Continuous Emission Monitoring System (CEMS)

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CEMS- What & Why?

- Strong pollution control regime is must
- Unlike US, EU, developing countries suffers from - weak/missing-pollution norms, standardised monitoring, market, transparency

India- inadequate existing regime

1. Manual monitoring- low frequency, prone to manipulation
2. Reported data doesn’t match actual emission
3. If online monitors- no check on calibration, limited reporting
4. Real time data not accessible to regulator for verification
5. Poor transparency- no public scrutiny
6. Limited inspection- fails to ensure adequate pollution control practices
GRP experience - Even if pollution norms are tightened with time, pollution keeps growing; False compliance; poor monitoring & reporting

- 55% TPPs had very high emission
- 10% TPPs with PM norms of 50-75 mg/Nm³ - visible emissions
- SO₂ – no control, reported <13mg/Nm³. Global best ~25mg/Nm³
- NOx - reported <0.1mg/Nm³. Global best ~80mg/Nm³

CEMS – A solution- An important tool
Ensures- data accuracy, higher monitoring frequency, minimal-manual intervention, firm regulatory monitoring, better transparency.
CEMS- framework

- CEMS selection and installation at industry
  - Device and Vendor selection
  - Device installation, software and hardware setup
  - Calibration, test run
  - CEMS audit
  - Regular maintenance and zero check

- Real-time pollution monitoring
  - Stack emission monitoring
  - Data collection in vendor software

- Data acquisition system (DAS) and transfer
  - Secure data transfer to server at collection and handling centre installed with regulators

- Data acquisition and handling centre (DAHC) at regulator
  - Data verification and analysis
  - Compliance check
  - Publishing on web portals: industry, regulators, public

- Data verification by regulator & Publishing
  - Plant’s Web Portal
  - Regulator’s Web Portal
  - Public Website

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2. Under ARP (Title IV of the 1990 Clean Air Act), stringent performance requirements for CEMS

- **Mandatory real time monitoring** - SO$_2$, NO$_x$, and CO$_2$
- If 2 or more CEMS in same stack/duct - primary + back-up
- May choose alternative monitoring system - demonstrate alternative having same/better precision, reliability, accessibility, and timelines

- **Selection of device & conformance with the performance specifications**
USEPA Experience

• **Certification:**
  ✓ Once installed, initial certification- within 30 days performance tests
  ✓ Report of initial certification within 60 days- Apply for certification
  ✓ Administrator’s approval/disapproval within 120 days; otherwise deemed certified
  ✓ On disapproval- monitored data invalid- certification retest

• **Re-certification:** *series of tests required*
  ✓ Any replacement/modification/change in a certified device, flue gas handling, operations that may affect device’s performance
  ✓ After modification/change, a probationary calibration error test
  ✓ During re-certification- data conditionally valid
  ✓ In case of failure- data to be flagged missing- get substituted
• **Quality Assurance (QA) Testing:** Regular, verifies accurate operation of equipment. E.g. for COMS – zero, upscale calibration drift test etc.

• **Data monitoring & collection cycle:**
  ✓ CEMS minimum one cycle in 15-mins. 4 cycles estimate hourly avg.
  ✓ COMS- every 10 sec data (sampling & analysis ) to average for every 6 mins cycle - 10 cycles estimate hourly avg. (state may permit differently)
  ✓ Plant to report the data hourly, daily, quarterly, and annually
  ✓ No cycle time (pollutant conc. monitors like O2, moisture etc.) exceeds 15 mins
USEPA Experience

• **Compliance check:**
  ✓ Check for PM emission compliance (for LCP) -
    o Min. total time of observations- 3 hours (30 six-minute averages)
    o Not to exceed 20 % opacity except one 6 minute period/hr (max 27 %)
  ✓ Check for SO₂, NOx emission compliance (LCP)
    o 30 days rolling avg. basis
  ✓ **Special condition**
    o Plants -construction/modification/reconstruction before May 4, 2011, norms do not apply during startup, shutdown, or malfunction
    o Applicable for those commenced after May 3, 2011

✓ **Relative accuracy test audits at any time.** If fails device is considered out-of-control till the next successful audit test
USEPA Experience

• Monitoring data availability and Substitution of invalid data:
  - Need to monitor % valid data availability/ year
  - To maintain record of hourly avg. data for at least 3 years
  - Certification, qlt control and assurance data- recorded daily
  - Invalid data to be substituted- If valid, quality assured data not provided by a certified equipment, missing/invalid data is substituted by estimating from valid data recorded in last 3 years.

• Plants are required to submit Excess Emission Reports (EERs): include excess emissions and excess monitoring system down time, quarterly and sometimes monthly
Real-time effluents monitoring in USA

Regulated by the National Pollutant Discharge Elimination System (NPDES) established under the Federal Water Pollution Control Act Amendments of 1972.

- Both sequential and continuous monitoring allowed
- If higher monitoring frequency needed- continuous samplers
- To establish continuous monitoring requirement- env. significance of effluent parameters and cost implications are assessed
- Limited parameters- flow, TOC, temp., pH, conductivity, residual Cl, F, DO etc.
- Monitoring and reporting requirements are decided on case-to-case basis. Requirements may be reduced based excellent historical performance

- **Effluent Limits**: by comparing BAT -based effluent with water quality-based effluent limits
- **Monitoring Frequency**: based on flow, pollutant type & concentration, treatment capacity & method, compliance history, permittee’s capabilities, discharge location & frequency etc.
EU Experience

Called as Automated Measuring System (AMS). European Standard (EN 14181) specifies 3 quality assurance levels and an annual surveillance test.

- **Quality assurance level 1 (QAL1):** Suitability of CEMS
  ✔ Before installation
  ✔ MCERTS certification for compliance with QAL1
  ✔ Plant to do required tests- zero span, linearity, leak detection etc.

- **Quality assurance level 2 (QAL2):** Calibration and Validation
  ✔ Post installation
  ✔ Verifies- through inspection and set of functional tests
  ✔ Frequency –
    - *After installation,*
    - *Every 5 year for LCP/ 3 year for waste incinerators,*
    - *Significant change in plant operations, significant upgrade or change in device*
EU Experience

• **System for uncertainty of CEMS**

Table. Allowable uncertainties of CEMS for coal-based LCP in EU

<table>
<thead>
<tr>
<th></th>
<th>Limits mg/m³</th>
<th>Certification range, mg/m³</th>
<th>Allowable uncertainty, %</th>
<th>Allowable uncertainty, mg/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOx</td>
<td>200-600</td>
<td>500-1500</td>
<td>20%</td>
<td>40-120</td>
</tr>
<tr>
<td>SO₂</td>
<td>200-850</td>
<td>500-2125</td>
<td>20%</td>
<td>40-170</td>
</tr>
<tr>
<td>PM (LCP)</td>
<td>30-50</td>
<td>75-125</td>
<td>30%</td>
<td>9-15</td>
</tr>
</tbody>
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• **Quality assurance level 3 (QAL3):**
  ✓ During operation
  ✓ Detects drift and changes in precision- **zero and span readings**
  ✓ Frequency- **weekly or shorter based on method** (CUSUM; cumulative sum control, Stewart chart etc.)
  ✓ Mandatory recording of all activities- **CEMS details & changes, manufacturers’ service visit, call out records, routine maintenance, corrective actions, zero and span drift plots and tabulation etc.**
EU Experience

**Annual surveillance test (AST):**
- Check that calibration function carried under QAL2 is valid
- Same functional tests as in QAL2, but less repetitions
- If the AST shows calibration invalid, then a full QAL2 is required

**Sampling frequency and duration:** decided in management plan
- Commonly duration is 30 minutes, but may vary depending on the pollutant (e.g. for PCDD/F duration is 6 hours), expected conc., detection limit and emission profile of the process.

**Compliance:** Vary among EU members, sector wise. For LCP:
- 95 % of all hourly avg (yearly) - not to exceed 200 % of the norm
- Daily average – not to exceed 110 % of the norm
- Monthly average – not to exceed the norm
- For <50 MW, daily average – not to exceed 150 % of the norm
Status in India

No established regulatory framework for CEMS till now

• A pilot project for continuous PM monitoring and ETS initiated in Gujarat, Maharashtra and Tamil Nadu-22.11.2013

• A direction by CPCB for installation of CEMS for air pollution monitoring and effluent quality monitoring from stationary sources. 05.02.2014

• CPCB guidelines for online continuous monitoring systems for effluents. 07.11.2014
CEMS guidelines for PM with special reference to pilot scale ETS

✓ Selection of suitable certified device-
  o Mass flow or, concentration based
  o $\leq 10\text{mg/Nm}^3$ detection level, $< 1\%$ drift, $< 5\%$ measurement deviation
  o Flow metre with $1\text{m/s min}$ detection, $< 1\%$ zero and span drift, $< 2\%$ measurement deviation
  o Hardware & software - to record every $1\text{min data}$, $90\%$ or higher data availability

✓ Certification from recognized agency - USEPA-PSII, MCERT, TUV etc.

✓ Initial calibration required before installation
✓ Device performance test after calibration
✓ Periodical quality control test
✓ CEMS audit at-least every 12 months
• **Standard operating procedure**
  ✓ Device installation, registration, configuration - *industry to do*
  ✓ Calibration - Accredited lab (by NABL/MoEF/CPCB/SPCB)
    - *Sampling under various operational conditions (load, efficiency of APC device etc.)*
    - 95% data availability
    - *Calibration at-least every 6 months* after initial calibration
  ✓ Post-calibration performance test - *to measure avg. deviation between raw readings and iso-kinetic readings and fix calibration equation*
  ✓ CEMS audit and CEMS audit performance test - *by accredited labs at fixed calibration equation, sample points and at different load*
  ✓ Recalibration -
    - *if operating out of range* - 10% or more in a week for 5 weeks or more/ 40% or more in a week for 01 week or more (45 mins moving average),
    - *device hardware changed, changes in fuel/process, major change in APC device*
    - *every 06 months,*
    - *failure of CEMS audit*
Real-time effluent monitoring in India

- **Selection of equipment** by industries
- **Device calibration** *(weekly for most parameters)* by manufacturer
- At-least **85% data availability**
- **1 min. data average - every 30 minutes** transfer
- Allows **10% exceedance of norm**; Regular exceedance- action
- Relative **difference between online and laboratory measurement**- ±10% allowed for BOD, COD, TSS and ±0.2 for pH
- **ZLD plants** to install camera with night vision and flow meter
- **Plants ZLD by utilizing treated water in irrigation**- to install continuous monitor at the outlet of ETP
- **Bank guarantee** *(of 25 % of device cost)* from manufacturer to ensure optimal performance of device, and 85% data availability.
- **Cost of effluent monitoring**- 1.5 lakh to 60.5 lakh across sectors