



ISA Delhi Section

Setting the Standard for Automation™

CEMS IN FERTILIZERS INDUSTRIES

Presented By-

1. Jitender Nasa
2. Sheikh R. Manihar Ahmed
3. Utsab Dutta

FLUOR

CEMS IN FERTILIZERS INDUSTRIES

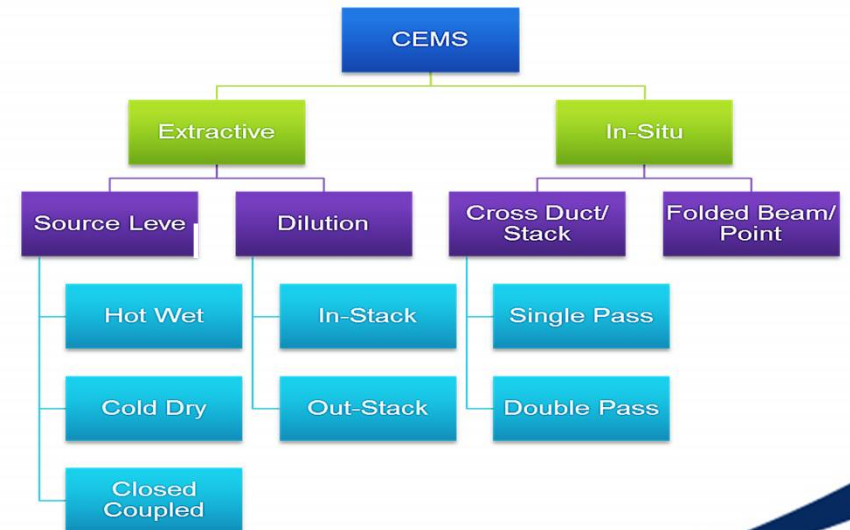
In recent years, environmental issues/ concerns have grown over the contribution of pollutants emitted by the fertilizer plants such as gaseous ammonia (NH_3), nitric and nitrous oxides (NO_x), carbon dioxide (CO_2) and hydrogen fluoride (HF) - sulfur oxides (SO_x), fertilizer dust and acid mists.

The violation of the environmental norms in terms of emission of pollutants can result in strict penalties from regional and national environmental authorities including complete lockout of the processing unit.



WHAT IS CEMS ?

A continuous emission monitoring system (CEMS) is composed of equipment and instruments to draw, condition, analyze the sample and provide the permanent record of emission or process control parameters continuously at real-time basis. CEMS analyzers are installed at the stack and equivalent locations to achieve the compliance with regulation and to ensure the correctness of measured values.



FLUOR

Common Pollutants and their Measuring Methods in Fertilizer Plants

S.No	Captive Plants and Fertilizer Industries	Area or Units	Parameters	Recommended Methodologies	Recommended Technologies
1	Ammonia Captive Plant (NH ₃)	Primary Stack Reformer (Flue Gas)	CO ₂ , SO ₂ , NO ₂ , CO.	Cold Dry Extractive	NDIR
2	Nitric Acid Captive Plant (HNO ₃)	Absorption Tower (Tail Gas)	NO _x , N ₂ O, O ₂ , H ₂ O And N ₂	Hot Wet Extractive	NDIR/ NDUV/ FTIR
3	Sulfuric Acid Captive Plant (H ₂ SO ₄)	Absorption Tower (Off Gas)	NO _x , SO ₂ , H ₂ SO ₄ Mist & Spray and Dust Particles	In-Situ, Hot Wet Extractive	NDUV/ FTIR
4	Phosphoric Acid Captive Plant (H ₃ PO ₄)	Grinder And Scrubbers	HF, H ₃ PO ₄ Mists And H ₂ S Acid	In-Situ Hot Wet Extractive	TDLAS/ FTIR/ DOAS
5	Urea Fertilizer Plant	Prilling Tower	NH ₃ and PM	In-Situ, Hot Wet Extractive	TDLAS/ NDUV/ FTIR
6	Ammonia Sulphate (Ammonia + Sulfuric)	Carbonation Tower, Filtration, Drying & Cooling	NH ₃ , NO _x , SO _x	In-Situ, Hot Wet Extractive	TDLAS/ NDUV/ DOAS/ FTIR
7	Calcium Ammonium Nitrate Fertilizer (CAN) (Ammonia + Nitrate)	Condenser, Lime Stone Grinder, Granulator	NH ₃ , NO _x , N ₂ O	In-Situ, Hot Wet Extractive	TDLAS/ NDUV/ DOAS/ FTIR
8	Single Super Phosphate Fertilizer (SSP) (Phosphate + Sulfuric Acid)	De-dusting, Scrubber Curing Shed	HF, PM, SO _x , and Fluorides	In-Situ Hot Wet Extractive	TDLAS/ FTIR/ DOAS
9	Diammonium Phosphate Fertilizer (DAP) (Ammonia + Phosphoric Acid)	De-dusting, Scrubber	NH ₃ , HF, NO _x , SO _x	In-Situ, Hot Wet Extractive	TDLAS/ FTIR/ DOAS
10	NPK Complex Fertilizer	De-dusting, Scrubber	NH ₃ , HF, NO _x , SO _x	In-Situ, Hot Wet Extractive	TDLAS/ FTIR/ DOAS

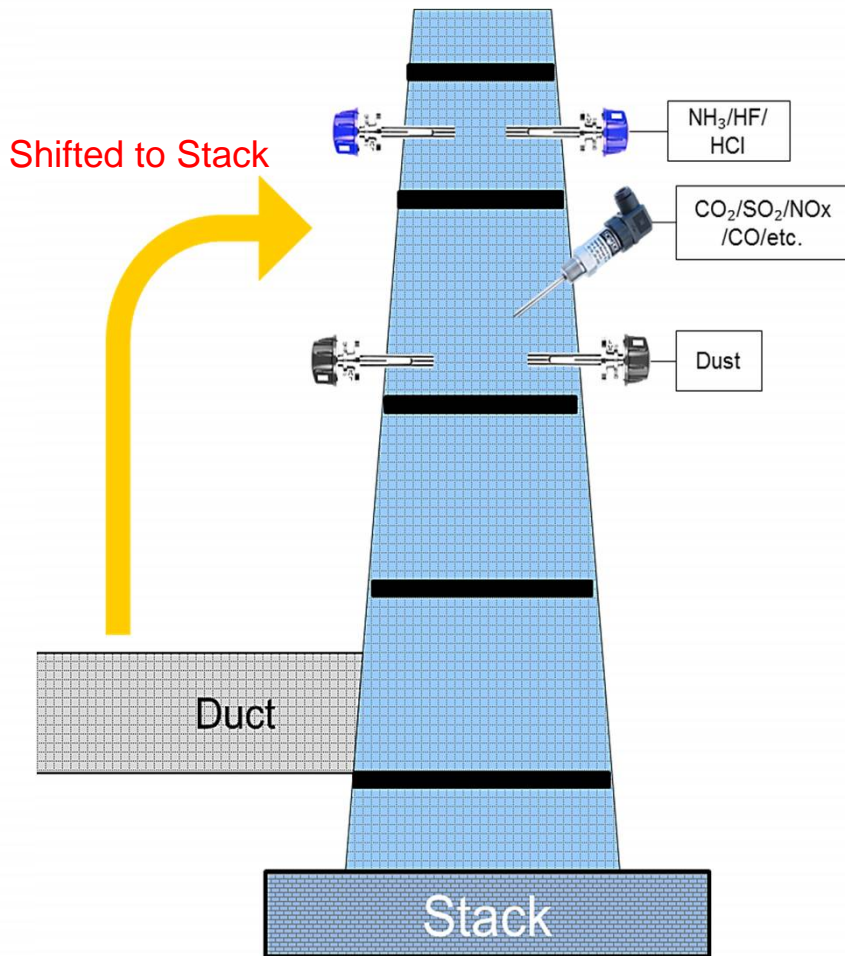
FLUOR

Technical Selection of CEMS for Fertilizer Plants

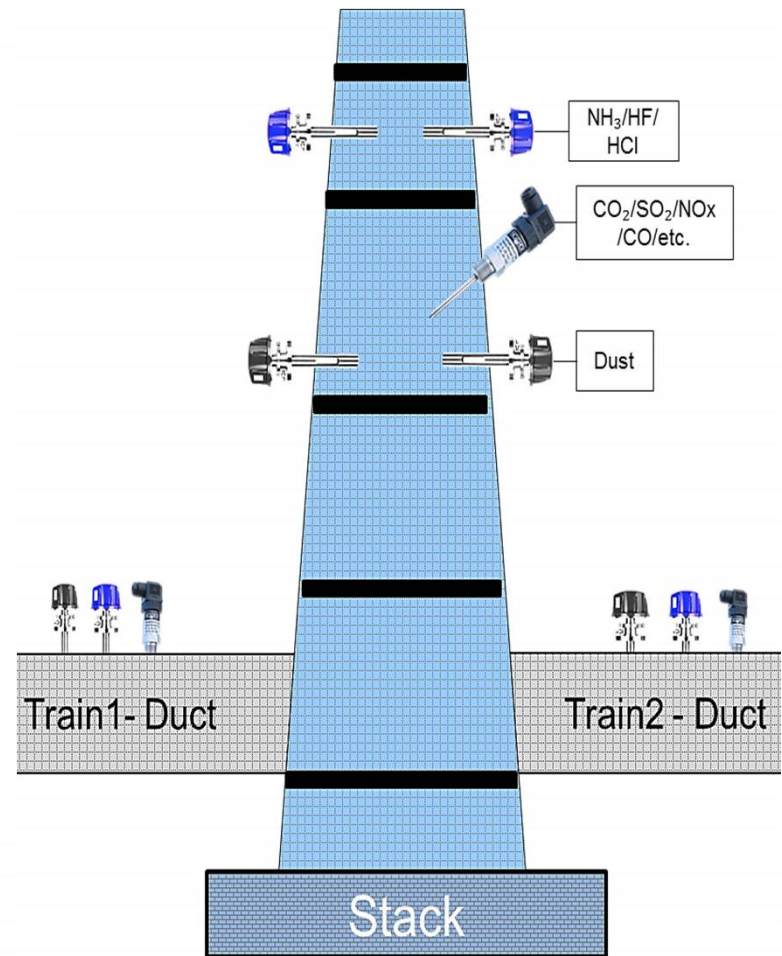
S.No	Technology	Methodology	Principle	Gases Measured	Suitable	Limitation of Technology based on parameter
1	NDIR	Cold Dry Extractive Hot Wet Extractive In-Situ	Beer Lambert Law Filter Photometer	CO ₂ , SO ₂ , NO _x , CO, etc.	Upto 4-5 gas measurements	Inability to measure HF, Cl ₂ , H ₂ S etc. Soluble gases can be lost during cooling.
2	NDUV	Hot Wet Extractive	Beer Lambert Law Filter Photometer	SO ₂ , NO _x , NH ₃ , Cl ₂ , CS ₂ etc.	Upto 2-3 gas measurements	Wet based measurement is mandatory for soluble gases like NH ₃ .
3	FTIR	Hot Wet Extractive	Beer Lambert Law Filter Photometer	CO, CO ₂ , SO ₂ , NO _x , NH ₃ , N ₂ O, HF, HCl, Moisture etc.	Upto 5-12 gas measurements	Heated Sample Line
4	DOAS	In-Situ : Open Path Long distance/ Perimeter	Differential Optical Enhanced Absorption Spectroscopy	CO, CO ₂ , SO ₂ , NO ₂ , NH ₃ , HF, HCl, VOC etc.	More than 5 gases	Limitation in high dusty stacks and smaller dia. Stacks.
5	TDLAS	In-Situ: Path Type	Wavelength Modulation Spectroscopy	CO, CO ₂ , NH ₃ , HF, HCl, CH ₄ , O ₂ , H ₂ S and Moisture etc.	Cost effective for single component	Wet based measurement requires online measurement of H ₂ O, O ₂ , P T, Flow. Limitation in high dusty stacks and smaller dia. Stacks.
6	Transmissiometry	In-Situ	Light attenuation	Particulates Matters	Dry Stacks	Can't monitor particulate levels below 25 mg/m ³ per meter path length.

FLUOR

Case Study – Common CEMS Analyzer for Combined Duct



Case1



Case2

FLUOR

Non-Dispersive Infrared/ Ultra Violet (NDIR/UV)

1. Non-Dispersive Infrared (NDIR):-

- ✓ **NDIR** is a direct method for continuous monitoring of multiple gases suitable upto **4-5 gas** without any dilutions.

Advantage:

- Popular for **low level SO₂/ NO_x**;
- Avoid background interference from moisture;
- Less **chances of failure**;
- Consumes less **calibration gas**;
- Probe installation at **lower height**.

Limitation:

- Time consuming installation;
- Inability to Measure soluble gases;
- Required heated sample line.

2. Non-Dispersive Ultraviolet (NDUV):-

- ✓ **NDUV** is a direct method for continuous monitoring of multiple gases suitable upto **2-3 gas** measurements without any dilutions.

Advantage:

- Measures **both NO and NO₂**;
- Popular in **harsh applications**;
- Lower Interferences;
- Available for **soluble gases like NH₃**.

Limitation:

- Cannot measure other gaseous pollutants like **CO, CO₂, HCl, HF etc.**

FLUOR

CEMS:

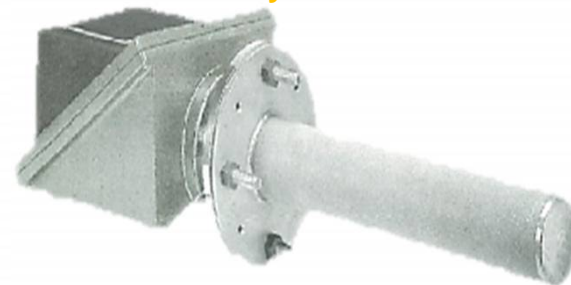
Analyzer used : **IR/UV Based Extractive system**



CO₂/SO₂/NO_x/CO/etc.

CEMS:

Analyzer used : **IR/UV sed Point system**



SO₂ /NO_x/CO/CO₂/O₂

Fourier Transform Infrared (FTIR) & Differential Optical Absorption Spectroscopy (DOAS)

3. Fourier Transform Infrared (FTIR):

- ✓ FTIR is a direct method for continuous monitoring of multiple gases suitable upto **5-15** gases using **high-end spectroscopy** technique.

Advantage:

- Preferred for very **low concentration** of soluble gases.
- Uses Hot Wet extractive technique for **complex stack** gas matrix with high moisture and soluble gases;
- Additional modules **O₂** and **VOC** can be also integrated into the online measurement.

Limitation:

- **Highly** expensive.

4. Differential Optical Absorption Spectroscopy (DOAS):-

- ✓ DOAS is a Non-contact method for continuous monitoring of multiple gases preferably more than **5** gases using **optical measurement path** that can operate across the stack.

Advantage:

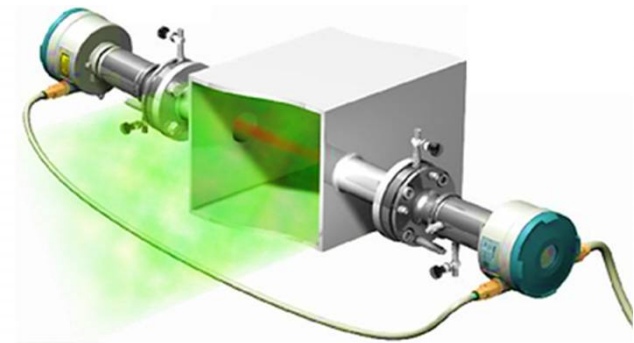
- Suitable for **Trace** measurements;
- No **sampling** and very **less maintenance** is required;
- Preferable in **harsh** applications.
- Multiple **stack measurements**.

Limitation:

- **High** initial cost;
- Limitation in **high dust and moisture** application;
- No **online** and **remote** calibration is available;
- Limitation in Optical Fiber cable and **Calibration challenges** at site.

CEMS:

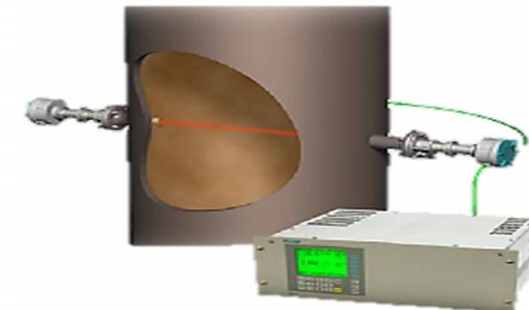
Analyzer used : **TDLA/ DOAS**
Path system (**Cross Duct**)



DOAS- SO₂/NO_x/CO/CO₂/NH₃
TDLS- NH₃/HCL/HF/CO/CO₂

CEMS:

Analyzer used : **TDLA/ DOAS**
Path system (**Across Stack**)



DOAS- SO₂/NO_x/CO/CO₂/NH₃
TDLS- NH₃/HCL/HF/CO/CO₂

FLUOR

5. Tunable Diode Laser Absorption Spectrometry (TDLAS)

5. Tunable Diode Laser Absorption Spectrometry (TDLAS):-

- ✓ TDLAS is an indirect method for continuous monitoring of **NH₃**, **HF** and **HCl** using optical measurement path that can operate across the stack.

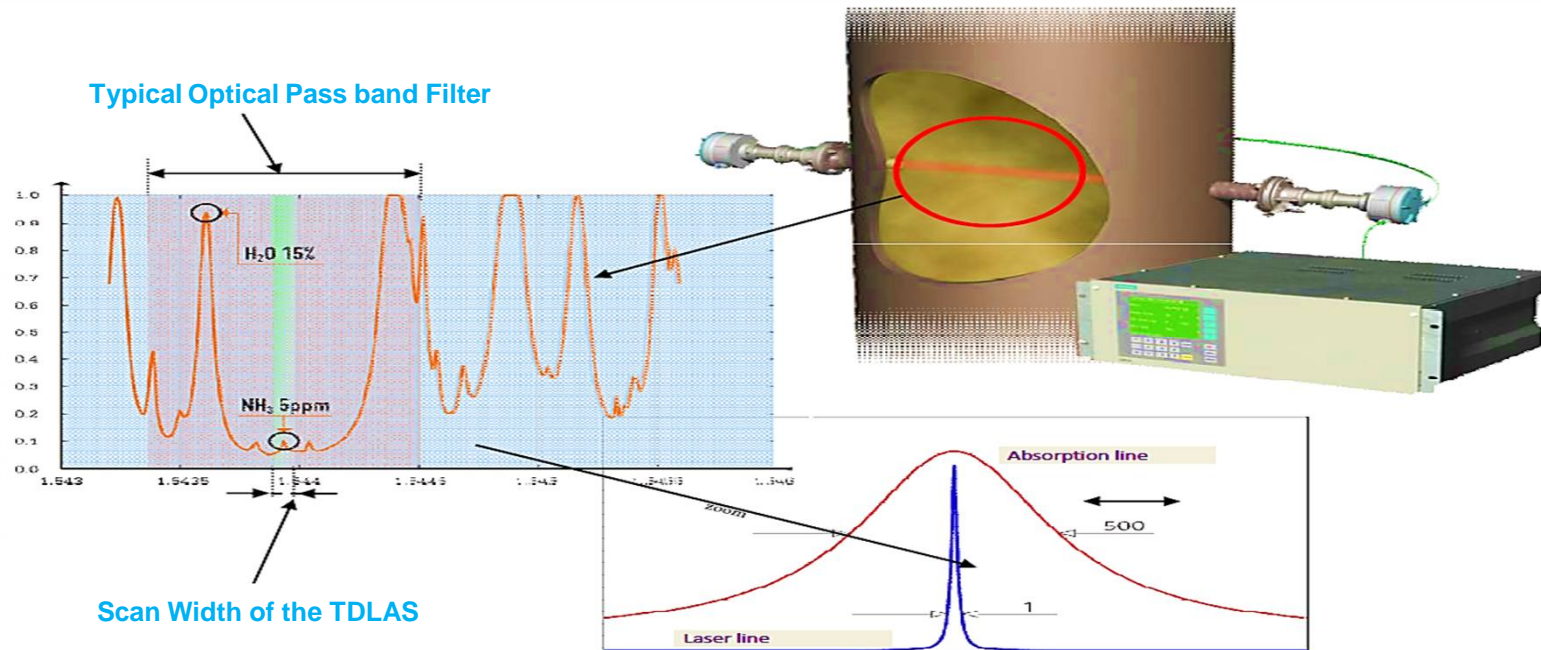
Advantage:

- Capable of measuring a **no. of near infrared** absorbing;
- Capable of measuring the sample under **difficult condition**.
- Integrated across **path length**;
- **Cost effective** solution for single measurement.

Limitation:

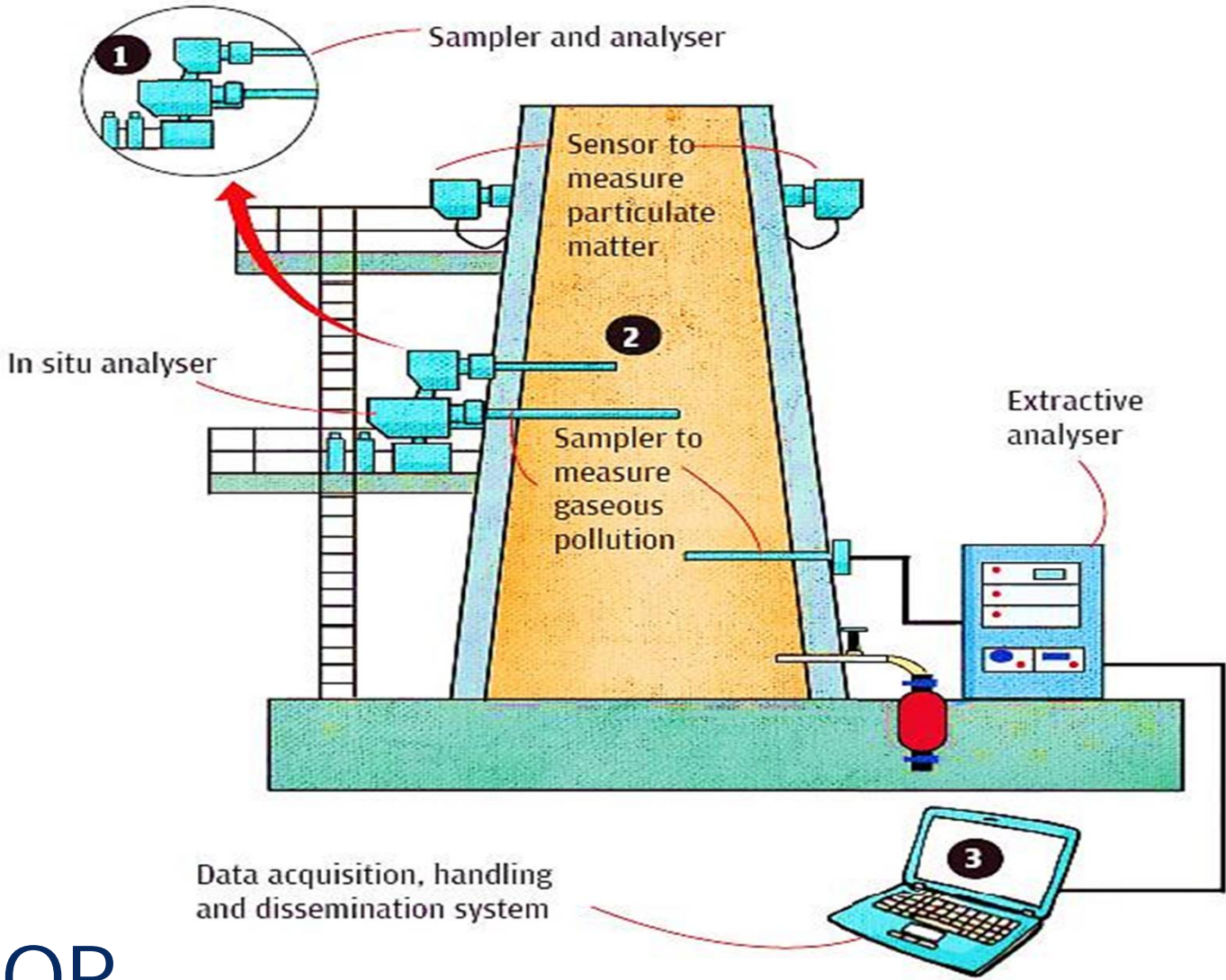
- Deformation of ducting can lead to **misalignment**;
- Initial installation for the **mounting flange** is required;
- **Very expensive** for multi-gas measurement

In-Situ Single Line Absorption Spectroscopy



FLUOR

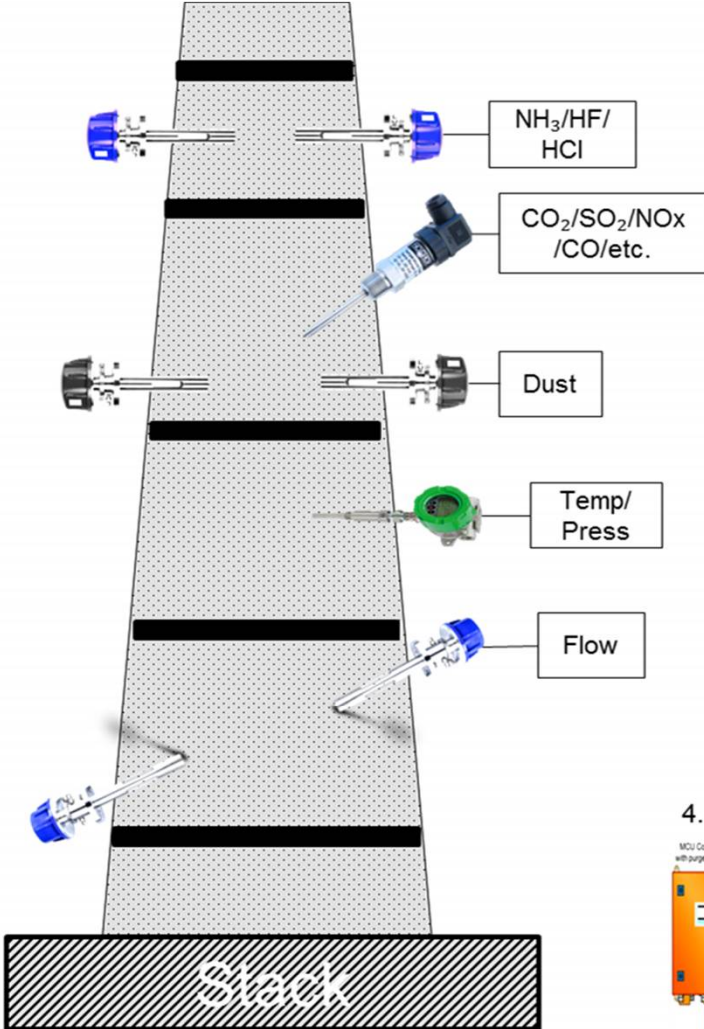
CEMS Analyzer Interconnection Drawing



FLUOR



CEMS Analyzer Interconnection Drawing



FLUOR

1. Extractive system: IR/UV Based



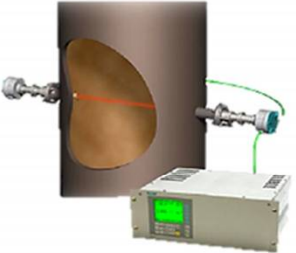
CO₂/SO₂/NO_x/CO/etc.

2. Point System: IR/UV Based



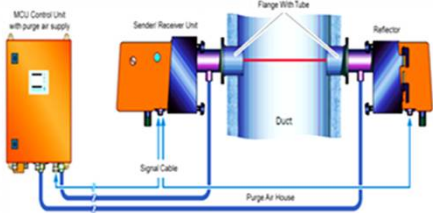
SO₂ /NO_x/CO/CO₂/O₂

3. Path System: DOAS/ TDLS

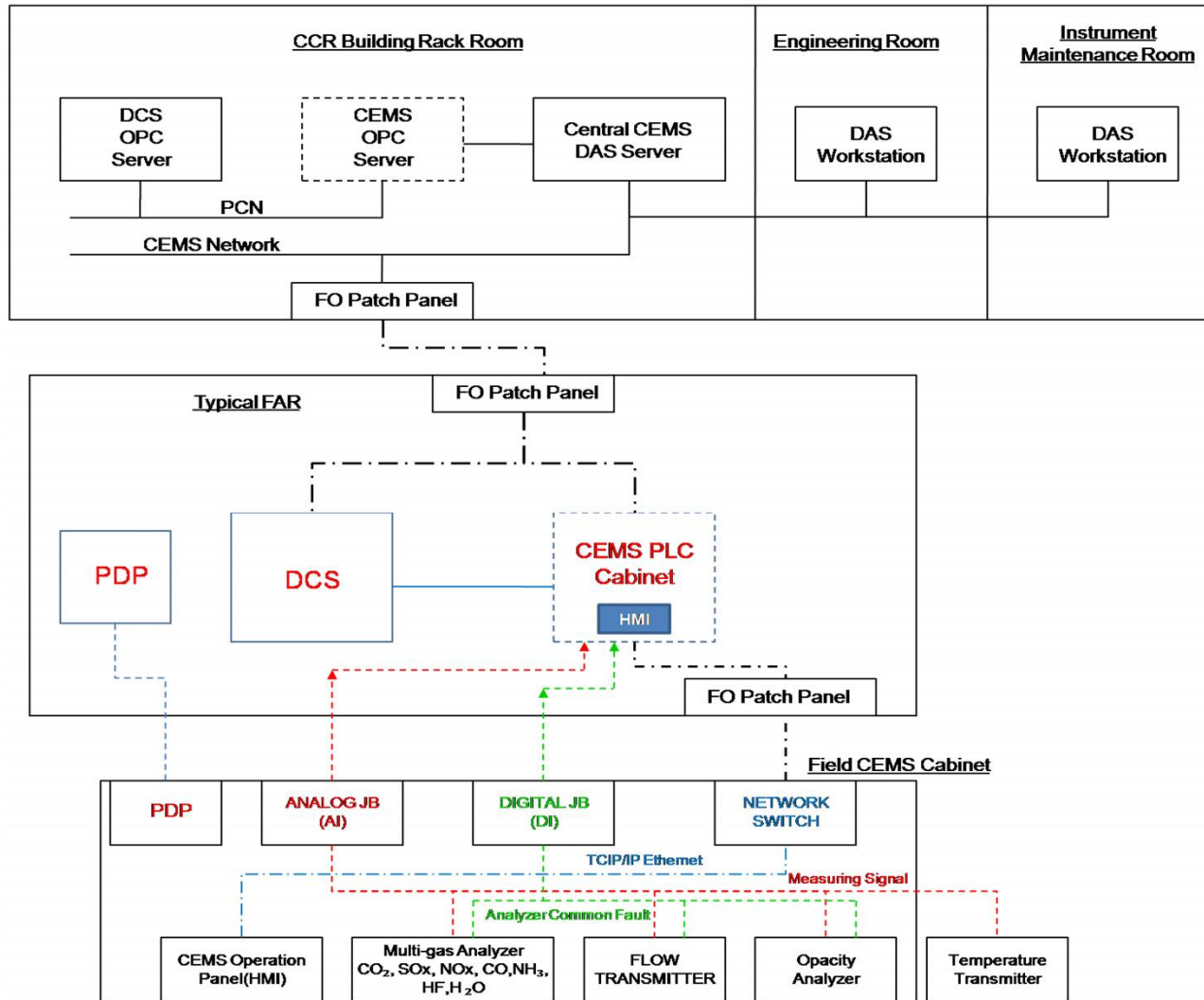


DOAS- SO₂ /NO_x/CO/CO₂/NH₃
 TDLS- NH₃/HCL/HF/CO/CO₂

4. In-situ or cross duct PM CEMS



Overall Network Architecture Of CEMS





Overall Network Architecture Of CEMS

Typical overall system block diagram of CEMS consists of following modules:

- 1. CEMS Field Cabinet:** It consists of analyzers (such as multi-gas analyzer, flow & temp. transmitter, PM, Opacity etc.), CEMS operation panel (HMI), Analog & Digital Junction Boxes, Power distribution panel (PDP), and network switch. CEMS field cabinet shall be provided with large enough reinforced window in the door so that the analyzer can be seen without opening local cabinet door. It contains PDP with power supply connections. Network switches are used to convert the TCP/IP Ethernet to optical signal send via fiber optical cable (FOC) to CEMS PLC. Analyzer measuring (AI) signal and common fault alarm signal (DI) send separately to the CEMS PLC cabinet thru field junction boxes.
- 2. Local Equipment or Field Auxiliary Room (LER/ FAR):** It consists of CEMS PLC cabinet, PDP, DCS and FO patch panel. The system will ensure the intermediate data storage of the raw input values at minute intervals from analyzers and eventual flow/temperature and pressure. CEMS results (i.e. NO_x and O₂) used for DCS purpose. Analyzer stream components used for control shall be redundant MODBUS TCP to the DCS.
- 3. Central Control and Administration:** It consists of CCR building rack room, engineer room and Instrument maintenance room. CCR building rack room consists of DCS OPC serves (S), CEMS OPC Server, Central CEMS DAS server and FO patch panel. Integration of CEMS analyzer is required in the centralized server based CEMS Data acquisition System (DAS) located in CCR. The DAS shall be provided with an uninterrupted power supply (UPS) for a minimum of 30 min. backup for uninterrupted operation in case of power failure.
- 4. Data Acquisition System (DAS):** The DAS plays a critical role in reading hourly averages of pollutants emitted and also produces the data to the government inspector to certify that the industry is working within the specify norms. The DAS can also be connected to the plant DCS system/ central DAS for conversion of wet basis to dry basis measurement as well as consolidating all the CEMS analyzers data by Management Information System (MIS) in a centrally located server for overall report management, though the connectivity requirement might vary from client to client. The tamper proof (encrypted format) data shall be transferred directly from the analyzer to the server at regional and national pollution control board via central CEMS DAS. The system shall record all the monitored values and transfer 30 min. average value to Data Acquisition & Handling System (DAHS).

FLUOR

Thank You



FLUOR

A blue swoosh graphic is located in the bottom right corner of the slide.