graph showing arsenic concentration vs signal strength]
Acknowledgment

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