AAETI
Anil Agarwal
Environment Training
Gaseous CEMS
CEMS (Continuous Emission Monitoring System)

**ENDA-5000 Series**

HORIBA
Continuous Emission Monitoring System
<ENDA-5000 series>

Special Features
- CFM NDIR (NOx, CO, CO2, SO2), MPA O2
- Patient “Cross flow modulation “
- Compliance to US EPA
- Own made sampling scrubbers

Applications
- Compliance Stack monitoring for Power, Steel, Cement, Chemical plant etc
- Process monitoring such as FGD

Consulting services as per your Sampling Condition to select proper SAMPLING SYSTEM
Continuous Emission Monitoring System
<ENDA-5000 series>

- **Continuous Emission Monitoring System**
  - The system which can measure target gas continuously to monitor the mission is within decided limit. It includes gas analyzer, data collecting logging system and transferring system.

- **Composition of CEMS**
  - Sampling probe
  - Sampling tube
  - Sample Handling System (SHS)
  - Calibration gas
  - Gas analyzer
  - Temperature meter
  - Flow rate monitor
  - Dust analyzer (Opacity)
  - Data logging system
Continuous Emission Monitoring System
<ENDA-5000 series>

- Gas Analyzer (NOx/SO2/CO/CO2/O2)
  - ENDA-5000 series

- Dust analyzer (Opacity)
  - EM-D5100(D-R290): Opacity(%) or Dust (mg/m³)
  - D-R820F: Dust (mg/m³) for wet stack

- Flow rate monitor
  - D-FL100 (Pressure difference method)
  - D-FL200 (Ultrasonic flow method)

- Data collecting System
  - DCS base
  - PC base

- Engineering
  - Shelter, Big cabinet, internal cabinet
  - Data collecting cabinet (for internal)
  - Data transferring system (MODBUS etc)
  - Others (Moisture monitor, Hg monitor)
Continuous Emission Monitoring System
<ENDA-5000 series>
Topics

1. Potential Applications

2. Application Summary

3. Principle, Features & The Benefit

4. Specification & Competitors

5. Solutions
Potential Applications

- Major stationary emission source
  - Power Plant, Steel plant, Cement Plant, Waste initiator, Chemical Plant, Pulp & Paper, Glass Furnace, Refinery etc
- Cogeneration power in Industrial factory/facility
  - Food, beverage company, Water treatment plant

Whenever “Stack “, there is demand !
<table>
<thead>
<tr>
<th>Country</th>
<th>Enduser Name</th>
<th>Model</th>
<th>Qty</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td>Power Plant, Petrochemical, Steel, Incinerator etc.</td>
<td>ENDA-5000 series</td>
<td></td>
<td></td>
</tr>
<tr>
<td>India</td>
<td>National Thermal Power Corporation (NTPC, Jhantor)</td>
<td>ENDA-1220</td>
<td>2</td>
<td>1993</td>
</tr>
<tr>
<td>Thailand</td>
<td>BLCP (EGAT) Project by MHI (Power Plant)</td>
<td>ENDA-5610/D-R 290 with monitoring software</td>
<td>2</td>
<td>2005</td>
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<tr>
<td>India</td>
<td>Mankalore Refinery and Petrochemicals Limited (MRPL)</td>
<td>ENDA-5300/5150</td>
<td>19</td>
<td>2006</td>
</tr>
<tr>
<td>China</td>
<td>Environment Protection Agency</td>
<td>ENDA-5400/Dust analyzer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USA</td>
<td>OPPD by IHI (Power Plant)</td>
<td>ENDA-5220/Zir O2 NZ-3000</td>
<td>4</td>
<td>2007</td>
</tr>
<tr>
<td>China</td>
<td>Environment Protection Agency</td>
<td>ENDA-5400/Dust analyzer</td>
<td>256</td>
<td>2008</td>
</tr>
<tr>
<td>Thailand</td>
<td>EGAT RFCL Project by MHI (Power Plant)</td>
<td>ENDA-5610/D-R 290 with monitoring software</td>
<td>4</td>
<td>2007</td>
</tr>
<tr>
<td>Malaysia</td>
<td>Port Dickson Phase 2 Project by Toshiba (Power Plant)</td>
<td>ENDA-5800/D-R 290</td>
<td>2</td>
<td>2007</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>Rabigh IWSP Project by MHI (Power Plant)</td>
<td>ENDA-5610/D-R 290</td>
<td>3</td>
<td>2007</td>
</tr>
<tr>
<td>Korea</td>
<td>Korea Electric Power Corporation</td>
<td>ENDA-5610</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USA</td>
<td>Shintech Louisiana Plant (Chemical production emission monitoring)</td>
<td>ENDA-4000/Exceed (Software)</td>
<td>5</td>
<td>2007</td>
</tr>
<tr>
<td>China</td>
<td>Environment Protection Agency</td>
<td>ENDA-5400/Dust analyzer</td>
<td>218</td>
<td>2008</td>
</tr>
<tr>
<td>USA</td>
<td>PPPP by IHI (Power Plant)</td>
<td>ENDA-5220/Zir O2 NZ-3000</td>
<td>4</td>
<td>2008</td>
</tr>
<tr>
<td>Thailand</td>
<td>EGAT South Bangkok Combined Cycle project (by MHI) (Power Plant)</td>
<td>ENDA-5610/D-R 290 with monitoring software</td>
<td>2</td>
<td>2008</td>
</tr>
<tr>
<td>Bahrain</td>
<td>Gulf Industrial Investment Company Pellet Plant by Kobe Steel (Steel)</td>
<td>ENDA-5800/D-R 290 with monitoring software</td>
<td>2</td>
<td>2008</td>
</tr>
<tr>
<td>Vietnam</td>
<td>Can Tho City Power Plant O-MON Project (by MHI) (Power Plant)</td>
<td>ENDA-5800/D-R 290 with monitoring software</td>
<td>1</td>
<td>2008</td>
</tr>
<tr>
<td>Korea</td>
<td>SNNC by Kawasaki Heavy Industries (Power Plant)</td>
<td>ENDA-5400/D-R 290</td>
<td>3</td>
<td>2008</td>
</tr>
<tr>
<td>Bahrain</td>
<td>Gulf Industrial Investment Company Pellet Plant by Kobe Steel</td>
<td>ENDA-5800/EM-D5100 with monitoring software</td>
<td>6</td>
<td>2008</td>
</tr>
<tr>
<td>Chile</td>
<td>EMPRESA ELECTRICA Guacolda POWER</td>
<td>ENDA-5300/5220/5400/5130/D-R 290/D-FL100/820F</td>
<td>1</td>
<td>2008</td>
</tr>
<tr>
<td>Taiwan</td>
<td>Dragon Steel Co. (Steel Plant)</td>
<td>ENDA-C2000/ENDA-5150/ENDA-5220</td>
<td>2</td>
<td>2008</td>
</tr>
<tr>
<td>Australia</td>
<td>Ainita Tamar Valley Power Station (Power Plant)</td>
<td>ENDA-5420</td>
<td>1</td>
<td>2008</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>SHUQAIQ by MHI (during construction) (Power Plant)</td>
<td>ENDA-5800/ENDA-5320/D-FL100/D-R 820</td>
<td>3</td>
<td>2009</td>
</tr>
<tr>
<td>Indonesia</td>
<td>Muara Karang by MHI (Power Plant)</td>
<td>ENDA-5800/EM-D5100</td>
<td>2</td>
<td>2009</td>
</tr>
<tr>
<td>USA</td>
<td>Shintech Louisiana Plant (Chemical production emission monitoring)</td>
<td>ENDA-4000 with monitoring software</td>
<td>1</td>
<td>2009</td>
</tr>
<tr>
<td>Thailand</td>
<td>EGAT North Bangkok project (Power Plant)</td>
<td>ENDA-5610/D-R 290/D-FL100</td>
<td>2</td>
<td>2009</td>
</tr>
<tr>
<td>Australia</td>
<td>Hamsasley Iron Pty.Ltd. (Power Generation in the steel plant)</td>
<td>ENDA-5420</td>
<td>8</td>
<td>2009</td>
</tr>
</tbody>
</table>

- < 90% Share in Japanese Power Plant Market
- <10,000 units sales to World Wide
Applications

- **Compliance Monitoring of Stack Emission**
  - Regulation depends on country
  - US EPA, TUV,
  - Provide as system including Opacity, Flow meter

- **Process Monitoring**
  - Flue Gas Desulfurization (FGD) Process
  - De-NOx (SCR) process
  - Combustion efficiency Monitoring (CO, O2
  - Other process

**Concept**
- Long Term Stability
- Toughness
- Complete solution from professional
Stack Gas Analyzer, ENDA-5000 uses HORIBA patent cross-flow modulation (CFM) technique with NDIR method which results in remarkable improved zero drift & sensitivity. The Ref & Sample gas is introduced each 0.5sec by SV. Detector also provide compensation function.

- NDIR (NOx, SO2, CO, CO2)
- CFM*1
- No zero drift
- No optical adjustment
- Automatic cell cleaning

*1 CO2 is not with CFM
Principle, Features & The Benefit
- Conventional NDIR Method-

- Un stability of zero by dirty sample (Cell getting dirty)
- Need optical adjustment
## Principle, Features & The Benefit
- NDIR for NOx, SO2, CO, CO2 -

<table>
<thead>
<tr>
<th></th>
<th>NDIR CFM</th>
<th>Normal NDIR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optical adjustment</td>
<td>Not necessary</td>
<td>Necessary</td>
</tr>
<tr>
<td>Zero Drift</td>
<td>Stability is very good in long time</td>
<td>Stability is good</td>
</tr>
<tr>
<td>Measurement cell</td>
<td>Keeps the cell clean always</td>
<td>Cell cleaning is required</td>
</tr>
</tbody>
</table>

**Diagram:**
- Light source
- Measurement cell
- Sample gas
- Reference gas
- Solenoid valve
- Main detector signal (Target + Interference)
- Subtractor
- Output (Target compound)
- Comp. detector signal (Interference)

- **NDIR (NOx, SO2, CO, CO2)**
- **CFM**
- **No zero drift**
- **No optical adjustment**
- **Automatic cell cleaning**

*1 CO2 is not with CFM
Reliable / High sensitive optical unit

- Small cell will reduce the anticipated trouble
- High sensitive by CFM
- 60 degreeC heated cell protect from corrosion
Principle, Features & The Benefit
- Owen Made Optical Unit -

**Detector & Optical filter**

- Images of detector and optical filter components.

**Light Source**

- Images of light source components with emphasis on specific parts.
Stack Gas Analyzer, ENDA-5000 uses Magneto Pneumatic uses paramagnetic feature of oxygen but it will use special structure designed by HORIBA will give you long term stability & life time of the parts and less interference and corrosion by dirty sample gas.

- MPA
- Paramagnetic
- Special structure, sample gas does un-touch to detector
Because oxygen has very strong paramagnetic properties, when oxygen exists in non-uniform magnetic fields, oxygen is attracted to the stronger magnetic fields and the pressure for that part changes (increases). Pressure changes are indicated by the following formula.

\[ \Delta p = \frac{1}{2} H^2 \cdot X \cdot C \]

- \( \Delta p \): Pressure change
- \( H \): Strength of magnetic field
- \( X \): Magnetic susceptibility of paramagnetic gas
- \( C \): Temperature of paramagnetic gas
**Principle, Features & The Benefit**

- **Magneto Pneumatic Method for O2**

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**Sample gas (NOT contain O2)**

- Electro magnet OFF
- O2 is NOT attracted to the magnet

**Sample gas (contain O2)**

- Electro magnet ON
- O2 is attracted to the magnet

**Pressure increase**

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Principle, Features & The Benefit

Special Features
- CFM NDIR (NOx, CO, CO2, SO2), MPA O2
- Patient “Cross flow modulation “
- Compliance to US EPA
- Own made sampling scrubbers

Applications
- Compliance Stack monitoring for Power, Steel, Cement, Chemical plant etc
- Process monitoring such as FGD

Consulting services as per your Sampling Condition to select proper SAMPLING SYSTEM
Principle, Features & The Benefit
- Composition of Stack Gas Analyzer -

(1) Sampling Probe
- Heated
- Including dust filter

(2) Sampling Tube
- Heated (Electrical or steamed) : Nox, SO\(_2\)
- Teflon (PTEF) tube : CO, CO\(_2\), O\(_2\)

(3) Complete Solution
- Analyzer & Sampling unit
Principle, Features & The Benefit

- HORBA Special Dust Filter at Sampling Probe -

**Type SE3 / SS3**
- Dust less than 0.1g/m³
- SE3/SS3 type probe is used
- 2um filter
- ex) Gas fuel power plant

**Type LE3 / SS3**
- Dust less than 1g/m³
- 2um filter
- ex) Coal fuel power plant

**Type PE5 / SS5**
- Dust us more than 1g/m³
- 2, 1, 0.5, 0.3um filter
- ex) Cement industry

Dust can not be captured inside of dust filter & dust might be split out
Principle, Features & The Benefit
- HORBA Sampling Probe & Blowback System -

- Small size blow back system by instruments air
- Combination with PE5 probe when dust is high.
- Manual blow back is possible if you use PE5
Principle, Features & The Benefit
- Complete Solution from Professional -

**SHS**
(Sample Handling System)

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pump 1&amp;2</td>
<td>Performs sample gas suction, compression into analyzer.</td>
</tr>
<tr>
<td>2</td>
<td>Secondary Filter 1</td>
<td>Collects the sample gas dust passed through the primary filter.</td>
</tr>
<tr>
<td>3</td>
<td>Air Filter</td>
<td>Collects dust in the air for reference gas.</td>
</tr>
<tr>
<td>4</td>
<td>Scrubber or Zero gas generator</td>
<td>A catalyst eliminating NOx, SO2, and CO from the reference gas. “Zero gas generator” can be “Scrubber” depending on the specification.</td>
</tr>
<tr>
<td>5</td>
<td>Silica gel</td>
<td>Eliminates moisture in the MPA carrier gas.</td>
</tr>
<tr>
<td>6</td>
<td>Mist Catcher</td>
<td>Collects the sulfuric acid mist in the sample gas.</td>
</tr>
<tr>
<td>7</td>
<td>Protection Filter</td>
<td>Collects powders generated from silica gel.</td>
</tr>
<tr>
<td>8</td>
<td>NOx converter</td>
<td>A catalyst unit converting NO2 in the sample gas into NO.</td>
</tr>
<tr>
<td>9</td>
<td>Secondary Filter 2</td>
<td>Collects the reference gas dust that passed through the air filter.</td>
</tr>
</tbody>
</table>
Principle, Features & The Benefit
- Complete Solution from Professional -

We have developed our analyzer systems to meet the demands of our customers.
Development of HORIBA's stack gas analyzers and progress in environmental protection

- Fulfilling the demand of our customers -
Simplified method for the analysis and automatic measurement of stack emissions

Development of a mist catcher designed to protect piping materials and cells from erosion caused by sulfuric acid mist

1966: Start of the development of the ENDA series stack gas analyzers using the NDIR method

An interference-canceling gas detector designed to eliminate the effects of interference gas in sample gas. This detector was developed to improve measurement accuracy

1971: July
ESDA-200 Series

Manufacture of a stack gas SO2 analyzer (ESDA type) starts

1978: ENDA-800 series

Simplification of system upgrading procedures for 10-inch rack-type analyzers in order to gain access to overseas markets (especially the U.S.)

1983: ENDA-900 series

Achievement of Nitric Oxide measurements with an accuracy of 10 ppm using the NDIR method to meet future need for low-level measurements of NOx content in stack emissions


Development of an analyzer designed to perform continuous and simultaneous measurements of a maximum of five components (NO, SO2, CO, CO2 and O2), with improved maintainability and efficient energy consumption

2001: ENDA-5000 series

Development of a stack gas analyzer using touch panels to improve the user interface. The analyzer is designed to be maintained from the front side to reduce the space required for installation

<45 years experience in the development of stack gas analyzer / Sampling system

<45 years experience in the development of stack gas analyzer / Sampling system
Principle, Features & The Benefit
- Complete Solution from Professional -

Three stages dehumidifying system

NOx converter

Acid mist remover
Principle, Features & The Benefit
- 3 stages Dehumidifying System -

- Reduce the burden to cooler unit
- Minimizes dissolution loss of SO2 and NO2
- A trouble by drain is reduced dramatically
- Up to 40% H2O is endured by this system

<table>
<thead>
<tr>
<th>Test Method</th>
<th>Calculation Value of Standard Gas Addition</th>
<th>SO2 Analyzer Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Gas Addition Method (Air-base)</td>
<td>2.2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>4.4</td>
<td>4.2</td>
</tr>
</tbody>
</table>

Outlet
Principle, Features & The Benefit
- HORIBA Designed Small, High Efficiency Converter -

**NO\textsubscript{x} converter COM-50**

- **Product and role**
  - **Product**: ENDA-5000
  - **Role**: Sample gas line NO\textsubscript{2} → NO conversion
    - Measurement of unmeasured component (NO\textsubscript{2})

- **Catalyst reaction and characteristic**
  - **Activated carbon + Mo**
    - Pass CO around 190\textdegree}C atmosphere ⇒ Convert to NO

  - **Chemical reaction**
    - $2\text{NO}_2 \rightarrow 2\text{NO} + \text{O}_2$
  - **Ability**
    - Can use less than flow rate 0.7L/min, NO\textsubscript{2} ≤ 18ppm
  - **Caution**
    - Cannot use in condition there is catalyst poison (NH\textsubscript{3})

- **Small Size NOx Converter**
- **Low Temperature but high efficiency**
**Mist catcher MC-050A**

- **Product and role**
  - **Gas product**
  - Remove sample gas line SO₃ mist
  - Direction stabilize when gas is measured

- **Filler effect and characteristic**
  - **Exchinese noil** (＝Pearlite(SiO₂ + Al₂O₃ + K₂O))
    - Pass SO₃ mist around 0～50degC atmosphere ⇒ Remove
  - Can use less than flow rate 0.7L/min, SO₃ ≤ 50ppm
    - (#3030A can be used under the condition of SO₃ ≤ 200ppm)
  - Periodical exchange is necessary.
  - It is cause of direction differential error in SO2 low concentration meter (less than 20ppm)

- **Removing corrosive gas such as SO3**
Principle, Features & The Benefit
- HORIBA Designed High Efficiency Halogen remover

**Halogen, H2S scrubber HS-050**

- **Product and role**
  - **ENDA-5000**
    - Remove Halogen gas of sample gas line
    - Direction stabilize when gas is measured

- **Filler reaction and characteristics**
  - **Copper wool** (Fulfill pamister as coloring)
    - Pass halogen gas around 0～50degC atmosphere
    - Remove
    - **Chemical reaction** \( 2Cu + Cl_2 \rightarrow 2CuCl \)

- **Ability**
  - Can use less than flow rate 0.7L/min, Halogen gas \( \leq 2 \text{ppm} \).

- **Caution**
  - Periodical exchange is necessary
  - (Exchange when coloring is turning color)

• Removing Halogen such as HF, HCl, Cl2 and H2S
Principle, Features & The Benefit

- Complete Solution from Professional -

**HORIBA = Analyzer Manufacture**

Light Source
Optical Filter
Detector
Sampling parts

HORIBA make all the key components at our factory. This have enabled us to understand various phenomenon and principles of analyzers and to provide best performance solution to customer with the knowledge.

< 40 years experience give
Complete Solution Stack gas analyzer
## Specification & Competitors

- Please Check the Performance on Brochure-

<table>
<thead>
<tr>
<th>Components</th>
<th>Nox</th>
<th>SO2</th>
<th>CO</th>
<th>CO2</th>
<th>O2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measuring method</td>
<td>NDIR</td>
<td>NDIR</td>
<td>NDIR</td>
<td>NDIR</td>
<td>MPA</td>
</tr>
<tr>
<td>Range (Std.)</td>
<td>200~5000ppm</td>
<td>200~5000ppm</td>
<td>200~5000ppm</td>
<td>5~25%</td>
<td>10~25%</td>
</tr>
<tr>
<td>Range (Optional)</td>
<td>100ppm</td>
<td>50ppm</td>
<td>100ppm</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Repeatability</td>
<td>+/- 0.5% of full scale (with optional range +/- 1.0% of full scale/week)</td>
<td>+/- 1.0% of full scale/week</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zero drift</td>
<td>+/- 1.0% of full scale/week (with optional range +/- 2.0% of full scale/week)</td>
<td>+/- 2.0% of full scale/week</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Span drift</td>
<td>+/- 2.0% of full scale/week</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response time</td>
<td>Within 60 seconds</td>
<td>Within 240 seconds</td>
<td>Within 60 seconds</td>
<td>Within 60 seconds</td>
<td>Within 60 seconds</td>
</tr>
<tr>
<td>Power supply</td>
<td>AC100-240V +/- 15V 50/60Hz</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power consumption</td>
<td>About 800 VA (heated piping 30m; +1100VA, heater in tray; +300VA)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Cross Flow modulation is HORIBA unique technology!**

**Own Made Sampling Systems as Complete System**
Solutions

- Long term stability & Toughness
  - Reliable optical unit & Principle (CFM)

- Complete solution from professional
  - 45 years experience,
  - Own made analyzer & Sampling System

- Tailor made design depending on application
  - Including corrosive gas such as SO3, H2S, HCl
  - Including high dust
  - Multi point (up to 16 points we have experience)
  - US EPA, TUV compliance etc
Thank you

Dziękuję

Gracias

اشْكُر

Tack

Danke

감사합니다

ありがとうございました

Большое спасибо

Obrigado

Omoshiro Okashiku
Reference Videos
Q & A

Q : Why can you say that sample gas and reference gas are 100% exchanged at each 0.5 seconds in cross flow system?

A :

Flow rate in sample line = 5cc/0.5sec (=10cc/sec=600cc/min)

Flow amount in sample cell : 2.649cc (=0.375cm*0.375cm*3.14*6cm)
Q&A

Q : Why is it possible to measure low range by shorter cell length?
A :  
When anlayzer measure low concentration, signal from detector is small due to less absorption. Therefore, it is required to increase the signal value by prolong sample cell.
However, cross flow modulation technology, zero signal is very stable, so it is possible to detect even small signal.
Signal at zero calibration

- **Non CFM**
  - Even during zero calibration, some signal comes out from the detector because of light intensity differences, etc.

- **CFM**
  - During zero calibration, basically, no signal comes out from the detector.

**This difference affects the measurement of low concentration.**
Further explanation

- If there are two beakers one is pale blue color and the other is transparent color. Then if we put blue ink to them, you can find out change of color easier for the beaker colored transparent.

```
Non CFM
```

```
CFM
```
Q&A

Q : If reference gas include target parameters for example CO, it makes unaccuracy of measurement?

A :
ENDA-5000 has scrubber unit on reference line and the unit purify and remove target parameter gas.
Q : How many times we can use solenoid valve of cross flow modulation

A :
More than hundred million times.
It is able to replacement even become non work.
Q : How beam splitter divide IR to each detector?

A :
HORIBA use own optical filter technology and refract and pass through some specific wavelength only.
Taper Block for CO2 splitting

Mirror finish reflect light to detector

Go to CO2 detector
Beam Splitter

① Band cut filter ⇒ Reflect IR less than 5μm, Pass through more than 5μm
② CO filter ⇒Pass through IR from 4.66μm ~ 4.8μm
③ NO filter ⇒Pass through IR from 5.4μm ~ 5.55μm, reflect more than 5.55μm
④ SO2 filter ⇒ Pass through more than 6.25μm
Q&A

Q: What is the function of chopper?
A: To make the output of alternating current. Direct current is not suitable for amplification of signal and removing signal noise.

Frequency: 1Hz for ENDA-5000
Q&A

Q : How to replace O2 analyzer
A :
Open analyzer unit and replace O2 detector unit. No need to go to sampling point for replacement.
Zilconia oxygen Principle

\[
\text{emf} = \frac{RT}{4F} \ln \left( \frac{P_{\text{ref}}(O_2)}{P_{\text{sample}}(O_2)} \right)
\]

Right electrode: \(O_2 + 4e^- \rightarrow 20^{2-}\)

Left electrode: \(20^{2-} \rightarrow O_2 + 4e^-\)

- \(R\) = ideal gas law constant
- \(F\) = Faraday's constant
- \(T\) = cell temperature

\(P_{\text{ref}}(O_2)\) = partial pressure of \(O_2\) in reference side of the cell

\(P_{\text{sample}}(O_2)\) = partial pressure of \(O_2\) in the sample side of the cell
O2 correction method

The stack gas from the fixed discharge source, when measured, gives a diluted, low concentration value due to the air mixture amid the stack path. This is why when measuring the nitrogen oxides from the fixed discharge source, the suitable correction according to the oxygen concentration in the discharged gas is included in the enforcement regulations of Clean Air Act.

For the measurement of carbon monoxide correction for industrial waste incinerator, too, the correction according to the oxygen concentration is required.

The operation for the oxygen correction is as follows:

\[
\text{O}_2 \text{ corrected concentration} = \frac{21 \text{ (vol\%)} - \text{O}_2 \text{ set value (vol\%)} \times \text{measurement value (ppm)}}{21 \text{ (vol\%)} - \text{O}_2 \text{ measurement value (vol\%)}}
\]

\(\text{O}_2 \text{ set value (vol\%)}\) is a concentration set depending on the fuel facility as well as fuel type. Two types of \(\text{O}_2\) values can be set.
CO2 correction method

Normally, O2 correction is used for correction of instant value, however CO2 correction is used for DILUTION METHOD because O2 is included in dilution air. So O2 correction is not possible.

\[ c_d(12\% \text{ CO}_2) = c_w \frac{12}{\%\text{CO}_2w} = c_d \frac{12}{\%\text{CO}_2d} \]
1. Assurance of appropriate product quality standards

Industrial standardization can ensure certain levels of product quality. Industrial standardization concerning product quality should be prepared, focusing not on company needs but on the needs of users and consumers, with full consideration given to social needs, including the public interest. With regards to safety and environment conservation, products are restricted by technical standards established through mandatory legislation.
# Dust / Opacity meter

## Dust meter

<table>
<thead>
<tr>
<th>Model</th>
<th>EM-D5100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement method</td>
<td>Autocollimation (Double-pass)</td>
</tr>
<tr>
<td>Range</td>
<td></td>
</tr>
<tr>
<td>Dust</td>
<td>300 ~ 4,800mg/m³</td>
</tr>
<tr>
<td>Opacity</td>
<td>20 ~ 100%</td>
</tr>
<tr>
<td>LDL</td>
<td>±3.0% of F.S.</td>
</tr>
<tr>
<td>Repeatability</td>
<td>±1.5% of F.S.</td>
</tr>
<tr>
<td>Output</td>
<td>DC4-20mA</td>
</tr>
<tr>
<td>Enclosure</td>
<td>IP65</td>
</tr>
<tr>
<td>Power Supply</td>
<td>AC95 ~ 264V</td>
</tr>
</tbody>
</table>

## Purge air unit

| Supply air | 80 ~ 90 m³/h |
| Enclosure  | IP55 |
| Power supply | AC100/115/230V |
| Power Consumption | 400V(50Hz), 500V(60Hz)|
Light transparent (Opacity)

**Light transparent ratio**

\[ T = \frac{I}{I_0} \]

ランバート・ベールの式

\[ T = \frac{I}{I_0} = e^{-clc} \]

<table>
<thead>
<tr>
<th>Opacity %</th>
<th>Optical Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ O = 1 - T ]</td>
<td>[ E = \lg \left( \frac{1}{T} \right) = \frac{k}{2.3} \times c \times l ]</td>
</tr>
<tr>
<td>[ O[%] = 1 - T \times 100% ]</td>
<td>[ c = \frac{1}{l} \times \frac{2.3}{k} \times \lg \left( \frac{1}{T} \right) ]</td>
</tr>
<tr>
<td>[ I_0 ] - Light intensity</td>
<td>[ c = \frac{1}{l} \times \frac{2.3}{k} \times E ]</td>
</tr>
<tr>
<td>[ I ] - Received light intensity</td>
<td>Dust (mg/m³)</td>
</tr>
<tr>
<td>[ K ] - Constant factor</td>
<td>(Calibration reg. VDI 2066 or other standard method)</td>
</tr>
<tr>
<td>[ c ] - Concentration</td>
<td></td>
</tr>
<tr>
<td>[ l ] - Length of pass</td>
<td></td>
</tr>
</tbody>
</table>

Light goes and come back in the stack, so it can measure more accurately.
Moisture / Flow meter

**Moisture analyzer**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas Temp.</td>
<td>Up to 1,300 degree C</td>
</tr>
<tr>
<td>Enclosure</td>
<td>NEMA 4 X</td>
</tr>
<tr>
<td>Output</td>
<td>4-20mA</td>
</tr>
<tr>
<td>Measurement method</td>
<td>Insitu measurement</td>
</tr>
<tr>
<td>Purge (OPTION)</td>
<td>Filter blow back</td>
</tr>
<tr>
<td>Case Heater (OPTION)</td>
<td>-40 degree C</td>
</tr>
</tbody>
</table>

**Flow analyzer**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement method</td>
<td>Differential-pressure</td>
</tr>
<tr>
<td>Range</td>
<td>0-2,000,000Nm3/h</td>
</tr>
<tr>
<td>Repeatability</td>
<td>± 2.0% of F.S.</td>
</tr>
<tr>
<td>Output</td>
<td>4-20mA</td>
</tr>
<tr>
<td>Enclosure</td>
<td>IP65</td>
</tr>
<tr>
<td>Power Supply</td>
<td>AC100V / 115V / 230V</td>
</tr>
<tr>
<td>Power Consumption</td>
<td>50VA</td>
</tr>
</tbody>
</table>
Measuring the difference of pressure A & B. Compensate by absolute pressure & temperature.
Ultrasonic flow (Flow rate)

Measure flow velocity & rate by using the velocity of ultrasonic etc

\[ v = \frac{L}{2 \cos \alpha} \left( \frac{t_+}{t_-} - \frac{t_-}{t_+} \right) \]
NZ-3000 (O2 Zirconium analyzer)

Futures
- Fast response
- High accuracy Zirconia cell
- Easy to replace for the cell

<table>
<thead>
<tr>
<th>Components</th>
<th>O2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range</td>
<td>Display : 0~100vol%O2</td>
</tr>
<tr>
<td></td>
<td>Selectable range is available</td>
</tr>
<tr>
<td>Measuring method</td>
<td>Zirconium</td>
</tr>
<tr>
<td>Drift</td>
<td>±2.0% / month</td>
</tr>
<tr>
<td>Response time</td>
<td>T90 within 5 seconds</td>
</tr>
<tr>
<td>Power supply</td>
<td>AC 100~240 V 50/60 Hz</td>
</tr>
<tr>
<td>Power consumption</td>
<td>100 VA~300 VA</td>
</tr>
</tbody>
</table>