Durag
Model HM-1400 TRXC
HgCEMS

EPA Compliant PS12a
HM-1400 TRXC HgCEMS

- Extractive principle
- Certified Hg$^0$ Calibration Gas bottle daily cal-checks
- Detection of Hg$^0$ by dual beam photometer
- Operation by help of keypad with text messages
- Cabinet design, easy to use, simple exchange of components easy access
- PLC control
## HM-1400 TRXC HgCEMS

<table>
<thead>
<tr>
<th>Model</th>
<th>Use</th>
<th>Description</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>HM-1400TRXC</td>
<td>Continuous mercury emissions monitoring for cement, power, industrial or Superfund sites</td>
<td>Direct extraction to a dry cold vapor atomic absorption and UV photometer  First HgCEMS to use certified bottled Hg(^0) Calibration Gas</td>
<td>Control module interface via MODBUS, TCP/IP; minimal maintenance; EPA protocols for compliance/calibration; switchable ranges</td>
</tr>
</tbody>
</table>
Flow Chart Diagram
HM-1400 TR

HM-1400 TRXC HgCEMS
HM-1400 TRXC HgCEMS

Photometer

Dual Beam Detector View
HM-1400 TRXC HgCEMS

Photometer
Dual beam UV Detector

Slit screen

UV Lamp
(Lifetime 6 years)

Gas in

Reference cell

Measuring cell

Subtraction Measuring – Reference cell

PLC

Signal output

3.25 µg/m³

Hg trap
(Lifetime 1 year)

Photodiode
(Lifetime 6 years)
HgCEMS with certified Hg$^0$ bottles and supply system

- The principle of using Calibration gas has been in use since the inception of CEMS (and the EPA).
  - With respect to Hg$^0$ Calibration Gas, over the last 7 years there has been significant work done in the specialty gas bottle market.
  - A breakthrough in mid-2013 for a stable Hg$^0$ gas that meets EPA and NIST accuracies and shelf life

- HgCEMS has been developed that is designed specifically to use Gas bottles.
  - The overall costs, initial and operational shall be lower with drastically reduced risk of lost or no data.
The testing shows that using certified bottled calibration gas is much more stable than the Hg$^{++}$ to Hg$^0$ calibrator.

The results from this has shown stable, repeatable measured values as low as 0.1ug/m$^3$.

In addition, we ran 2 additional tests:

- Tests where run to check for cross sensitivity effects from SO$_2$.
  - We ran the spectrum from 0.1 ug/m$^3$ - 9.0u/m$^3$ with SO$_2$ levels at 200ppm and 300ppm with no effects to the Hg value.

- A quarterly Calibration Gas Audit (CGA) as defined by USEPA was run on the photometer based on a scale of 0-10ug/m$^3$ and the unit passed without difficulty.
  - using values of 2.0ug/m$^3$,
  - 5.0ug/m$^3$ and
  - 9.0ug/m$^3$
HM-1400 TRXC HgCEMS

Universal Analyzer Hg Probe System

- 275E Extraction Probe w/
  - SN-316 Stainless Steel w/ SilcoNert® Coating < 400°F (204°C)
  - TK-T/C Only (Type K) For Remote Control
  - 4in Flange
  - Standard “Cannon Shot” Blowback
  - 3in Boot (Standard) - 2.75-2.9 (69.8mm-73.5mm) Dia. Flood Cal (Standard)
  - 115-115 VAC 50/60 Hz
  - Failsafe (Standard) HK-Integrated HPA with Type K T/C for Remote Control
  - Filter Element, Sintered Titanium, (9" Long)
Universal Analyzer Hg Probe Tube

- Heated Probe Assembly
  - 6SX - 6 FT 316SS Heated Probe, w/ Titanium Inner Tube - (Stack Temp < 750°F)
  - 4 Inch Flange
  - 115 - 115 VAC 50/60 Hz
  - Remotely Controlled
HM-1400 TRXC HgCEMS

Universal Analyzer
HMI/PLC Sample System Controller

- PLC Enclosure
  - Probe Temperature Control (Type-K TC Input)
  - Heated Probe Tube Temperature Control (Type-K TC Input)
  - Combustion Chamber Temperature Control (Type-K TC Input)
  - Heated Sample Line Temperature Control (Type-K TC Input) (w/ GFCI Circuit)
  - Blowback Control
    - Includes Associated Solid State Relays
O’Brian Sample Line

- Pre-insulated sample tube bundle with SV47 jacket
- Heated: Quantity (1) 3/8” x 0.062” and (1) 1/4” x 0.040” wall, PFA tubes
- Unheated: Quantity (3) 1/4” x 0.040” wall, PFA tubes
- 18 watt/ft. zone style constant power density, CPD,
  - cable rated for 208 V nominal (200-216 VAC)
  - Maximum controlled temperature of 400°F/204°C
  - Type K thermocouple located 50 ft. in from the power end
  - Quantity (9) 14 gauge TFE 204C rated wires (color coded)
  - Quantity (4) 18 gauge TFE 204C rated wires (color coded)
  - Quantity (3) 18 gauge type K shielded messengers
- Ambient Conditions
  - LOW Ambient Temp with 25 MPH (40 kph) wind: . . . -20° F
  - HIGH Ambient Temp with 10 MPH (16 kph) wind: . . . 104° F
  - Process Temperature at LOW ambient: . . . . . . . . . . . 388° F
  - Process Temperature at HIGH ambient: . . . . . . . . . . . 597° F
  - Operating Voltage: . . . . . . . . . . . . . . . . . . . . . . . 208 VAC
  - Max Inlet Temperature: . . . . . . . . . . . . . . . . . . . . 400° F
  - Max Current Draw: . . . . . . . . . . . . . . . . . . . . . . . 139’/15 Amps
HM-1400 TRXC HgCEMS

Universal Analyzer 500 Series Gas Cooler

- Two (2) 5” heat exchangers
  - Titanium
- One or two gas streams
- Flow rates from 1 – 5 l/m STP
- Digital display
- Adjustable temperature set point
- Stable dew point
- On-board electronics for liquid sensor
Cylinders:

- AirGas Hg$^0$ certified gas meets 40CFR Part 63; Appendix-A, section 3.1.4:
  - “NIST-Traceable Elemental Hg Standards means either: compressed gas cylinders having known concentrations of elemental Hg, which have been prepared according to the “EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards”; or calibration gases having known concentrations of elemental Hg, produced by a generator that meets the performance requirements of the ‘EPA Traceability Protocol for Qualification and Certification of Elemental Mercury Gas Generators’ or an interim version of that protocol.”

- Handling the cylinders is the same as handling other low concentration, reactive EPA protocols (i.e. NO, NO$_2$, SO$_2$, H$_2$S, CO) are now.
  - The gas cylinders are easy to transport from site to site. More tests can be performed in a day.
Elemental Mercury Gas Specifications

- Concentrations range from $0.2\text{ug/ml}^3$ to $60\text{ug/ml}^3$
- Balance Nitrogen
- Pressure (depending on cylinder size)
  - 300A’s = 2000 PSIG (5500 Usable Liters)
  - 150A’s = 1800 PSIG (3600 Usable Liters)
- Traceable to NIST certified cylinder mixtures
- Analytical Accuracy $\pm 5\%$ (currently)
AirGas Specialty Gas Division

- AirGas developed a standardized regulator and valve treatment.
  - AirGas has perfected a new coated regulator that has eliminated the initial value "creep"
    - Previous systems had approximately an hour of "creep" time initially

Medical grade regulator
AirGas Specialty Gas Division

Double Block & Bleed Feedback Prevention System

Zero Gas Fastloop Module

Process:
1. Timer #2 energizes S1. This flows gas from the bottle through the NO port (vent) of S2.
2. One (1) second later Timer #1 energizes. This allows gas to flow through the NC port of S2 and to the probe.
3. When the calibration is ended, 24VDC to the module ends.
4. Timer #1 de-energizes removing power from S2 and the gas flows through the NO port (vent).
5. Timer #2 de-energizes 1 second later. This puts the B&B back into standby for the next zero mode calibration.
Utilities Applications

• The Durag HM-1400 TRXC HgCEMS
  - Provides dual range with an auto-switching capability with a contact closure to indicate when on high range.
• The system will be calibrated and checked daily, for a specified operating condition.
  - The measured range for normal operation is 0-10ug/m³
    ○ Low level measuring range 2-20ug/m³
• SO² levels can be 200 - 300ppm with plant scrubbing
## Utilities Applications

<table>
<thead>
<tr>
<th>Reference Gas</th>
<th>SO2 Conc.</th>
<th>Actual Conc.</th>
<th>% FS (10ug/m3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.6 ug/m3</td>
<td>0 PPM</td>
<td>5.6 ug/m3</td>
<td>0.00%</td>
</tr>
<tr>
<td>5.6 ug/m3</td>
<td>1000 PPM</td>
<td>4.8 ug/m3</td>
<td>8.00%</td>
</tr>
<tr>
<td>5.6 ug/m3</td>
<td>800 PPM</td>
<td>5.0 ug/m3</td>
<td>6.00%</td>
</tr>
<tr>
<td>5.6 ug/m3</td>
<td>600 PPM</td>
<td>5.2 ug/m3</td>
<td>4.00%</td>
</tr>
<tr>
<td>5.6 ug/m3</td>
<td>500 PPM</td>
<td>5.3 ug/m3</td>
<td>3.00%</td>
</tr>
<tr>
<td>5.6 ug/m3</td>
<td>300 PPM</td>
<td>5.5 ug/m3</td>
<td>1.00%</td>
</tr>
</tbody>
</table>
## Utilities Applications

<table>
<thead>
<tr>
<th>Gas Applied</th>
<th>SO2 Conc.</th>
<th>Displayed Value</th>
<th>Gas Applied</th>
<th>SO2 Conc.</th>
<th>Displayed Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 ug/m³</td>
<td>200 PPM</td>
<td>0 ug/m³</td>
<td>0 ug/m³</td>
<td>300 PPM</td>
<td>0 ug/m³</td>
</tr>
<tr>
<td>5.0 ug/m³</td>
<td>200 PPM</td>
<td>5.0 ug/m³</td>
<td>5.0 ug/m³</td>
<td>300 PPM</td>
<td>4.9 ug/m³</td>
</tr>
<tr>
<td>2.0 ug/m³</td>
<td>200 PPM</td>
<td>2.0 ug/m³</td>
<td>2.0 ug/m³</td>
<td>300 PPM</td>
<td>2.1 ug/m³</td>
</tr>
<tr>
<td>1.0 ug/m³</td>
<td>200 PPM</td>
<td>1.2 ug/m³</td>
<td>1.0 ug/m³</td>
<td>300 PPM</td>
<td>0.8 ug/m³</td>
</tr>
<tr>
<td>0.5 ug/m³</td>
<td>200 PPM</td>
<td>0.5 ug/m³</td>
<td>0.5 ug/m³</td>
<td>300 PPM</td>
<td>0.5 ug/m³</td>
</tr>
<tr>
<td>0.2 ug/m³</td>
<td>200 PPM</td>
<td>0.1 ug/m³</td>
<td>0.2 ug/m³</td>
<td>300 PPM</td>
<td>0.1 ug/m³</td>
</tr>
</tbody>
</table>
**Utilities Applications**

**HM-1400 TRXC HgCEMS**

**TEST RESULTS**  
**LINEARITY TEST**  
**US Utility Test Site**

<table>
<thead>
<tr>
<th>CLIENT: US Utility</th>
<th>SYSTEM Stack</th>
<th>ANALYZER Hg System</th>
<th>MFG. &amp; MODEL Durag</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>S/N</strong></td>
<td><strong>FULL SCALE</strong></td>
<td><strong>10µg/m3</strong></td>
<td><strong>DATE</strong> 2/19/2014</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>REQUIRED INPUTS</th>
<th>X AXIS CONC %</th>
<th>Y AXIS RESPONSE %</th>
<th>ABSOLUTE DIFFERENCE</th>
<th>% DIFFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOW</td>
<td>0.89</td>
<td>0.9</td>
<td>0.01</td>
<td>1.124%</td>
</tr>
<tr>
<td>MID</td>
<td>5.00</td>
<td>4.9</td>
<td>0.1</td>
<td>2.000%</td>
</tr>
<tr>
<td>HIGH</td>
<td>9.20</td>
<td>9.2</td>
<td>0</td>
<td>0.000%</td>
</tr>
<tr>
<td>LOW</td>
<td>0.89</td>
<td>0.9</td>
<td>0.01</td>
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</tr>
<tr>
<td>HIGH</td>
<td>9.20</td>
<td>9.1</td>
<td>0.10</td>
<td>1.087%</td>
</tr>
<tr>
<td>LOW</td>
<td>0.89</td>
<td>1.0</td>
<td>0.11</td>
<td>12.360%</td>
</tr>
<tr>
<td>MID</td>
<td>5.00</td>
<td>4.8</td>
<td>0.20</td>
<td>4.000%</td>
</tr>
<tr>
<td>HIGH</td>
<td>9.20</td>
<td>9.1</td>
<td>0.10</td>
<td>1.087%</td>
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</table>

**SLOPE** = 0.9869  
**INTERCEPT** = 0.0138  
**C.F.** = 0.9995

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<thead>
<tr>
<th>INPUT CONC</th>
<th>LOW AVG RESPONSE</th>
<th>AVG % DIFF</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.89</td>
<td>0.93</td>
<td>4.490</td>
</tr>
<tr>
<td>5.00</td>
<td>4.87</td>
<td>2.600</td>
</tr>
<tr>
<td>9.20</td>
<td>9.13</td>
<td>0.760</td>
</tr>
</tbody>
</table>
Cement Applications

- The system must be scaled to measure worst case – “Raw Mill Down”
- Unit has to be capable of measuring up to 200ug/m³
  - does not require a daily cal check at this level. Only a check (with either Hg⁰ or Hg⁺⁺) that is not required to be certified and only after the raw mill is shut down.
Cement Applications

- The Durag HM-1400 TRXC HgCEMS
  - Provides dual range with an auto-switching capability with a contact closure to indicate when on high range.

- The system will be calibrated and checked daily, for an operating condition where the Raw Mill is on.
  - The measured range for normal operation is 0-25ug/m³
    - Low level measuring range 10-40ug/m³

- SO² levels can be as high as 850ppm when the raw mill is down and 200ppm when the raw mill is in operation.
  - A bottle of Hg⁰cal gas on site at 160-180ug/m³.
## Cement Applications

### High Level SO2 Interference

<table>
<thead>
<tr>
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