Emission Testing at Two South African Power Stations using the US-EPA’s Mercury Toolkit

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Overview

• Background
• Methodology
• Results
• Discussion
• Way Forward
• Acknowledgements
Background

- Project was undertaken as part of a UNEP project “Reducing mercury emissions from coal combustion in the energy sector – Part 1”
- Emission testing was undertaken by a team from the US-EPA using the EPA Mercury Toolkit
- Two power stations in the Witbank area were sampled
- Simultaneous coal and ash (fly ash and bottom ash) samples were taken
- All previous estimates of mercury emissions from South African power stations were based on emission factor calculations
South Africa’s coal fired power generation fleet
Methodology

• Mercury Emission Measurements
  – Paired carbon traps are co-located in the stack and are sampled individually (US-EPA Method 30B)
  – 30 minute sampling runs
  – Traps are analysed individually
  – Each emission test is required to have 3 sets of valid paired trap measurements
  – All testing is undertaken according to an agreed quality assurance project plan (QAPP)
  – Speciating trap samples were taken from all stacks
  – Results give the oxidised / elemental Hg split
Methodology

- **Solid Sampling**
  - Raw coal samples
  - Fly-ash samples
  - Bottom-ash samples
  - The solid sampling should be viewed as a separate exercise from the emission testing
  - The results can assist in the interpretation of the emission testing results
Methodology

• Limitations of the study
  – Only one sampling port used for the sampling (representivity ?)
  – Time constraints (12 stacks in 5 days on 2 sites)
  – Some unexpected results from the control efficiency calculations (negative performance ??)
Results

• Duvha Power Station
  – 3 600 MW (6 x 600MW units)
  – Coal Consumption – 11.7 million tons / annum
  – Average Hg content – 0.23 ppm historical
  – Average Hg content – 0.15 ppm measured (0.11 – 0.21 ppm)
  – Annual Hg emission – 1883.7 kg/annum (calculated)
  – Annual Hg emission – 1748.5 kg/annum (measured)
  – 3 units – Electrostatic Precipitator with SO$_3$ injection
  – 3 units – Fabric Filter Plants
## Results

### Duvha Power Station

<table>
<thead>
<tr>
<th>Unit Number</th>
<th>Hg Concentration (µg/m$^3$ 3% O$_2$)</th>
<th>Hg 2+ (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>13.81</td>
<td>89%</td>
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<tr>
<td>2</td>
<td>4.65</td>
<td>73%</td>
</tr>
<tr>
<td>3</td>
<td>4.09</td>
<td>88%</td>
</tr>
<tr>
<td>4</td>
<td>35.49</td>
<td>56%</td>
</tr>
<tr>
<td>5</td>
<td>29.01</td>
<td>54%</td>
</tr>
<tr>
<td>6</td>
<td>40.37</td>
<td>55%</td>
</tr>
</tbody>
</table>
Results

- Kendal Power Station
  - 4 116MW (6 x 686 MW units)
  - Coal Consumption – 13.9 million tons / annum
  - Average Hg content – 0.44 ppm historical
  - Average Hg content – 0.23 ppm measured
    (0.17 – 0.34 ppm)
  - Annual Hg emission – 5504.4 kg/annum (calculated)
  - Annual Hg emission – 3030.6 kg/annum (measured)
  - 6 units – Electrostatic Precipitators with SO$_3$ injection
## Results

### Kendal Power Station

<table>
<thead>
<tr>
<th>Unit Number</th>
<th>Hg Concentration (µg/m³ 3% O₂)</th>
<th>Hg 2+ (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>39.20</td>
<td>70%</td>
</tr>
<tr>
<td>2</td>
<td>43.45</td>
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<tr>
<td>3</td>
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<tr>
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<td>52%</td>
</tr>
<tr>
<td>5</td>
<td>39.47</td>
<td>48%</td>
</tr>
<tr>
<td>6</td>
<td>46.34</td>
<td>54%</td>
</tr>
</tbody>
</table>
Discussion

• Clear distinction between the performance of ESP vs FF in the Duvha results
• Higher fraction of oxidised mercury in the fabric filter stacks
• The calculated mercury emissions based on historical Hg coal concentrations may be an overestimate (specifically in the case of Kendal)
• This may indicate that the emission factor (0.1) for ESP’s in the UNEP toolkit may not be appropriate for application in South Africa
• Extrapolation of results – caution !!!
Way Forward

- Continuation of the UNEP project “Reducing mercury emissions from coal combustion in the energy sector – Part 2 – Demonstration Project”
- Detailed understanding of the coal mercury chemistry to allow Eskom to understand the levels of mercury that may be captured using the existing gas control technologies and future co-benefits
- Coal analysis – objective is undertake extensive coal sampling and mercury analysis to improve the accuracy of emission factor calculations
- Emissions testing programme – verification and validation of calculations
Acknowledgements

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Thank you for your attention

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