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5th Technical Conference on

AIR POLLUTION CONTROL & MONITORING- ISSUES & SOLUTIONS

December 7-8, 2015
FICCI, Federation House, Tansen Marg, New Delhi

Background Paper





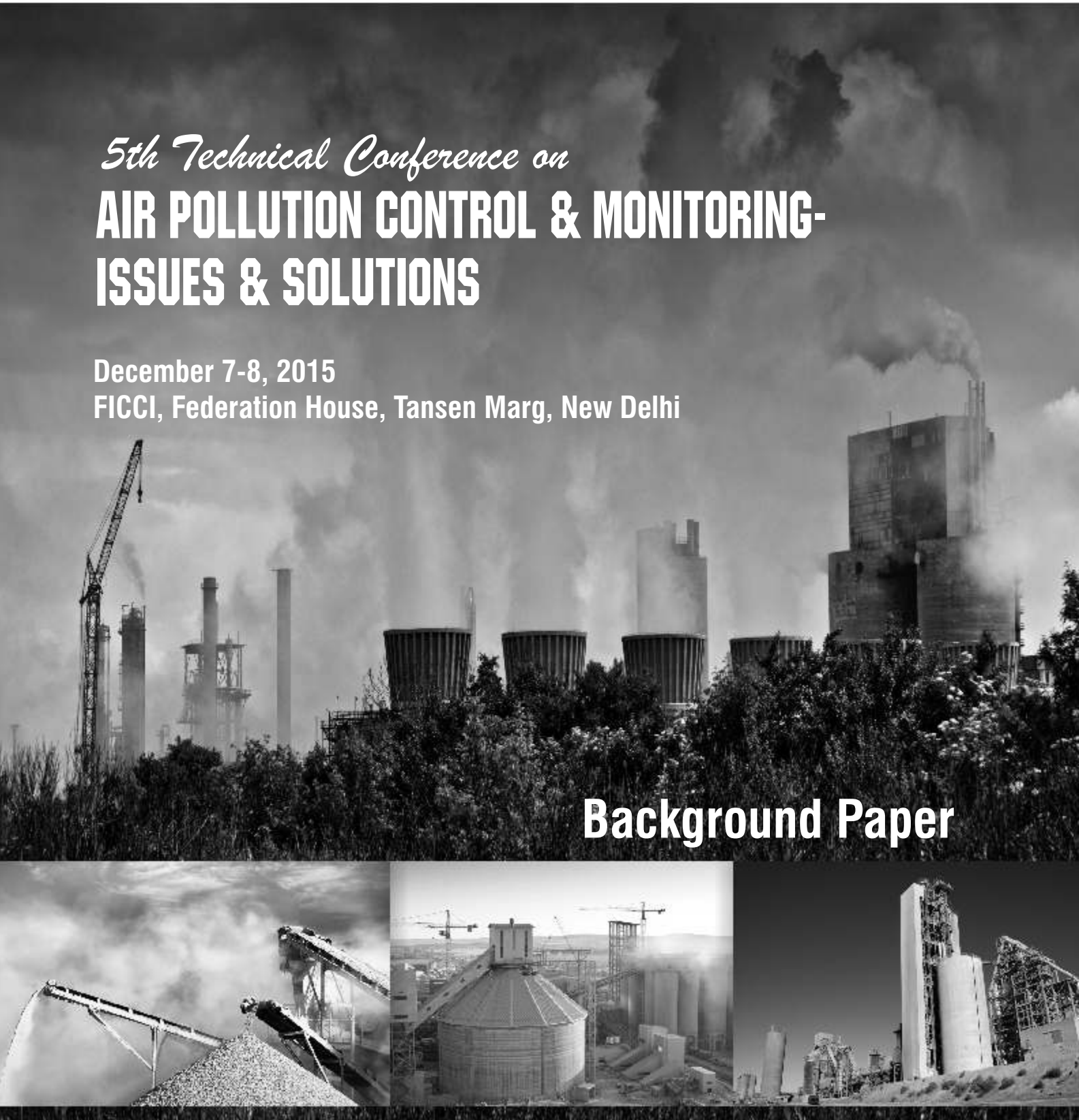
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1 Air Quality Monitoring System to Air Quality Management System

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Background

Air quality being a concern for all, the knowledge on instantaneous air quality data has become a need for the society. The instantaneous data may also become relevant for depicting real-time generic information in the form of AQI has been taken as one of the priority of concern for CPCB. These data once started displaying at respective locations, would bring participation of general public in the prevention & control of air pollution at respective area of activity. The data may also link with all developmental authorities in respective areas.

Over the years, CPCB, SPCBs/PCCs have established a large no. of on-line real time CAAQMS across the country and gradually these data are being taken for use by the regulatory organizations and attempts are on to link these data with developmental authorities / local bodies /road transport authorities. Thus, stress is required for checking of all data submitted / generated by concerned agencies, so that the generated data may be linked with developmental authorities at local areas without any question mark. These data may also be used for regional planning. The CPCB has prepared National Air Quality Index, wherein all real-time air quality data will be used for projection of real-time AQI at all respective locations. Thus, the data generated by CAAQMS have to be made available at respective sites with scientific validation so that the same may be utilised with confidence.

It's true that viewing and validating all these data for all stations is not a feasible option. Hence, we need to develop a system with in-built features so that all (regulators, local authorities, public in general etc.) can utilize the data at respective levels besides review of actions plan for all the area with respect to air quality goal. The in-built system should be such that all will love to work with maximum efficiency in minimum time on regular basis.

The in-built vendor-software system is capable of checking data or flagging the data for exceedence of set data range, negative values, signal of instrumental non-functional, faulty communication, etc. before the data is visualized by public in general. These are the practices followed across the globe for instantaneous data dissemination / visualization by the public.

It may be remembered that instantaneous data dissemination is not considered as validated data dissemination to the public. The actual validation of data is done by a team of experts in a regular frequency. While doing the validation process, the experts discuss the issues related to local conditions, meteorological data, rationality on data of the past, exceedence in data range, calibration frequency, outlier data etc. On satisfactory validation of data, the validated data is

published by the experts are acceptable for all. To maintain transparency of the system, collaborative portal for handling of issues are though mandatory.

Development of Collaborative portal

With view to work efficiently, there is need for development of "central server system", which should provide collaborative portal to be used by all stake-holders CPCB, SPCBs/PCCs, Development Authorities, Local bodies, Vendors and Industries.

This should be an interactive portal and should be able to interact with user specific activities. We may also think of having a sequential data process to check in line activities like Data generation point - primary data validation point - secondary data validation point - data hoisting point and so on.

Defining the responsibilities

Vendors

- SLA (Service Level Agreement) in maintenance contract for timely calibration and maintenance of analyzers.
- SLA for sending minimum 85% data to central server and ensure all infrastructure required for that like UPS, internet connection etc.
- Vendors should enter their information in portal and keep it up-to-date. This will be used for sending alerts and it is vendor's responsibility to take timely action for each alert

Industries

If the station is setup by an industry or any other agency, then above points should be included in their consent to operate / environmental clearance certificate

Calibration

System should store all data during calibration as well as all diagnostics data like drift, gain etc. during calibration. System should also alert users with proper escalation mechanism if calibrations are not done as per defined intervals.

Extra-ordinary events workflow

For any extra ordinary event like exceedance of permissible limits, instrument malfunction, data not received for certain period, calibration not done for certain period etc., a defined workflow will be followed. This will include alert for the event, SMS to all concerned users, investigative / analytical comments by users etc. History of all events will be maintained and will be used to analyze performance of each station / vendor / industry etc.

Data Validation and Missing data

A data validation protocol is defined by CPCB and implemented in the system for all systems, however more training are needed to be organised so that regulators can not only check output of

the protocol and but also look extraordinary data / events to provide additional comments, if any, on regular basis. A missing data protocol is also required to be defined. The system should have diagnostic features like Next Calibration date, non- operation of system, etc.

Regulation by Exception

In this concept, system should monitor all data received and only alert concerned users about exceptional events (exceptional data, absurd data, un-calibrated data, etc.).

Dashboards with analytics

The user-specific dashboard shall provide actions to respective users depending on the role on the way to generation of quality data. Thus, user specific role dashboard widgets are also required to be prepared. This also should have specific provision for alert sending options (mail / sms) for rectification to specific service provider.

Air Quality Management System

Air quality management is a complex activity of integrated science. There is a need for integration of science irrespective of discipline. Some 10 point program is accepted and adopted in for successful implementation of air quality management program. These are: (1) Setting the target for air quality goal with economically sound monitoring mechanism having robust database on baseline data, receptor based data and trend line data for city of concern; (2) Good quality science based monitoring mechanism with linkage with health, environment, impact at receptor level, cost analyses including burden to the society; (3) Understanding and knowledge on analytical sciences and atmospheric sciences including the information on the nature, sources and impacts of air pollution; (4) Shared understanding of the problem among major stakeholders (pollution sources, political leaders, environmental officials, public interest groups, citizens); (5) Active involvement of stakeholders and shared commitment to improve air quality; (6) Shared burden of control across contributing sources in the city and regions (surroundings); (7) Leadership at local level, regional level, national level, to enable participation, set fair levels of control, and resolve conflicts between stakeholders; (8) Defined roles for each level of government involved including defining the mandate; (9) Strong penalties, clear accountability, and strict enforcement at the national, state, and local levels, etc. We need to organise debate on above stated issues at regular intervals and at all levels (local and regional).

By doing and putting all the issues in practice including defining local expert group with systematic monitoring and quality data generation, it is hoped that the systems and purpose of Continuous Ambient Air Quality will attain grand success. It may be remembered that the data generated are basically meant for public in general, used for forecasting, early alarm system including building of confidence among public in general, regulators and various urban area management organization. It is also necessary to understand that the success of environmental management is largely dependent on the participation of public in general.

2 Catalytic Activated Dust Filter (Ceramic or Bag) – A New Technology for Combined Removal of Dust, NOx, Dioxin, VOCs and Acids from Off Gases

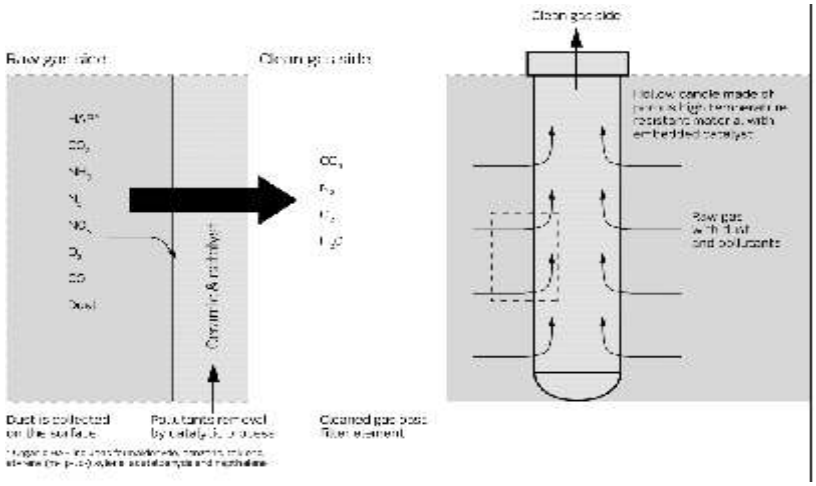
by Mr. Sachin Panwar, Haldor Topsoe India Pvt. Ltd.
sapa@topsoe.in

In recent years there has been increasing concern worldwide and also in India for air pollution caused by industry off gases and vehicular emission. Sulfur Oxides, Nitrogen Oxides, Volatile organic compounds/ Hazardous Air pollutants (VOCs or HAPs) and Particulate Matter (PM)are major pollutants, which are generally believed to have substantial damaging effects on our health and environment. NOx also reacts in the atmosphere to form ground- level Ozone, bringing yellow smog in urban areas.In modern India there is huge demand of, Power, Fuel and Petrochemical products for meeting the day today requirements. Capacity augmentation or addition of new plants is foreseen in all areas. To meet the product demand, Industry is adopting state of art technologies & up-gradation of existing operation, but the measures being taken for reduction of Air pollutants has not been significant due lack of driving force and constraint of finances for CAPEX & OPEX of such solutions

HALDOR TOPSOE has developed a unique way of removal of dust, Dioxin, VOCs/ HAPs and acids from off-gases through catalytic activated dust filter (ceramic or Fibre).

Principle

During the last few years, a Catalytic Activated Dust Filter (CADF) has been developed and commercialized by Haldor Topsoe A/S together with partners, under trade name of Top-Frax (ceramic) and EnviroTex (fabric). CADF combines highly efficient surface barrier filtration of dust with Highly efficient catalytic destruction at 170 to 450°C of NOx, dioxin and VOCs in the off gas from thermal processes. The candles (similarly fiber bags on cartridge) are installed as an alternative to conventional bags in pulse jet cleaned bag houses. The catalyst is microscopic particles embedded in walls of the CADF candles/fibres and protected by the surface barrier against any contact with dust from outside.



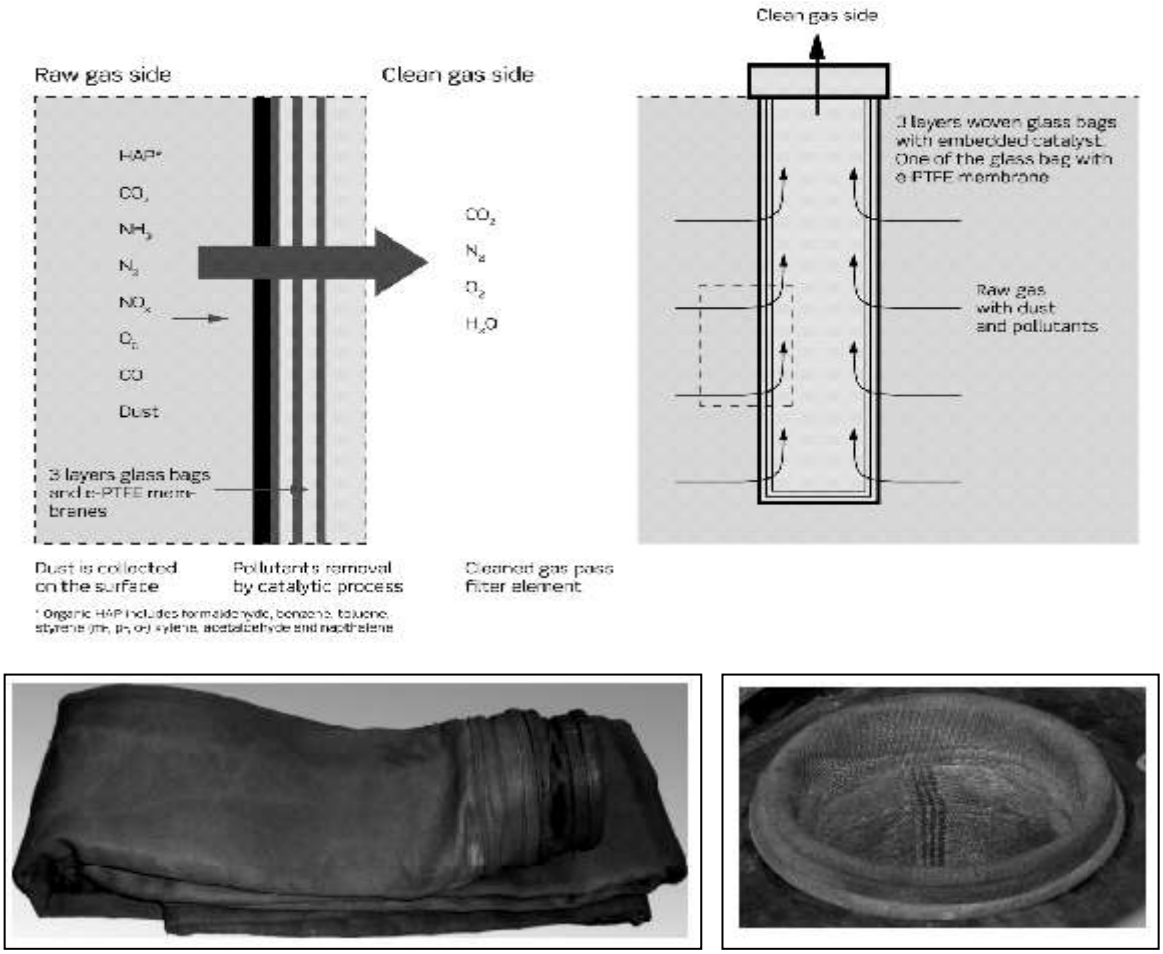


Figure1. Schematic principle of the ceramic and fibre Catalytic Activated Dust Filter.

The catalyst particles are micro-porous and due to their small size, they catalyze the gas phase reactions without diffusion restriction (i.e. almost 100% utilization of the catalyst intrinsic activity) as opposed to usual pellet or monolithic catalysts. In industrial plants the conventional catalyst types typically operate with 5-15% catalyst effectiveness in the SCR (Selective Catalytic Reduction of NOx by NH3), and with even lower catalyst utilization in dioxin destruction. The latter is highly gas film controlled in usual catalysts due to the low diffusion coefficient of dioxins. As determined by microprobe analysis (EDS) the V and Ti components of the catalyst are evenly distributed across the wall in the desired atomic ratio for optimal catalytic activity. V/Ti based catalysts are best for deNOx and de-dioxin applications. Figure below shows removal of NOx and VOCs w.r.t to Temp.

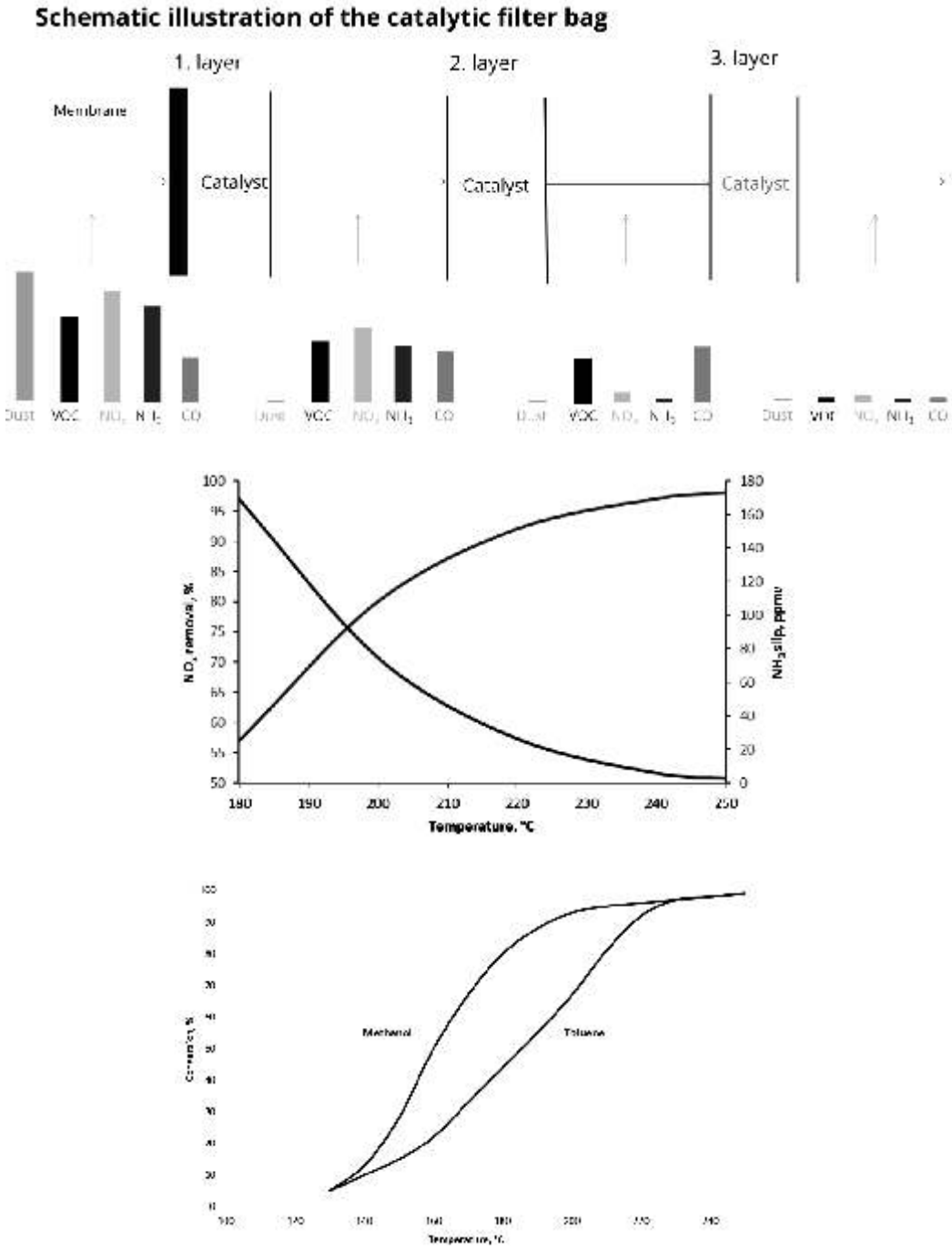


Figure 2. Temperature correlation to NOx and VOCs removal.

Applications of CADF technology

The CADF technology has great potential in particular for use in (waste) incinerations plants, diesel engines and combustion of bio mass and petroleum residues (petcoke, tar, heavy fuel oil), cement industry.



Cement kilns



Power plants



Waste incinerators



Chemical Industry

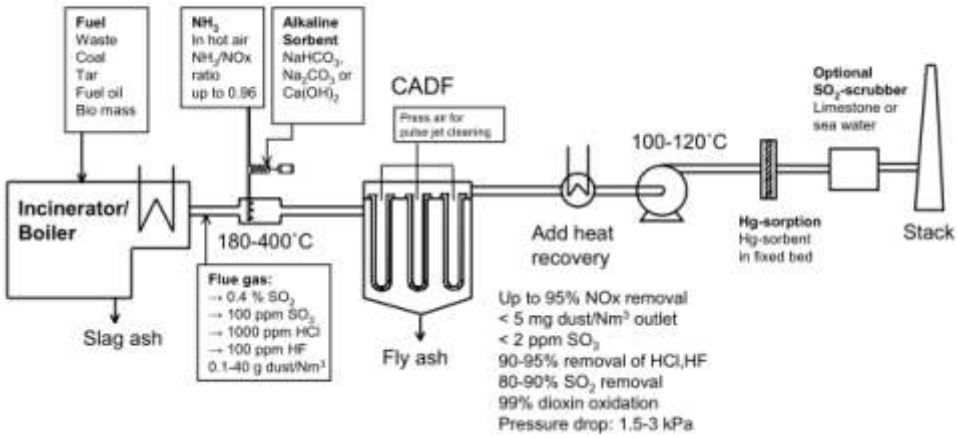


Figure 3. Incinerator/Boiler with Catalytic Ceramic Dust Filter (CADF) and Optional Wet FGD.

Incinerations plants: A significant simplification and reduction in investments and operating cost can be obtained compared to the current BAT-technology, which involves an ESP, active carbon injection, a SO2 scrubber and a tail-end SCR with gas reheat. High dust SCR deNOx and dioxin removal using monolith SCR catalysts is not possible due to the sticky fly ash from waste

incineration. With CADF it is possible to combine removal of dust, SOx, HCl, HF, NOx and dioxin in the dust filter equipped CADF elements at temperatures from 180 to 400 °C, as seen in fig 3. In special cases, the operating temperature can be down to 160°C or up to 500-600°C. NH3 or urea for the NOx reduction is injected in the gas upstream of the CADF as with ordinary SCR reactors. As with ordinary SCR catalysts, Hg in the gas will be oxidized to Hg++ which can be adsorbed either at 100-140°C in a fixed bed with Hg-sorbent, or in a wet scrubber.

The elements can operate at temperatures from 170-180° C, which is the minimum temperature of sufficient deNOx activity of the catalyst, and up to 400-450°C, which is the maximum long term operating temperature sustainable for the catalyst. 99% of the dioxin in the gas is destroyed at temperatures down to about 160°C.

Very often the dust in the flue gas from combustion of waste and bio mass tends to foul the boiler tubes in particular when the gas is cooled to temperatures below 200-300°C. If that is the case, it is advantageous to cool the gas in two steps and insert the CADF treatment at, say, 300°C followed by further cooling of the dust-free clean gas in a more price-effective finned tube boiler for increased heat recovery down to 100-120°C, up-stream of a possible Hg-absorption, followed by a wet scrubbing tower in case that it is desired to remove high concentrations of HCl and SO2 by a cheaper sorbent such as limestone. The Hg-absorption may be carried out in a fixed bed and is favoured by the low temperature and the fact that Hg is present in oxidized form.

Operation on or below the NH4HSO4 (ABS) dew point may be possible when injecting the alkaline sorbent (preferably NaHCO3 or Na2CO3 in reactive form) together with the NH3 of the

CADF. SO3 in the flue gas immediately forms ABS at temperatures on or below the ABS dew point. The ABS condenses on the particulates in the gas where after the ABS on alkaline particles is decomposed by the sodium carbonate under liberation of the NH3:

$$Na_2CO_3(s) + NH_4HSO_4(s) \longrightarrow Na_2SO_4(s) + NH_3 + CO_2 + H_2O$$

The reaction is slow and requires at least 10 minutes residence time in the dust layer accumulating on the surface of the CADF elements between the pulse jet cleanings. In this way, the use of gas surface filtration in CADF- in place of using ESP for dust removal - may make it possible to carry out SCR NOx-reduction with SO3-rich flue gases on or below the ABS dew point, where ordinary SCR catalysts would deactivate quickly by ABS condensation in the catalyst. This additional unique possibility with CADF may, as seen in the next example, be utilized in purification of diesel exhaust which is characterized by a high content of NOx and SO3 in the flue gas.

Diesel engines: In both two and four stroke engines, the use of CADF technology provides great advantages with regard to removal of both NOx, SO3, SO2 and particulates in the flue gas and makes it possible to use fuel oils with high sulphur and high metal content without emission problems. This is illustrated in fig 4 with a two-stroke engine where the flue gas is cleaned by CADF installed downstream of the expansion turbine at 260-280°C. The flue gas typically contains 1600 ppm NOx

(at 14% O2). With 3% S and 500 ppm vanadium and nickel in the fuel oil, the flue gas also contains 600 ppm SO2, 60 mg ash/Nm^3 and 20-40 ppm SO3 corresponding to an ABS dew point of about 330°C after injection of 1500 ppm NH3. The ABS condenses on the alkaline sorbent particles where the ABS will be decomposed in the dust cake on the filter elements, provided that the sorbent is sufficiently reactive and present in excess. If not, the cake will be sticky and difficult to remove by pulse jet. However, it remains to demonstrated in industrial practice how much the gas can be ABS

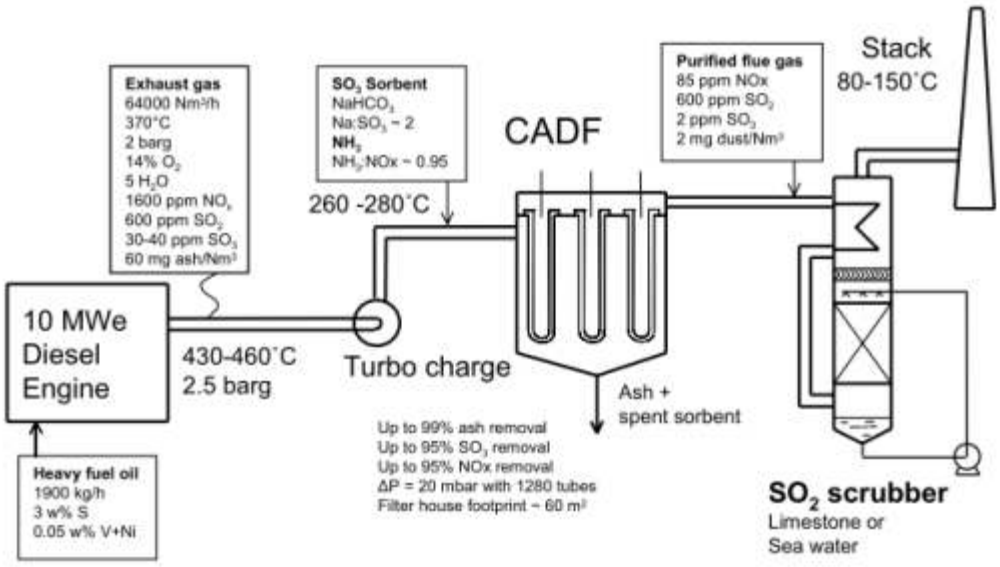


Figure 4. 2-stroke diesel engine with CADF installed downstream gas turbine.

The CADF and the injection of sorbent and NH3 can, alternatively, be placed upstream of the expansion turbine at 3,5 bar, 430-460°C. This placement is advantageous as the actual gas volume is nearly 3 times lower but not possible with ordinary SCR catalyst due to excessive formation of additional SO3 by SO2-oxidation in the vanadium rich ash fouling the catalyst surfaces and in the SCR catalyst itself. With CADF and injection of sorbent (could be Mg-Ca oxides), the SO3 will be adsorbed in the dust cake, and, furthermore, the rate of SO2-oxidation on the small catalyst particles will much lower relatively to the rate NOx-reduction because neither of the two reactions will be subjected to diffusion restriction in CADF, as opposed to ordinary SCR catalysts where the deNOx reaction is strongly diffusion restricted while the SO2-oxidation takes place un-restricted.

With 4-stroke diesel engines, the temperatures before and after the expansion turbine are 60-90°C higher which means that SCR deNOx can only be installed downstream of the expansion turbine. Also in this case, use of CADF will be advantageous compared to orinary SCR catalysts combined with possible ESP dust removal.

Biomass fired boilers: Traditional SCR systems suffer from high deactivation rates up to 50% per 1000 hours in biomass fired boilers due to deactivation by alkali aerosols. With CADF the sodium and potassium containing aerosols do not come in contact with the catalyst since they are stopped in the surface barrier and the catalyst lifetime may be prolonged significantly.

Cement Industry: In cement industry the filter bag have got best application due to small foot print and easy in operation and low in cost.

Industrial experience. CADF elements have been installed in industrial waste incineration plants:

- In a medical waste incineration plant in UK in which 50 ngTDE/Nm^3 is reduced to 0.4 ng/Nm^3 at about 155°C. Sodium carbonate is injected upstream the CADF in order to remove HCl and HF. An element was taken out after 14 months of operation with injection of sodium carbonate for removal of HCl, SO2 and HF. Its oxidation and deNOx activity was unchanged from new, and no Na had penetrated the filtration surface barrier.
- In an animal fat incineration plant in France where 0.01 ng TDE/Nm3 and 80% NOx-removal with 1-2 ppm NH^3-slip are achieved at 220-240°C.
- In an iron scrap thermal treatment plant in France, where < 0.06 ng TDE is achieved at 380°C with 5-50 ng TDE/Nm^3 inlet.

Summary

Finally ,Topsoe's CADF technology can help in reducing the air pollution from industrial off gases at 80% (approx.) less cost as compared to conventional method where on needs to install different technology for NOx, VOC and Di-oxin removal. It creates minimum complexity in revamp cases.

EnviroTex™ Catalytic filter bags	TopFrax™ Catalytic ceramic filters
o Each bag consist of three fabric layers (bags) which individually are impregnated	o Each filter consist of a ceramic fiber based filter impregnated with a catalyst in the filter wall (20 mm thick)
o High filtration efficiency	o High filtration efficiency (<2 mg/Nm3)
o Filter bag up to 464 F (240 deg. C)	o Up to 662 F (350 deg C) with present catalyst (filter up to 900 deg. C)
o VOC, ammonia removal, and DeNOx at low temperature	o DeNOx, ammonia and VOC removal.
o No poisoning of catalyst	o No poisoning of catalyst

3 Portable Solution for Industrial Stack Emissions

by Vimal Chavda, Testo India Pvt Ltd.
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Air quality monitoring is carried out to assess the extent of pollution, ensure compliance with national legislation and evaluate control options. For this, various Air Pollution Control and Monitoring Technologies with different methods of measurement are available in the market. But most of the industries find it difficult to make decisions in choosing the most suitable technologies for the Pollution Control systems, especially due to absence of comparative assessments, design deficiency of equipment or system or both, expert's opinion and lack of knowledge on best technology. To bridge this gap between technology and design, Testo offers two unique instruments testo 340 & testo 350 with high performance and accuracy for Air Pollution Monitoring.

Testo India Pvt. Ltd., a 100% subsidiary of Testo AG, a world leader in design, development and manufacturing of portable test and measuring instruments. Backed by more than 55 years of measurement engineering experience, our mission is to provide the best quality, service and value in the industry. In addition, Testo is recognized as the leading worldwide manufacturer of portable combustion efficiency analyzers. Testo has also become a major supplier for HVAC industries, refrigeration, airflow and environmental monitoring instruments for markets as diverse as chemical, food and beverages, pharmaceutical and biotech. Testo is committed to provide prompt and efficient service, and for this purpose, there is a service and calibration laboratory set up at its headquarters in Pune.

The New testo 340 Emission Analyser is a single solution for a range of applications. From burner tuning, to optimizing combustion process in boilers and furnaces, from diesel engine exhaust analysis, to NOx monitoring in gas turbines, from flue gas analysis in incinerators, to measuring emissions in gas engines, you name it and the testo 340 can handle it.

It's a powerful instrument, yet surprisingly comes in a relatively smaller footprint. It is equipped with a maximum of 4 gas sensors, and one can select gases based on one's needs, and applications. You can choose from O2, CO, NO, NO2, SO2, NO low and CO low.

A wide range of modular probes can be fitted, with varying lengths of 335 to 700 mm. one can also use the heavy duty industrial probe, where lengths of up to 3 meters are possible. These probes are made of different materials depending on the stack temperatures. Inconel is used for temperatures upto 1200 deg C, and Aluminium Oxide is used for temperatures upto 1800 deg C.

For sample extraction, a heavy duty pump provides a constant flow within a stack gas pressure ranging from -200 to +50 mbar. In case of gas concentration going over range, a built in dilution will extend the range of all sensors by 5 times. A built-in condensate trap prevents moisture from

entering the sensors, and the instrument warns if the condensate trap is full, and needs to be emptied.

Parameters like efficiency, air ratio, flue gas loss are calculated and displayed. The analyser comes with a powerful internal diagnostic feature. One can know the sensor status, last calibration done, pump flow, battery level and life, serial no, instrument version etc, at a press of a button. A user friendly "easy emission" software helps with the analysis, and for generation of reports, in graphical and tabulated formats.

For NOx measurement either real NOx can be measured using 2 sensors for NO & NOx , or NO2 can be calculated from NO, and then NOx is derived. It has a comprehensive memory, where 200 logs can be stored per site, and 10 such sites per folder, while a total of 100 folders can be stored.

Upto a maximum of 10 user defined fuels, including test gas as a fuel, are preset in the instrument. The long life battery lasts between 3 to 4 years, depending on usage. While the analyzer carries a warranty of 2 years, the O2 sensor has a 1.5 year warranty, and all other toxic sensors carry a 1 year warranty.

Flue Gas Analyser - testo 350, carefully designed and crafted, keeping in mind the needs of the user, this unique instrument is matchless in performance, and engineered to perfection.

With the testo 350, up to 6 gases can be analyzed at the same time - the user can choose between the following sensors: O2, CO, CO2, NO, NO2, SO2, HC, H2S. The sensors are easily replaceable by the user in the field, within minutes, with not even using any tools.

The feature packed analyzer also calculates the standard parameters like flue gas loss, excess air ratio, boiler efficiency. By connecting additional probes, the unit measures velocity, differential pressure, and temperature. With its easy on-site calibration program, which can be also done from the user, there is simply no downtime. Testo 350 is the ideal solution for Flue Gas Analysis.

The testo 350 can be equipped with a wide range of sampling probes. Special hoses of up to 5 mtrs length are also available for most accurate NO2/SO2 measurements.

The analyser has a built-in peltier cooled gas preparation unit, with a peristaltic hose pump for automatic condensate removal, for avoiding any kind of condensation and for highly accurate measuring results. Higher concentrations are no problem due to an optional dillution system, which provides a measurement range extension for all sensors.

Testo 350 is a truly multifunction instrument in every sense, and offers lots of versatility. It can store upto 250,000 measurements for longer-term measuring programs, has facility for RS 232, and testo data bus connection, comes with a rechargeable NiMH battery pack. All these features are provided in a very compact size and a weight of just 5 Kgs. All with Testo's standard 2 years warranty.

The testo 350 Flue Gas Analyser is easy to use, accurate, reliable, and dependable. If precise measurement of flue gas parameters is indispensable in the combustion process, then there is only one indispensable solution - the TESTO 350.

4 Catalytic Technologies for Treatment of Industrial Exhaust Gases

by M.M.Khokhani, P. Srinivas, R.M. Cursetji, T.A.Siddiquie
SudChemie India Ltd; baroda@sud-chemie-india.com

India is admittedly one of the fastest growing economies in the world. With a population of over 1.2 billion it carries one fifth of the inhabitants of the globe. While this generates a healthy demand for all industrial products, there is a mounting concern on the effects of unsustainable developments that can take a major toll on the eco system and human health. A recent study at Yale University placed India amongst the last five countries (only above Pakistan, China, Nepal and Bangladesh) in terms of Ambient Air Quality, out of a total of 178 countries assessed. Delhi achieved the dubious distinction of being named the most polluted city in the world.

Air Pollution was not news until the Great London Fog of 1952 which killed 4000 people within 5 days of foggy weather and resulted in 8000 more deaths in the months that followed. Smog is the result of a dangerous mix of oxides of nitrogen and volatile organic compounds, which in the presence of sunlight produces highly toxic secondary pollutants ozone and Peroxy Acetyl Nitrate (PAN) that are harmful to both human health and environment.

The understanding of the chemistry of how pollutants affect both humans and other living organisms is still not fully understood, but technology for monitoring and controlling emissions has evolved into an important business sector that can deliver significant benefits to society. Over the last fifty years, driven by legislated norms, the emissions from manmade sources have been reduced to a great extent, but the problem is far from resolved. In addition to the dangers to human health, the air borne pollutants pose a serious threat to the eco system, reduce the earth's ozone shield and contribute to global climate change.

Figure 1: Common Pollutants and their harmful effects

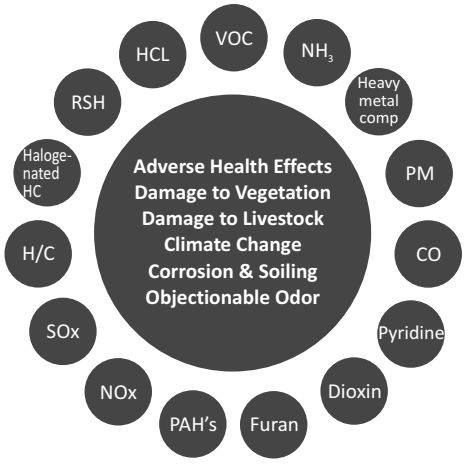


Figure 1 presents a summary picture of the major man made pollutants and its adverse effects. It is often thought that pollution control is an "end-off-the-pipe" clean up that does not contribute to the financial bottom line. Nothing could be further from the truth. It has been reliably estimated that a 10% increase in the life span of individuals leads to ~ 0.4% increase in the GDP of a country. The primary responsibility for controlling pollution falls on the Government to introduce policies and legislate emission norms to protect human life and the environment.

The current emission regulations for the various major pollutants are presented industry wise in following Table 1.

Industries	SOx	NOx	PM	CO	VOC/TOC	NH_3	T. Dioxins & Furan
	mg / Nm^3						ng TEQ/Nm3
Pesticides	200		20-50	100	20	30	0.1-0.2
Pharma-Incinerator (Bulk Drugs)	200		50	100	20		0.1
Dyes & Dyes Intermediate	200		50	100	20	30	0.1
Waste Incinerators	200	400	50	50 - 100	20		0.1
Petro-chemicals	50 – 1700	250 – 450	10 – 100	100 – 200	0.1 - 150		

Sud Chemie India is a joint venture company and part of the Clariant Group. The first plant of the company was set up in 1969 at Cochin and its operations were extended by setting up the second plant at Baroda in 1975. During the last five decades it has pioneered the development and manufacture of a wide range of catalysts for the fertilizer, refinery petrochemical and specialty chemicals industry.Our catalysts contribute significantly to value creation in our customers' operations, ensuring that finite raw materials and energy are used efficiently in the production of industrial chemicals, plastics, and fuels. Our products enable the use of alternative raw materials - such as natural gas, coal and biomass - as chemical and energy feedstock, and are used to clean emissions from industrial processes and combustion engines to limit the impact on the environment.

The Air Purification Industry Group has been a leading supplier of catalysts for emission control since 1982.It offers solutions for control of emissions through a globallycoordinated network of competencies in R&D, production and technical services.

For the treatment of Industrial Exhaust Gas, Sud Chemie offers the following range of catalytic solutions under the EnviCat trade mark.

EnviCat® VOC

Most VOC emissions are from man made sources. It has been esimated that 235 million tons of VOC's are released per year from anthropogenic sources (Guenther 1995) the most widely adopted abatement system for VOC destruction is total oxidation to CO2 and water. Amongst the options, catalytic incineration has several advantages over that of thermal incineration.

Advantages of Catalytic Oxidation

- Lower operating temperature ~ Lower Energy ~ REDUCED COSTS
- High destruction efficiency (>99%)
- Low secondary pollutants,
- Less severe MOC, hence lower equipment costs
- High selectivity
- Ease of Operation
- Less Space Requirement

The lower energy requirement for destruction of some of the VOC's is reflected in the following Table 2.

Temperatures (^{o}C) for 99% Destruction Efficiency

VOC	Catalytic	Thermal
Alcohols	~250	~690
Aldehyde	~300	~775
Ester	~325	~750
Aromatics	~250	~845
Alkanes	~425	~750

EnviCat®NOx series

This range of catalysts have been developed for control of pollutants like NOx,NH3 and N2O.

The EnviCat SCR is for the selective catalytic reduction of NOx with NH3. Three different well proven formulations have been commercialized to cover the application specific requirements of temperature and sulfur resistance for both mobile and stationery applications.

- **EnviCat NOx Blue--** best at low temp but susceptible to sulfur poisoning.
- **EnviCat NOx Yellow --** best at intermediate temp and resistant to sulfur poisoning.

- **EnviCat NOx Red --** best at higher temperature and resistant to sulfur poisoning.

The **EnviCat SCO** is a base metal selective oxidation catalyst for destruction of NH3 with following performance benefits:

- ❖ Signifiacnt advantage in costs compared to noble metal catalysts
- ❖ High selective conversion of NH3 to N2 conversion with low N2O formation

The typical Industry wise, application areas listed in following Table 3.

Application Examples	Typical pollutants
Basic chemicals	**VOC, CO**
► Formaldehyde	
► Acetaldehyde	
Polymers & Plastics (Petrochemical Industry)	**VOC, CO, NO_X, N_2O**
► Styrene	
► Phenol	
► Terephthalic Acid (PTA)	
► Phthalic/Maleic Anhydride (PA/MA)	
► Acrylonitrile (AN)	
► Methyl Methacrylate (MMA)	
► Acrylic Acid (AA)	
► Caprolactam	
► Adipic Acid	
Fertilizer Production	**CO, NO_X, N_2O, NH_3**
► Nitric Acid	
Food Industry	**VOC, CO**
► Food-grade CO_2 (purification)	
► Exhaust gas: restaurants, char-broiling, coffee roasting (odour decomposition)	
Refining Industry:	**CO, NO_X**
► Hydrogen (H_2) Plants	
► Fluid Catalytic Cracking (FCC) Plants	
► Gas-to-liquid, Biomass-to-liquid, Coal-to-liquid (GTL/BTL/CTL)	
Other industries and appliances:	**VOC, CO**
► Printing, packaging, coating and laminating	
► Pharmaceutical industries	
► Paint booths	
► Wood processing, panelboard, furniture manufacturing – Formaldehyde, Methanol	
► Metal decorating, coil coating, wire enamelling	
► Wood stoves and gas heating appliances	
► Kitchen oven (smoke eliminators)	

The EnviCat® range of catalysts for several of the above applications have been successfully commercialized and illustrative case studies are provided in the presentation.

In addition to the above suite of EnviCat catalysts, Sud Chemie also offers to custom develop tailor-made catalyst formulations to suit individual client requirements. Sud Chemie has established a state-of-the-art research laboratory attached to the manufacturing plant at Vadodara manned by experienced scientists and engineers and is well equipped to develop, scale up and commercialize catalysts for protection of the environment.

5 HORIBA Solution for Continuous Particulate Matter Elemental Analysis

by Team of HORIBA Japan & HORIBA India
samir.buwa@horiba.com

Recently, the Asian countries face environmental pollution with economic growth. Especially air pollution such as PM2.5 is recognized as transnational common issues and Asian countries are dealing with the air pollution problem through intergovernmental cooperation. We describe the features of PX-375 - the possibility of continuous PM elemental analyzer - as key to the PM2.5 air pollution.

INTRODUCTION

While the concentration of major air pollutants such as carbon monoxide (CO) and sulfur dioxide (SO2) in the air has decreased, the concentration of photochemical oxidants is on a slight increasing trend. Also, with regard to the fine Particulate Matter (called "PM2.5" below) described in the 2009 environmental standards in Japan, an environmental monitoring network is being prepared. However, in FY2012 , 43.3% of the environmental standard was achieved at air pollution monitoring stations, and 33.3% of the standard was achieved at motor vehicle exhaust monitoring stations , and effective countermeasures are being required. Atmospheric environmental problems are one of the major issues in building a recycling-oriented society that can continuously grow and must be solved on a global scale, not just in Japan. Measuring the air is different from measuring gases emitted from fixed sources such as garbage incineration or power generation--the concentration of the substance to be measured that diffuses into the air is generally low. For that reason, high-sensitivity, stable measurements are required for measuring components in the air. This paper will introduce the features of the newly developed PM2.5 automatic component analyzer (PX-375) which enables automatic sampling, continuous online PM quantitative and qualitative analysis and rapid air pollution source apportionment, and will also introduce the HORIBA Group's measurement technologies used in the air quality monitoring fields.

TECHNOLOGY

1. Continuous PM & Elements Analysis with Single Compact Unit

- Continuous hourly measurement for PM (TSP, PM10 or PM2.5) & the Element.
- Extremely compact design. Easy installation. For Ambient, Indoor Air Quality, Stationary source etc.
- Power distribution functions from the main unit for necessary tool (PC, Heater, Pump etc)

2. **Advanced Analysis with the Reliable Methods & Functions**

- World proven technology (X-ray fluorescence & Beta-ray attenuation)
- Possibility to observe collected sample of PM by installed in PX-375 CMOS camera
- Running cost cut down by not using vacuum pump and liquid nitrogen, usually used in X-ray fluorescence detector.
- Possibility to make calibration curve by using the existing laboratory instruments such as ICP.

3. **Low Concentration & High Sensitivity Measurement Realized by New-Developed Filter Tape**

- 2 layer, PTFE & non-woven fabric, filter construction prevents passing of PM on the reverse side, while roll the filter tape.
- Chemical background of the filter is extremely low. Therefore filter with collected sample could be used for chemical analysis by other scientific analytical instruments in laboratory.

4. **User Friendly Display & Operation**

- Visible trend graph display help to check the relations between PM and the elements trend
- Easy operation and data management by data logging PC with original software
- Remote operation will help to check the status without going site

CONCLUSION

By incorporating a fluorescent X-ray analysis device that can measure the inorganic elements in PM2.5 into continuous PM mass concentration monitor, we have developed PX-375 that ca n measure bot h the mass concentration and inorganic elements in PM2.5 using one unit. As such, although there was not much contribution to mass concentration, inorganic elements are extremely important as index components of the source. Because it is now possible to measure things like sulfur dioxide and nitrogen oxide in the same one-hour value, we expect that source analysis using the Chemical Mass Balance (CMB) method and Positive Matrix Factorization (PMF) method will play a part in analyzing particle sources.

Currently, air pollution problems such as PM2.5 are wide- ranging problems that go beyond national borders, and Asian nations recognize these as common issues. To create effective countermeasures against PM2.5, it is becoming important to do detailed analysis, not just of mass concentration. HORIBA is developing an analyzer and measuring device for the automotive, environmental, scientific, semiconductor, medical, and other fields. We intend to work toward the conservation of the global environment and the development of the industry by successfully combining these analysis technologies to provide opportunities to solve these problems.

6 How to Technically Evaluate a Cloud Based Environment Monitoring Platform for Effluent, Emission, Air Quality and River Monitoring

by Mayank Chauhan, LogicLadder Technologies
mchauhan@logicladder.com

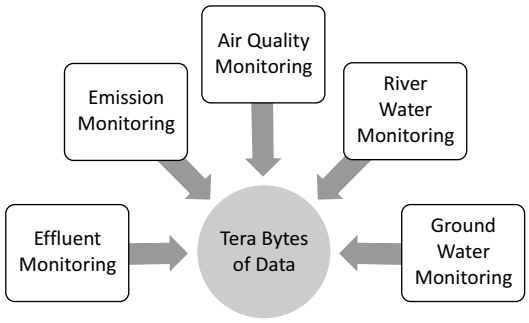
Why Online Environment Monitoring?

Objective

Environmental monitoring is one of the most vital roles involved in environmental responsibility and sustainability. Sound nice, but what does environment monitoring achieve?

Environmental Monitors has the capacity to mitigate negative environmental impacts associated with industrial activities. This plays a vital role in measuring, recording, communicating and archiving collected data and providing it to stakeholders in order to identify sustainable and responsible environmental practices. Environmental monitoring helps to ensure that the industrial projects being implemented abide by policies and practices to decrease their impact on the environment. Environmental monitoring helps to create a baseline for the impact of industrial pollutants in the air, land and water. By studying and submitting air, water and soil samples, scientists are able to determine the significant short and long-term impacts of industrial projects and the effect they may have on a given area.

Environmental Monitoring also helps to ensure accountability and transparency for industry. It helps to verify industry's compliance to environmental regulatory standards.



The challenges

Online environment monitoring initiative poses a lot of challenges:

1. There are numerous make of instrument suppliers each having their own proprietary protocol. Each equipment has different ways of extracting the data.
2. There are softwares provided by the equipment people. However most of the equipment companies are hardware manufacturing companies or suppliers with very little or no experience in running or maintaining an online environment platform.

3. Past experience shows that the software servers being operated by the equipment suppliers have very little data uptime

4. Maintaining servers from multiple equipment providers is a big challenge for the regulators, be it CPCB, SPCBs or the PCCs.

5. Interacting with multiple server providers becomes challenging.

6. Environment sensors can produce large amount of data.

Technology Solution for Environment Monitoring

IoT for Data Acquisition (Telemetry)

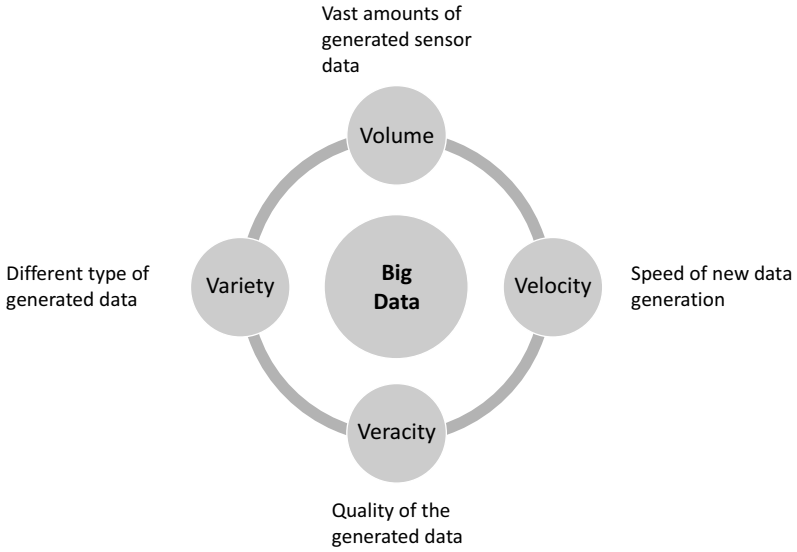
1. Data is acquired over public IP networks like GPRS, broadband and satellite.

2. Well known and tested security for public network like TLS is used.

3. IoT protocols like MQTT are well tested and accepted worldwide for telemetry. This has proven benefits over restful web services or file transfers.

Why does Environment need Big Data?

There is huge amount of data that is generated from environment sensors. The volume of this data becomes humongous over time. The Big Data allows for handling the volume, velocity, variety and veracity of the data.



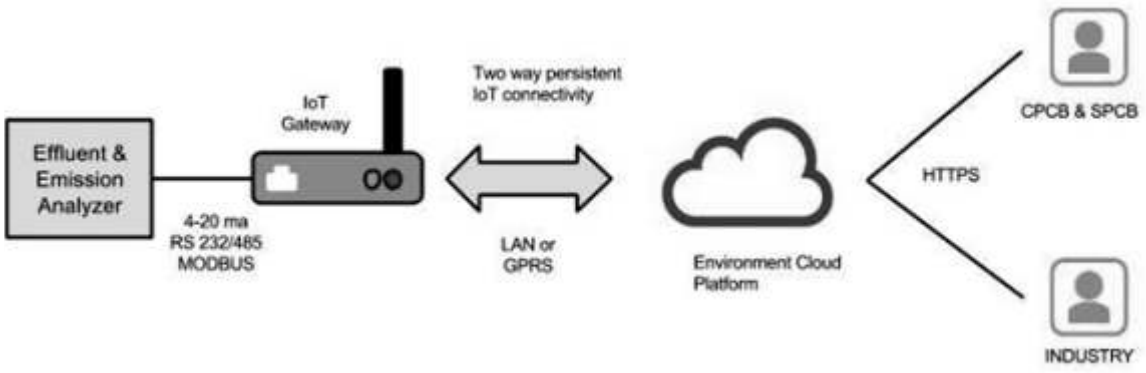
A case study : EnviroLogicIQ : Online Remote Environment Monitoring Platform

EnviroLogicIQ is a revolutionary software for clear insight into your environment data, so that you can be empowered to work for a cleaner environment.

What does EnviroLogicIQ do?

EnviroLogicIQ establishes a real time online monitoring system based on latest M2M (Machine to Machine) or Internet of Things (IoT) technologies for monitoring the Effluent, Emission and Ambient air parameters from the various industries. It acquires accurate real time data from any make or model of Analyzer using open communication protocols so that a level playing field can be provided to all analyzer manufacturers. Most importantly, it provides a solution that is secure and tamperproof. It allows direct secure connectivity between analyzer and central cloud server without an intermediary PC. It detects exceedance of monitored parameters for the statutory standards and provide real time alerts over email and sms. It provide a unified web based access controlled platform accessible from SPCB headquarters, all Zonal offices, District PCBs and Industry sited in the state based on the provided authorization level.

Physical Architecture



What aspects of a cloud platform for remote monitoring should organisations look

1. **Analyzer Agnostic -** The most fundamental requirement is establishing an architecture that is open to support any make and model of analyzer. Industry should be able to choose any analyser make and model that is approved internationally or by CPCB for monitoring the ambient and emission parameters. The system should also support retrofitting of analyzers already installed in Industry so that the existing investment in the equipment by the industry can be utilised.

2. **Secure and tamperproof -** The highest chance of tampering can be at the client side, so the system is based on IoT architecture, where the IoT client would be running on an IoT embedded gateway. Embedded systems are less prone to tampering than PC uploading a file using a Restful API. The data flow from Analyzer to the server should be secured through TLS.

3. **Scalability -** The system should be based on highly scalable Service Oriented Architecture to support thousands of analyzers and hundreds of IP cameras on the cloud.

4. **Interoperable -** The Central Software should expose authenticated Representational State Transfer (REST) based Application Programmer Interface (API) for integration with other applications like regulators website.

5. **Big Data Support -** Should have highly scalable backend database capable of storing time-series data acquired from Industry for a period of 10 years with minimum of 1 minute interval. The database should be capable of storing more than 100 Terabyte of time series data and 100 terabytes of camera video.

6. **Real Time Two Way Persistence Connectivity -** The connectivity between the Analyzer client and the Central Server should be two way and persistent. It should be based on IoT or M2M based push connectivity so that fixed IP are not required at the Analyzer end.

7. **Device Management -** The Central Server should show online or offline status of an Analyzer station. It should allow rebooting and troubleshooting of the remote client via the web interface to resolve client issues remotely.

8. **Analyzer Diagnostics -** Platform should be capable of showing raw values captured by the device which can be used in diagnostics. It should show registers in green, amber and red color depending on the values recorded by the device.

9. **Network Management -** The Central Server should be able to show Network status and quality. Most remote monitoring applications suffer due to poor network quality, this feature can help identify these Industry locations and such Industries can be requested to rectify the situation.

10. **Reporting & Dashboard -** The platform should provide ability to generate reports and view data on dashboards via a Web Application. It should also be possible to email reports from the system. Able to generate wind rose and pollution rose based on wind data collected from the various sites.

11. **Alerts & Alarms -** The Central Software should generate automated alerts on exceeding parameter threshold exceedance, data connectivity failure, analyzer failure etc. These alarms should be sent over email and sms using pre-configured message templates.

12. **User Management and Access Control -** For both the regulators, industry and the OEMs should be allowed for easy accessibility.

Compliance to Statutory Guidelines : Most Important Features

Among the multiple features provided by cloud platforms, the following two are the most important from a statutory perspective:

Analyzer Device Diagnostics & Configuration

1. Diagnostic parameters of the Analyzer station is important information. Example for spectrometer based effluent monitoring system these are parameters like Lamp Failure, Lamp Low, System Fault etc.
2. Support for the analyzer configurations and settings. Example for spectrometer based effluent monitoring system these are parameters like Path length, Flow Cell Steps etc.

Change Request (CR) Workflow

1. The Software should support corroboration between the Industry and regulator by providing an inbuilt feature for data validation and change request.
2. The Industry should be able to select a particular time range and request correction with proper comments or reason for request. It should be possible for the SPCB to approve the request. The request should follow proper workflow setup by CPCB for data correction.
3. The Industry should provide ability to annotate the data with specific events/comments provided by the Industry such as maintenance, breakdowns, analyser fault etc.
4. Industry should be able to inform the regulator of different maintenance events (analyzer maintenance, analyzer breakdown, plant shutdown etc.) using workflow feature of the Web Application.
5. The Web Application should provide the history of communication between the Industry and the regulator for specific events or workflows.

IoT Device (Client) Management

1. It should be possible to provision a device or client and generate its authentication tokens and id on the software platform using the Web Application. It should be possible for the OEM to regenerate the authentication token for a client.
2. Should display network parameters of the IoT Client. These are parameters like online status, network status, IP address etc.

On the edge : IoT Client Requirements

Embedded & Tamper Proof

To prevent tampering the client should be embedded into the Analyser processor or an external IoT gateway processor. The client should be able to identify the device, OS, modem details (like imei, mac id, ip), firmware version etc. so that it can be identified when it is being run on a PC to generate fake data.

Network Time Synchronization

The accuracy of timestamps is very important for real time monitoring. The client should have feature to synchronize its time from internet (using NTP) or GPRS network.

Data Logging

In absence of connectivity, capability to log data on the flash memory of the Analyzer or the IoT gateway in round robin fashion. It should automatically resend the data once connectivity is restored.

Two Way Communication Protocol

The client software should support the following IoT open communication protocols:

IoT Client Device to Analyzer (In case external IoT gateway device is provided by the Analyzer OEM)	• RS 232/485 Modbus • 4-20 ma Analog
IoT Client to Central Software	Open two way communication IoT protocol like MQTT, CoAP, XMPP etc.

It should be possible to push commands in realtime to the Analyzer like calibration commands.

Security

The client should use TLS 1.0 data encryption for transport layer security using secure IoT protocols. The client should authenticate using a client id and authentication token or client certificate produced by the OEM on the platform and embedded in his analyzer or external IoT client device.

Network Agnostic and Redundancy

The client should support any network like GPRS, LAN, Broadband etc. The client should be able to switch between networks to use any one of the available networks. As per CPCB guidelines the Analyzer client should be provided with two means of communication.

Message Acknowledgement

The client should retry transmitting data until it receives an acknowledgement for the message. The client should send an acknowledgement to the server on receiving and processing a message from the server.

Remote Firmware and IoT Client Upgrade

It should be possible to upgrade IoT Client remotely via the Web Application remotely. This will be used to update clients across Industry by OEM in case of security or software updates.

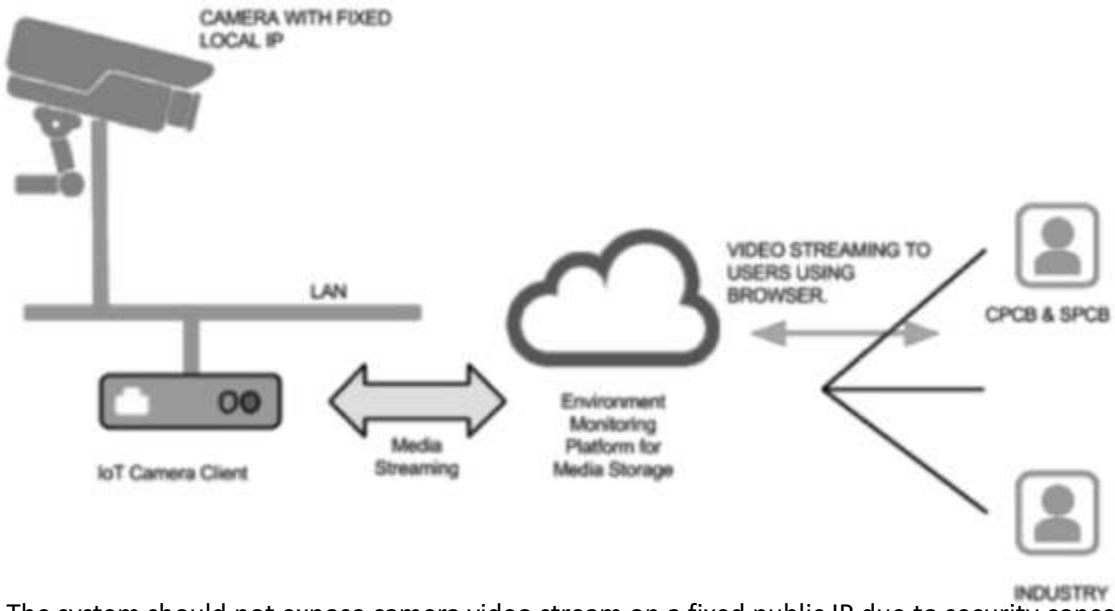
Remote Management & Diagnostics

It should be possible to restart the client remotely, view network statistics and other details of the client for troubleshooting and to detect tampering.

Support for Video Streaming

CPCB guidelines require video streaming from IP cameras for Zero Liquid Discharge (ZLD) Industries. Industries would install an IP camera as per CPCB requirement. Video stream from these IP cameras would be captured by an IoT client and pushed to the Central Server.

Video Transfer (Camera)



The system should not expose camera video stream on a fixed public IP due to security concerns. The camera should be able connect to the Central Server through the IoT camera client. The system should not require exposing of camera on a fixed public IP due to security concerns. Video storage for minimum seven days on a rolling basis is important to have to ensure checking historical records.

Conclusion

Choosing the right environment cloud platform is very essential to ensure the success of any environment monitoring program. The major points to consider are:

- Device agnostic architecture
- Ability for 2 way communication
- Both data and video support
- Scalability of the system to thousands of devices

7 On-line Emission Monitoring & Combustion Optimization

by Mr. Pravin Chavan, Forbes Marshall Pvt. Ltd.
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The aspiration for rapid economic growth is leading to rapid industrialization in India. Emissions of greenhouse gases and other pollutants are increasing with the increase in industrialization.

Air pollution is one of the primary causes of disease, health issues and long term livelihood impact for all living beings, it has become necessity for us to drastically reduce the air pollution. By optimising the combustion efficiency we can reduce the emission of greenhouse gases.

We at Forbes Marshall realized our social and ecological responsibility and with every new development, we emphasize our regards for the environment and the people who are part of it. Collaborating our efforts towards a clean, safe environment, we thought of clarifying the need of online monitoring of flue gases for improving combustion efficiency as well as for stack emission monitoring and bringing the monitoring product technology matrix.

On line SO_2, NOx monitors are used to meet environmental norms whereas CO and O_2 monitoring helps industries to maintain the air to fuel ratio, thus controlling the fuel consumption. CO is highly corrosive & explosive gas. Plant running under reducing atmospheric condition produces higher CO gas emission, which is very dangerous situation. Hence to protect the ESP from explosion, online monitoring and maintaining CO to zero level is the necessity to the plant. It also helps to minimize the corrosion caused by presence of higher CO concentration & thus increases the lifetime of the combustion area.

Online monitoring of Oxygen and CO gas for combustion control

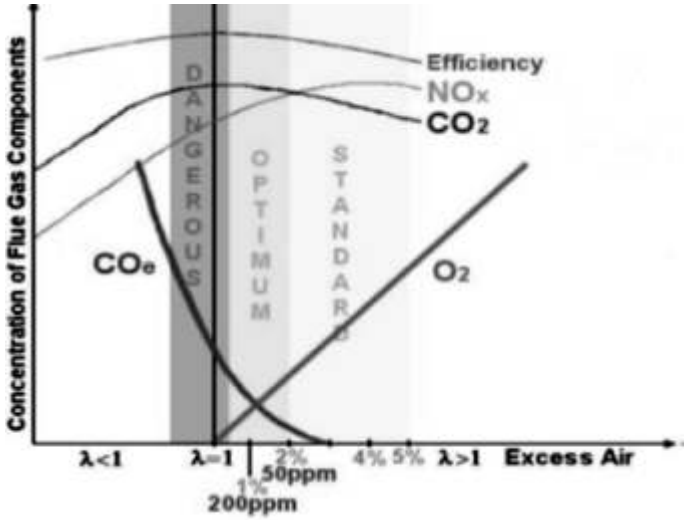
Perfect Combustion process is:

$$\text{Coal (C)} + O_2\,\text{(Air)}\ \text{Heat} + CO_2$$

Combustion is the act or process of burning. For combustion to occur, fuel, oxygen (air), and heat must be present together. The combustion process is started by heating the fuel above its ignition temperature in the presence of oxygen. Under the influence of heat, the chemical bonds of the fuel are split. If complete combustion takes place, the elements carbon (C), hydrogen (H) and sulphur (S) react with the oxygen content of the air to form Carbon dioxide (CO_2), water vapour (H_2O) and Sulphur dioxide (SO_2) and little amount of sulphur trioxide (SO_3). If enough oxygen is not present or the fuel / air mixture is insufficient then the burning gases are partially cooled below the ignition temperature, and the combustion process remains incomplete. The flue gases then still contain

unburnt components, mainly carbon monoxide CO, carbon C (soot) and various hydrocarbons CxHy. Since these components are, along with NOx, pollutants which harm our environmental, measures have to be taken to prevent the formation of them.

To ensure complete combustion, it is necessary to provide a certain amount of excess air. Combustion optimization is determined by a maximum percentage of complete combustion, along with a minimum of excess air (commonly 5 to 20% above the necessary level for ideal combustion). For perfect combustion, CO_2 emission should be maximum and O_2 should be close to or, zero in the flue gas. Since perfect combustion is not practically possible due to incomplete mixing of the fuel and air, most combustion equipment is set up to have a small percentage of excess oxygen present. The lower the temperature for a given O_2 or CO_2 value the higher is the combustion efficiency. This is because less heat is carried up the stack by the combustion gases.



Hence, excess air will have heat loss whereas plant running under reducing atmosphere i.e less air will have fuel lost. The ideal location for monitoring Oxygen and CO is on pre-heater outlet duct. At APH duct, flue gas temperature is around 350°C, dust content is 40-50 gm/m3 and gas velocity at 15-20m/s. For such hot, dirty and aggressive flue gas location, it is always recommended to use Insitu probe type Oxygen and CO gas analyser which work's 365 days a year, fast in response, highly accurate, demands negligible maintenance and are far better than any extractive gas analysers.

Benefits of monitoring Oxygen & CO:

- Energy saving due to increased combustion efficiency, which saves 3 to 4 % of fuel costs
- NOx reduction, because the thermal oxidising of nitrogen is lower.
- Total CO2 emission will be reduced, because less fuel is burned.

- Lifetime of the combustion area / heat exchanger walls is increased and therefore CO corrosion is at a minimum.
- Prevention against explosion risk - caused by unburned inside the ESP.

Stack Gas Emission Monitoring

During the combustion process, Nitrogen in air (used for burning coal, typically used fuel) oxidizes with oxygen and forms oxides of nitrogen i.e NOx. Sulphur in coal after oxidation forms SO_2. Similarly coal after burning becomes ash i.e dust. CO, SO_2, NOx gases are highly toxic and are harmful to the environment.

Hence our environmental authority has mandated industries to install emission monitoring devices and provide online real time emission data transmission to the central servers installed at Central Pollution Control board and at respective state pollution control board offices.

Pollution control board wants emission data transmission from each stack and its availability for more than 95% of the plant running time. Also software/hardware offered for CPCB/SPCB connectivity should compliance to following:

- Submission of the data exactly as generated at the monitoring station to regulatory authorities like CPCB, SPCBs
- Ensure continuous data submission without delay, delayed data should come with flag
- No human intervention should be there in the system
- Diagnostics data transmission
- Remote calibration mechanism
- Real time alarm transmission via Email, SMS

It is imperative for the industries to have long term solution which is maintenance free. To fulfil this requirement, many Industries prefers In-situ technology non sampling type field mounted emission monitoring devices rather continuing with the old maintenance prone hot extractive sampling type emission monitors.

To continuously monitor the stack gas emission, earlier the only available technique was extractive gas analyser. Later in the 90's up gradation in design and construction of direct on stack mounted analyser (i.e. Insitu analyser) became popular and resulted in the demand for this technology in the market for continuous emission monitoring. Hence, now days all major consultants, end-users actively state: "In-situ Gas analyser which avoids the need for sampling systems may, where available, be the best available technique"



In-situ gas analyser System requirement:

- In-situ SS probe
- Probe mounted transceiver unit for the ordered gases
- Only 24 V DC, 400 watt Power supply
- Local/remote mounted digital display & control unit
- Plant instrument air for zero calibration & reference air purging

Technological benefits of In-situ gas analyser

- Very rugged and reliable, works 365 days a year
- Field mounted (No AC room / shelter required)
- Measure gases like CO, SO_2, NOx together.
- Measures in ppm, mg/m^3, mg/Nm^3 with an accuracy of 2%
- Works on IR gas filter co-relation technique , no moisture interference
- Works on Gas diffusion technique, hence no filter choking
- No sampling/conditioning of gases
- Built in measurement of CO_2, H_2O, Temperature & Pressure for online normalization.
- On line calibration using audit gases.
- Bulk Measurement - no straight run required
- Negligible maintenance - No need of AMC
- Low power consumption (only 400 watt)

System limitation:

- Not suitable for flue gas temperature above 500 °C application.

"The in-situ gas analyser is perhaps the best thing a user can have. One doesn't have to worry about analyser room, heat tracing of sample lines, conditioning of sample, condensation of sample, clogging of sample lines & so on, which are typical problems of an extractive system. In-situ analysers are practically 'Fit-and-Forget' type analysers. The maintenance cost works to around 3% of an extractive system".

8 The Selection of Dust Monitoring Techniques for Industrial Applications (A Practical Guide)

by Steve Werrell, PCME Ltd
stevew@pcme.co.uk

The installation and operation of continuous particulate emission monitors in industrial processes has become well developed in European and North American markets and is also becoming common practice in the developing nations. The use of particulate monitors in industrial stacks and ducts over the past 30 years reflects the growth in both national and international legislation and the desire of many industrial companies to increase their green credentials.

This guide provides an overview of the types of continuous monitors currently available, the technology and Quality Assurance (QA) features available in the more sophisticated types of instruments together with installation considerations, instrument maintenance requirements and types of calibration/configuration procedures.

Types of Continuous Monitoring of Particulate

Regulators around the world tend to specify one or more of four different types of continuous particulate monitoring instrument depending on the purpose of the monitoring and the relevance of any legislative directives. This has implications on the type of instrument that can be selected and the type of calibration procedure that is applied to the instrument.

Types of Particulate Instrument

There are generally four types of particulate instrument used to satisfy regulatory requirements.

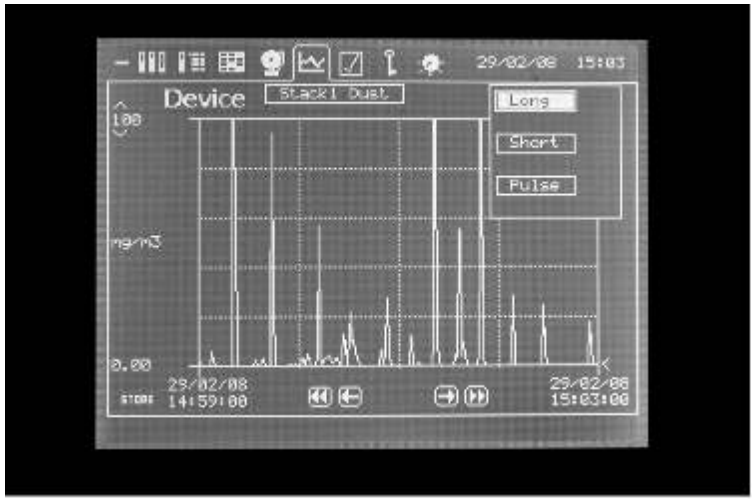
1) QAL1 approved CEM

A Continuous Emission Monitor (CEM) which has been independently certified to meet the European Standard EN 15267-3 (which is adopted in the MCERTS Class 1 performance standard) may carry the certificate as QAL1 approved. This instrument may be used to continuously measure mg/m3 according to the uncertainties expressed in the European Waste Incineration Directive and the Large Combustion Plant directive as well as used in other applications as specified by regulators on a case by case basis.

2) Quantitative monitor

A particulate CEM which may be used to monitor mg/m^3 continuously is referred to as a quantitative monitor. In many countries it is common that this instrument is also certified. A specific approval relevant to this type of instrument is MCERTS Class 2 which allow slightly higher uncertainty

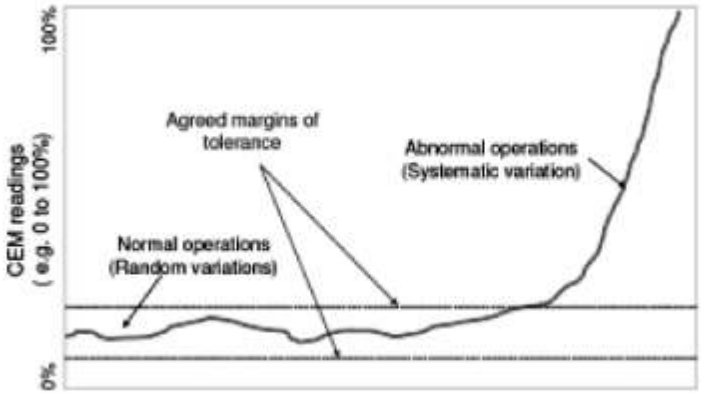
compared to a Class 1 instrument and less sophisticated on going Quality Assurance (QA) features built into the instrument.



Emissions Data from Quantitative Monitor

3) Filter leak monitor

A filter leakage monitor monitors for changes in the operation of the dust filter plant (typically a bag filter).The plant operator is warned when there is any leakage and can fix the leak and hence bring the process in control. The trend of emissions and arrestment plant condition are obtained from an associated report. Importantly, there is confidence in data because there are self-checks on the instrument.



Using Control Charts for Filter Leak Monitoring

4) Gross Filter failure detector

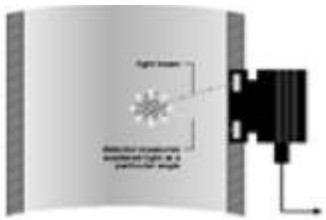
A simple instrument provides an alarm when there is a very significant change in emissions associated with filter rupture. These instruments tend to be used only on smaller filters since they provide no information to improve the plant performance and have no trend output or Quality Assurance (QA) features to provide confidence they are working correctly.

Technology and Design of Instruments

Particulate CEMS measure a parameter (eg scattered light) which can be correlated to dust concentration by comparison to a gravimetric sample taken under iso-kinetic conditions (eg EN 13284-1) rather than the mass concentration directly. The performance and suitability of any particulate monitor is therefore application dependent. A number of techniques are used in practice which between them provides a practical and robust solution for most industrial applications. The core techniques used for continuous for monitoring particulate are;



- **Light attenuation (Transmisiometry):** In which the amount of light absorbed by particles crossing a light beam is measured and correlated to dust concentration. In Opacity/Extinction instruments the amount of light reduction in measured directly whereas in Ratiometric Opacity the ratio of the amount of light variation (flicker) to the transmitted light is measured.



- **Light scattering:** in which the amount of light scattered (reflected) by the particles in a specific direction is measured. Forward, side and back scatter are a function of the angle of scattered light that is measured by the detector. Light scattering techniques (especially forward scatter) are capable of measuring dust concentrations several magnitudes smaller than that measured by light attenuation techniques.



- **Probe Electrification:** in which the electrical current produced by particles interacting with a grounded rod protruding across the stack/duct is measured and correlated to dust concentration. Charge induction (AC Tribolectric and ElectroDynamicTM) and dc Triboelectric instruments are types of probe electrification devices in which different signal and current analysis are performed.

One of the fundamental issues in obtaining good results from particulate instruments is to ensure that the instrument is fit for purpose for the intended application. This means that the instrument

1) Has a stable, reliable response which can be directly correlated to dust concentration with limited cross interference from likely changes in process or flue gas conditions. MCERTS certificates for certified products provide guidance on the application suitability of different instruments. Manufacturers should be contacted for more detailed guidance on the application suitability of a specific type of instrument.

2) Can operate long term in the application without the need for maintenance or cleaning. The Maintenance Interval as stated in the MCERTS certificate can provide guidance on servicing issues and longer duration tests and experience with an instrument also are very relevant

3) Sufficient resolution for the intended application. MCERTS certificates state the certification range in mg/m3 for the instrument which is the lowest dust range at which the instrument will still meet the MCERTS performance standards.

The table below shows the core application areas of the different technologies.

Guide to Application Suitability for Particulate Monitoring Technologies

Measurement Technology		Stack Diameter (m)	Concentration (mg/m³) Min	Max	Filter Type	Certification EU	Dry	Humid	Wet	Hazardous Zone Gas	Dust	Velocity Dependant
Probe Electrification	Charge Induction (AC)	0.2 - 4	0.1	1000	Bag, Cyclone, Drier, Scrubber (5) None (6)	QAL1 (7) TUV MCERTS	◊	◊	◊	◊ (7)	◊	No (8)
	Combination AC & DC	0.2-2	1	1000	Bag, Cyclone	TUV	◊	◊	◊	◊	◊	Yes
Transmisometry	Ratiometric Opacity	1 - 15	10 (3)	1000	Bag (1), Cyclone, EP, None	TUV, MCERTS	◊	◊	◊	◊	◊	No
	Opacity	2 - 10 (1)	30 (4)	1000	EP, None	QAL1 TUV MCERTS	◊	◊	◊	◊	◊	No
Scattered Light	Scattered Light (Forward)	1 - 4 (2)	<0.1	300 (10)	Bag, Cyclone, EP	QAL1 TUV MCERTS	◊	◊	◊ (9)	◊	◊	No
	Scattered Light (Back/Side)	1 - 4 (1) (2)	10	500 (10)	Bag (1), Cyclone, EP	QAL1 TUV MCERTS	◊	◊	◊	◊	◊	No

Notes:
(1) Concentration dependant
(2) Repeatable Flow dependant
(3) Application specific
(4) Stack diameter dependant
(5) No water droplets
(6) No filter - not advised
(7) Model specific
(8) Velocity range 8-20m/sec
(9) Using Wet Stack monitor
(10) Must have constant clean air purge supply 24/7

The above statements are meant as a guide only and all selections should be made in reconition of the actual application conditions
Extractive Light scatter and Beta systems are to be used in processes with flue gas below dew point (eg wet collectors)

Since instruments are typically used in aggressive stack environments which provide a challenge to an instruments operation and performance, regulators are becoming increasingly focused on ensuring that Quality Assurance (QA) checks are periodically done on instruments to ensure they are indeed operating correctly. Depending on the instrument selected these checks may be done automatically without the need for direct operator involvement. These QA checks are typically for:

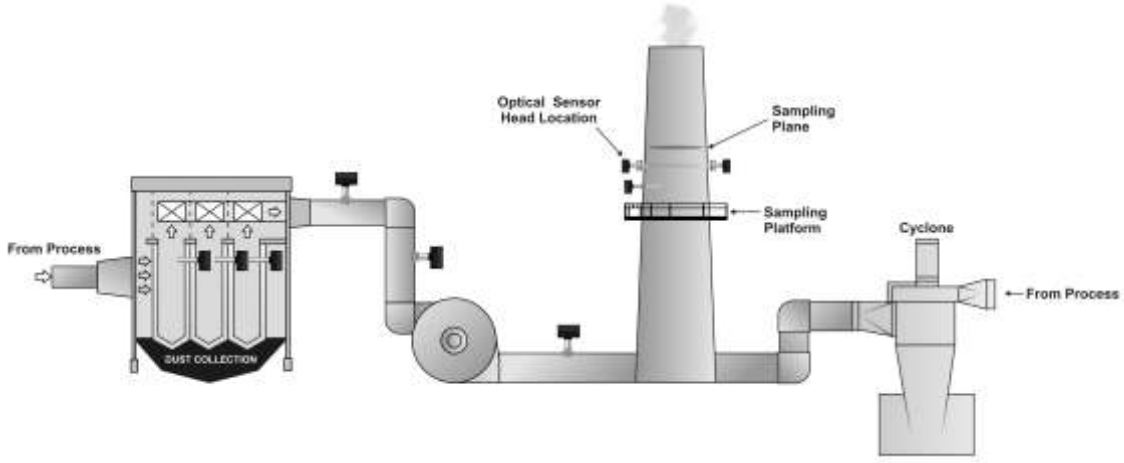
- Contamination and/or signal drift at a level equivalent to an elevated dust level (span)
- Instrument zero stability

These checks not only increase the confidence in emission results from instruments for the regulator and plant operator alike but also provide the plant operator confidence that emission levels and incidents are being monitored by a working instrument which is likely to reduce false alarms or incorrect analysis.

Instrument Installation

Particulate monitors should always be installed in a location where the measurement volume of the instrument is located in a position which is representative of the particulate in the stack. Since instruments which report in mg/m^3 are calibrated by reference to an isokinetic test and filter leak monitors must just respond to changes in dust, this location does not necessarily exclude locations

where the dust concentration is non homogenous across the stack, provided that when the dust concentration levels change in the duct the instrument's measurement volume is exposed to a proportionate increase in dust.



Positions to be considered for installation of Particulate Monitors

Both the instrument location and its measurement volume (length and position) should be considered together in a common sense way to ensure representative measurement. Any flue gas homogeneity results should be considered in relation to the specific needs of the particulate monitor (which are different to gas analysers due to different calibration approaches). It is Important to consider if any particle stratification is likely to occur (especially under arrestment plant failure conditions) and ensure that multiple instruments or instruments with longer measurement volumes are used in these cases. In practice the best location for the instrument's measurement volume of the instrument include:

- After the final ID fan where the particles are better mixed in the flue gas
- In areas of straights (4 diameters after bend or disruption and 2 diameters before bend or disruption)
- On the outside of bends (and not in the inside of bends) if plant geometry does not allow for alternative locations
- In the case of Intrusive instruments, not at the same location as the Isokinetic sampling location so as to avoid interference between the sample probes and instruments and visa versa
- In the cases where there is a small measurement volume (e.g. most light scatter instruments and extractive analysers) in a location of fully developed flow
- In the cases where there are multiple feeds to a stack in a position where the instrument will monitor the dust from all sources (i.e. where the flue gas is fully mixed or if this is not possible

with a sufficiently large instrument measurement volume, using multiple instruments if necessary)

Instrument Calibration/Configuration

Ahead of any calibration or instrument configuration it is fundamental measurement practice and increasingly a regulatory requirement that checks are done to ensure the instrument is operating correctly. This ensures the cost of the calibration is not wasted and the resulting results are valid. The tests performed to ensure an instrument is prepared for correlation testing against isokinetic sampling or configuration is referred to as

- A functionality test for mg/m^3 measurement and quantitative CEMs
- An instrument health check for filter leak monitors and Gross Filter failure detectors



Service Engineer carrying out Filter Leak Monitor health check

These checks form the fundamental first part of any calibration or configuration procedure:

The calibration procedure applied to the particulate monitor depends on the type of monitoring to be performed by the instrument.

1) If the instrument is to be used for quantitative or qualitative monitoring then the instrument response must be correlated to the results of multiple isokinetic gravimetric samples according to the standard national reference method (SRM)

   The number of samples taken and the quality of the results defines the type of calibration that is applied to the instrument.

- Typically 5 or 3 SRM samples are taken since dust levels from many plant using bagfilters are relatively constant and the SRM results form a calibration cluster
- In instances where dust levels are highly variable, up to 15 calibration points may be taken
- Even when instruments are to be set up in indicative mode (ie to report mg/m^3 as an approximate level), it is good practice to take 3 samples so that any random errors in sampling are exposed as outliers

2) If the instrument is to be used as a filter leak monitor then the instrument trend output range and alarm levels are configured once it has been established that the bagfilter is working according to specification. This is typically done by:

- an engineering inspection of the bagfilter to confirm that the bagfilter is operating correctly
- by checking the output from the leak instrument to ensure there are no dust peaks on bag cleaning which are out of the ordinary (i.e. different than those associated with other bag rows being cleaned).

This enables the base level of the instrument to be set correctly.



Bag filter after which a Filter Leak Monitor is installed

In both cases the zero of the instrument should be checked since the calibration line or filter leak response curve often uses the zero condition as a calibration point. Since it is often difficult to create zero dust conditions at the time of calibration this is often done by reviewing historical data when the plant is known to be off (nights or weekends) and/or creating a zero condition with a simulated reference material.

Instrument Maintenance

Particulate instruments are no different than any other type of electro-mechanical/optical equipment in that they require routine service, especially as they are exposed to the aggressive and dust contaminating conditions of flue gas. It is standard practice (through regulatory requirements and manufacturers' guidance) for an annual inspection of the instrument to be conducted and this may be more frequent depending on the complexity and operating principles of the instrument. Manufacturers of instruments are best consulted for guidance on preventative maintenance requirements to ensure reliable operation from an instrument in a specific application.

9 Critical Step Towards Healthy Environment - Emission and Immission Monitoring

by Mr Pankaj Rai, Chemtrols Industries Ltd.
pankaj.rai@chemtrols.com, chemtrols@chemtrols.com

Global warming and the emergence of the greenhouse effect make it necessary to act. Around the world, industries and regions that impact emissions are being prompted to reduce or, ideally, to prevent their generation of hazardous substances and environmental pollution. Here the focus is particularly on areas with intensive energy consumption and major urban industrial centers. They are all united by a common goal: to support effective climate protection and to preserve and restore a clean environment

In many countries there is a legislative basis for a sustainable, environmentally compatible reduction of greenhouse gas emissions as well as laws and regulations relating to the emission of pollutants. These regulations include specifications for technology and modes of operation for systems as well as specifications detailing the permissible pollutant limits. Moreover, provisions are being established that allow measurement technology to be used for monitoring.



EMISSION MONITORING SYSTEM

Emission monitoring system is the total equipment necessary for the determination of a gas or particulate matter concentration or emission rate using pollutant analyser meaurements and a conversion equation, graph or computer program to produce results in units of applicable emission limitation or standard. CEMS are required under EPA regulations for either continual compliance or determination of exceedance of standards.

Performance Specifications are used for evaluating the acceptability of the CEMS at the time of or soon after installation and whenever specified in the regulations.

IMMISSION MONITORING SYSTEMS

Monitoring of air quality has become an increasingly important function of all air pollution control agencies. To cope with the rapidly growing demand for comparable data from many locations some automated monitoring systems are now in operation and many more are in the planning or implementation stages. An effective atmospheric monitoring programme requires reliable ambient air pollution measurements over prolonged periods that indicate changes and trend in the air quality. Ambient air monitoring systems are developed to gather the data related to accepted or proposed air quality standards.

STRUCTURE OF THE SYSTEM

Structure of monitoring system depends on the available resources and guide line given by pollution control agencies. Wherever possible, the level of automation necessary for optimal functioning of the system should be chosen.

The principle characteristics of a monitoring system should be:

- A modular structure
- Possibility of extending measurement capacity
- Operational flexibility
- Low maintenance cost

A monitoring system contains equipment for:

- Sampling
- Measuring
- Data collection
- Data transmission

Although a large number of measuring instruments become available, only a small number are suitable for use in automated monitoring system. In choosing an instrument following points must be considered.

- Functional Characteristics - measuring ranges, measuring interval, drift level, lower detection limit, repeatability
- Operational Characteristics - behavior with respect to external conditions such as temperature and humidity, energy and maintenance requirements

- Control of the correct functioning of the instruments ("status" signals)
- Signals indicating need for maintenance and repair
- Approval of the analysers by certifying agency (USEPA/TUV/MCERT)
- Availability of service set up

Environmental regulations stipulate that certain harmful substances and reference values must be continuously monitored. Regulations on emission monitoring vary from country to country. Measurement technology must be assessed with regard to its suitability in many countries; for example, in accordance with EN 15267-3 in Europe, or in accordance with EPA standards in the USA.

FUTURE DEVELOPMENTS

In these times of accelerated change, far-reaching changes and revolutions in economics, politics and climate protection, the products and supply chains, which have established themselves over many years, are being put to the test. The process industry is affected by these changes in two respects. On the one side, the requirements placed on the industry are increasing. Scarcer resources and increasing costs for energy transport demand more efficiency.

Environmental considerations are increasingly being applied in globally strengthened regulations and laws. Globalization, as well as the increasing competition from emerging countries, offers the chance - but also the risk - of a worldwide market and competition. On the other side, the process industry can play a key role in mastering these challenges. Numerous products, which are intended to provide a good and sustainable way of living for millions of people in the future, touch on processes that are still in the experimental stage or have not yet even been invented.

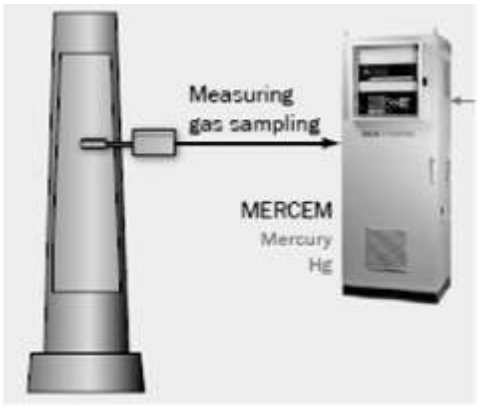
The Central Pollution Control Board (CPCB), serves as a field formation and provides technical services to the Ministry of Environment and Forests to improve the quality of air and to prevent, control or abate air pollution in the country. Respective state pollution control boards and central pollution control board is executing a state-wide and nation wide programme of connecting air pollution data from stacks of industries and from ambient air quality monitoring stations at different locations for regular monitoring. CPCB and PCB's want this information on Air Quality to be updated real-time on their website.

CHEMTOLS takes single point responsibility and provides solutions to various applications. Planning and engineering at CHEMTROLS is based on longtime experience with all kinds of emissions monitoring. Regardless of whether the applications are in power plants or subjected to difficult conditions of explosive environments in a refinery, CHEMTROLS engineers plan and design tailor-made solutions suitable for your specific requirements using state-of-the-art systems. All products are designed in accordance with the applicable international and national standards.

In the stack, the pollutants HCl, HF, CO, NOX (NO and NO2), SO2, NH3, dust, and the reference values of gas velocity, pressure, temperature, O2, and H2O are continuously measured.



Now continuous measurement of the total mercury content is also required. In order to further process this information and transmit it to the authorities, the measured values are transferred to a data acquisition system. The measurements must be taken in accordance with the relevant regulations



Modern legislation defines a very low limit value of pollutants that are emitted into the atmosphere. This leads to higher or even new standard measuring requirements in the measuring technology industry. CHEMTROLS is capable of providing solution for the same.

Air Quality Monitoring systems being used to measure various parameters in Ambient. These Systems are designed to provide reliable and high quality air pollution and metrological data. System is designed considering the ever changing ambient conditions in Indian subcontinent with due consideration for minimizing the time spent on maintenance and maximizing uptime.



Ambient Air Monitoring System with shelter

All analyzers are highly sensitive that give precise, reliable and repetitive measurements, and are relatively easy to maintain. Every instrument and associated components in the system meet rigorous quality and performance standards.

With Installed base in excess of 900 systems across different parts of country, timely response, reliability and multi analytical capability is the major strength of Chemtrols. Providing training is an important part of our philosophy. Customized training is provided to the users for operations, basic maintenance and trouble shooting of the system.

The key lies in forward-looking planning of industrial facilities and in continuous monitoring of their emissions. Targeted minimization of emissions requires them to be reliably de-termined and analyzed both quantitatively and qualitatively



Analysers Mounted on a rack

10 DOAS Technology for Ambient Air Pollution & Stack Emission Monitoring

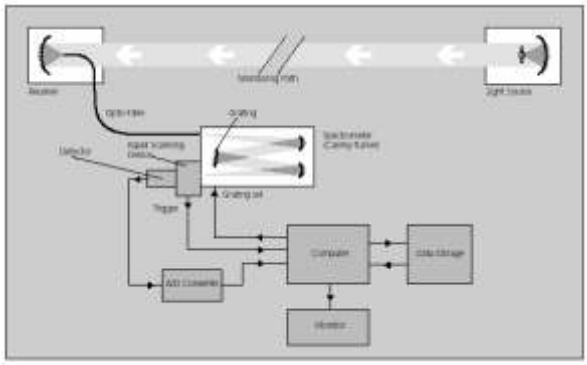
By Adarsh Kapur, Nevco Engineers Pvt Ltd
adarsh.kapur@nevcoengineers.com

Throughout the world, demands for air quality information continue to increase. Emissions legislation, scientific studies, environmental concerns and urban planning procedures are creating a variety of complex demands. This calls for a single, cost-effective method of air quality monitoring: one that will acquire maximum data of highest quality and present it in any number of ways with minimum time involvement.

The basis of the principle used by Opsis (a Swedish Company) to identify and measure concentrations of different gases is scientifically well established: Differential Optical Absorption Spectroscopy (DOAS), which is based on Beer-Lambert's absorption law. It states the relationship between the quantity of light absorbed and the number of molecules in the light path. Because every type of molecule, every gas, has its own unique absorption spectrum properties, or "fingerprint", it is possible to identify and determine the concentrations of several different gases in the light path at the same time.

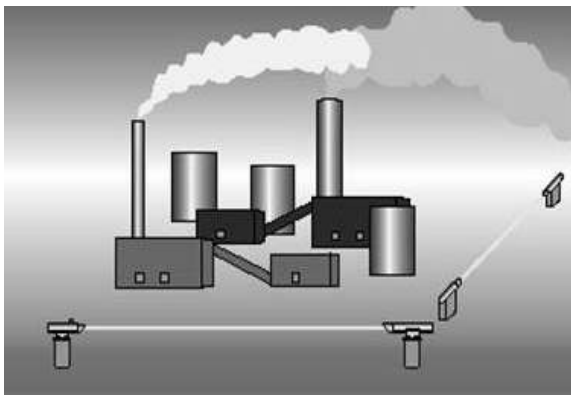
DOAS is based on transferring a beam of light from a special source - a high-pressure xenon lamp - over a chosen path and then using advanced computer calculations to evaluate and analyze the light losses from molecular absorption along the path. The light from the xenon lamp is very intense, and includes both the visible spectrum and ultraviolet and infrared wavelengths. The light is captured by a receiver and conducted through an optical fiber to the analyser. The fiber allows the analyser to be installed away from potentially aggressive environments.

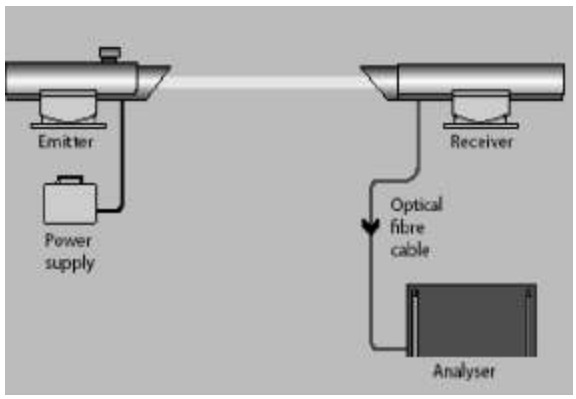
The analyser includes a high quality spectrometer, a computer and associated control circuits. The spectrometer splits the light into narrow wavelength bands using an optical grating. This can be adjusted so that an optimum range of wavelengths is detected. The light is transformed into electrical signals. A narrow slit sweeps past the detector at high speed, and a large number of instantaneous values are built up to form a picture of the spectrum in the relevant wavelength range. This scan is repeated a hundred times a second, and the registered spectra are accumulated in the computer's memory while awaiting evaluation. Evaluation is carried out for one wavelength range at a time. It works by comparing absorption curves. The absorption spectrum just registered from the light path is compared with one calculated by the computer. The calculated spectrum consists of a well-balanced summation of the reference spectra for the analysis concerned. The computer proceeds by varying the size factors for each reference spectrum until it reaches the best possible match. From this the different gas concentrations can be calculated with high accuracy.



For Ambient Air Quality Monitoring (AAQM)

With this technology, we can measure SO2,NO2,OZONE,Ammonia and Benzene with a Single UV Analyser. & PM10, PM2.5 with Another Analyser SM200. (Lead, Benzopyrene, Arsenic, Nickel. Arsenic and, Nickel can be sampled with the same Analyser SM200 by 47 dia Filter)Carbon Monoxide can be measured by an open path IR analyser or conventional IR/GFC analyser.





The technology used is based on Differential Optical Absorption Spectroscopy (DOAS) which is approved by most international organizations. US EPA approval was completed alredy in 1995 , and while being TUV/MCERTS approved in Europe for many years, Opsis is now also one of the first manufacturers to receive certification as equivalent method according to the latest European Directive EN 15267, which is a must for all AQM analysers in Europe by June 2013. There are several hundreds of satisfied users all around the world.

Advantages

Average concentration over the entire light path is provided , which gives a better representations of the pollution in an area than a single point monitoring station. Several gas parameters can be monitored with high accuracy in a single analyser. The instrument can also be used for fence line monitoring at industrial sites . Each side of an industry can be measured and very correct pollutant levels going in each direction is measured.

Important Features

a) The DOAS system has no sampling system, no converters, no filters , orifices , no pumps etc, as compared to conventional analysers. Due to this, the DOAS system has very little wear and tear , and will require significantly less maintenance than conventional analysers.This will also provide for better data capture and longer lifetime of the DOAS system.

b) The DOAS has span drift is only 4% per year whereas the conventional instruments have span drift of typically 1% per week. Because of this span drift, the conventional instruments need to be calibrated frequently where DOAS needs just a calibration once a year.

c) Maintenance costs of conventional instruments is very high as compared to DOAS. Whereas the DOAS open path system have life of over 15 years, the conventional point monitoring systems have about 5 years life after which most parts need to be changed.

d) The DOAS gives typically over 95% data capture which is difficult to achieve with conventional analysers.

e) It is approved by most international organizations like USEPA, TUV, MCERTS, China EPA, Russian Met Office.

f) Single analyser can monitor up to 6 light paths, which gives cost effective and superior area coverage.

For Continuous Monitoring of Ambient Particulates PM10,PM2.5

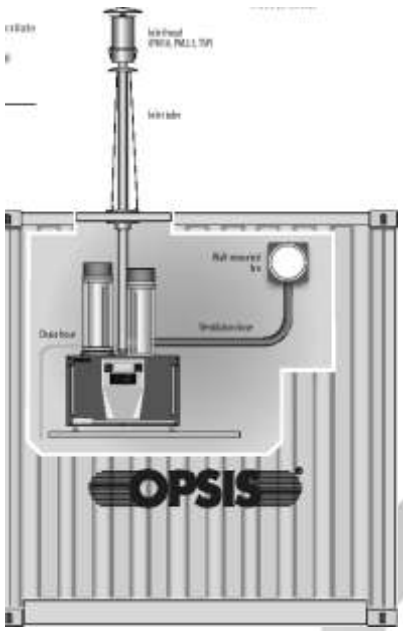
WORLD'S ONLY PM10, PM2.5 ANALYSER CUM SAMPLER WITH US EPA & TUV APPROVAL

Method of Detection: Beta Attenuation with 47mm Dia Filter Magazine





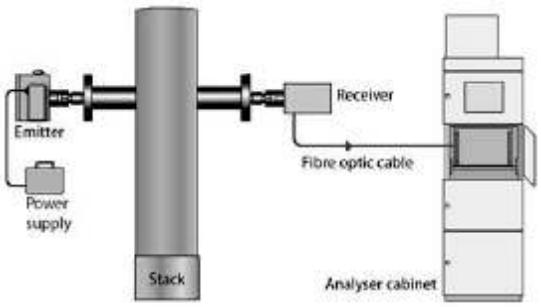


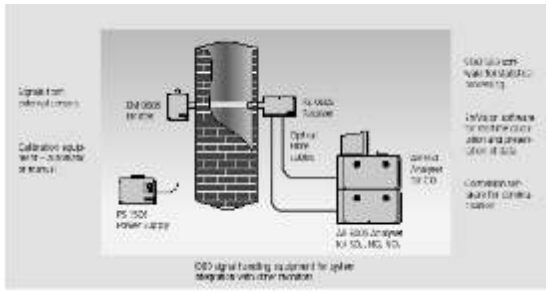


Features:

- Worlds only combined Beta monitor and 47 mm diam. filter sampler
- Temperature controlled inlet (TS200)
- Direct calibration of the monitor using gravimetric weighing of sampled filters
- Allows full lab analysis of filters Up to 80 days unattended operation
- Remote control via RS232/modem
- US EPA Equivalent method
- A cost-effective solution for particulate matter monitoring and sampling
- Real-time measurements of PM10 and PM2.5 based on particle counting
- Meets the new regulation for automatic monitoring of PM10 and PM 2.5
- Meets the new regulation for sampling on 47 mm filters for further analysis of cadmium, nickel, PAH and other substances
- Samples at ambient temperature - no need for correction factors
- Reference sampler according to EN 12341,when equipped with 2.3 m3/h inlet head
- The SM200 can generate both 1-24 hour data based on beta attenuation and real-time data based on particle counting
- Built-in Calibration Span, linearity and zero calibrations are automatically controlled at regular intervals
- Serial Communication - Remote Control
- The SM200 is equipped with three RS232 serial ports that can be used for connecting the SM200 to a PC, modem or data logger. By using the serial ports, the SM200 can be remotely controlled, which means that data retrieval and other operations can be performed at distance.The SM200 is ideally suited for use in a monitoring network.

For STACK EMISSION Monitoring(Continuous Emission Monitoring--CEMS)





OPSIS BENEFITS

Fast and flexible. : A single Opsis system will measure any gas specified in the operating software. There are no dedicated sensors, and a system may be re-configured to monitor additional substances at any time. The system's speed means that real-time data is always available.

Non-contact measurement : Although Opsis operates directly across a stack or flue, gases never come into contact with the system. Opsis is not affected by corrosives or other hostile substances.

Non-extractive: Opsis does not involve sample extraction, with its heavy maintenance requirements and possibilities for chemical change in the substances measured.

Low maintenance: Non-contact measurement and non-extractive sampling mean that Opsis has extremely low maintenance requirements.

Simple calibrations: Due to the low calibration drift, span/zero calibration is only required once per year. However, the system also provides for automatic calibration at any user-defined interval, if required by local regulations.

Simple report generation: Opsis software allows any report or analysis to be generated automatically, or 'on demand' through a few keystrokes. Statistical programs allow comprehensive trend analysis and other management routines. Data is easily portable to other systems for integration into wider studies. Data can be exported to several users via internet.

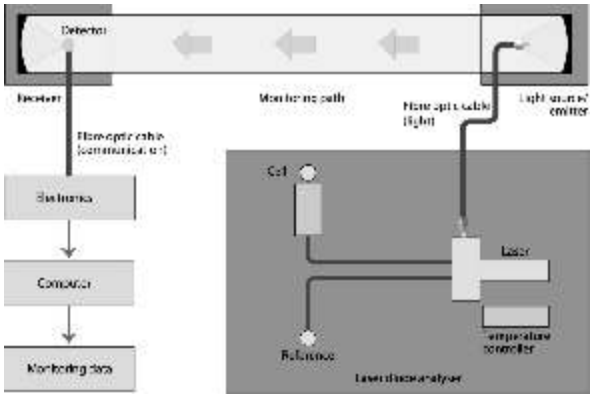
Comprehensive data logging: Apart from its own data, Opsis will log information from any other device producing a continuous output - such as flow and temperature sensors. This may be integrated with Opsis data for truly comprehensive emissions information and reports.

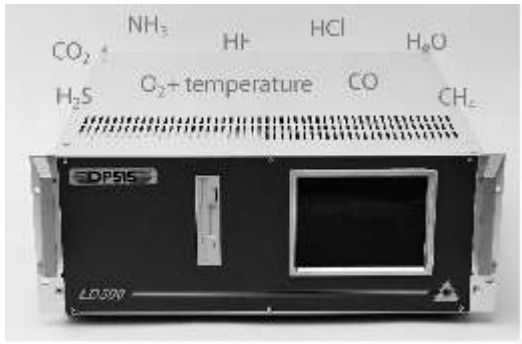
Logic outputs: An Opsis system can provide logic outputs for interface with wider control systems. This allows its real-time information to play a wider part in plant control and efficiency.

On-line supervision: All aspects of an Opsis system are accessible via telemetry from a remote station. Routine checking of system parameters does not involve site visits.

Worldwide support: Opsis is supported internationally by a worldwide network of representatives.

For Continuous Process/Stack Emission/Ambient Air Quality/
Fugitive Emission/Pot Room Monitoring through Laser Diode Gas Analyser





LD 500 Laser Diode Gas Analyser

The LD500 emits laser light in the near infra-red section of the wavelength spectrum. The measurement is made by rapidly scanning the laser over the absorption line in the gas absorption spectrum. The laser operates continuously, and it is tunable, so the laser wavelength can be slightly changed. This is achieved by applying an electric voltage across the semiconductor diode. The voltage applied is precisely controlled, and varies according to a ramp function during

a scan. During a measurement, the LD500 averages a large quantity of scans. The measurement interval is in the order of

1-20 seconds, and the scanning rate is in the kilohertz range. In the end of the measurement interval, the averaged spectrum enters an evaluation procedure. The result is compared through a least squares fitting procedure with the known absorbance cross section of the gas. The cross section relates to the strength of absorption in the gas, at specific wavelengths. Knowing the monitoring path length, the concentration of the gas can then be evaluated.

Features :

- Fast response time (~ 1 sec) , Multiple paths , Multiple gases , Long fibre lengths (< 1 km) , Low detection limits
- Measuring principle Tunable Diode Laser , Light source NIR Semiconductor laser
- Temperature stability Stability guaranteed within 18-25 °C, ambient temperature (LD 500)
- Scanning frequency 1000 times per second , Scanning temperature accuracy Better than 1/1000 °C

- Evaluation method PLS (Partial Least Square) of cross section absorption spectra
- Cross interference < 1% of reading
- Response time < 1 second (integration times 1 to 30 seconds user selectable)
- Internal QA/QC Auto zero and wavelength check by gas cell, auto-system check (laser)
- No. of laser modules Maximum 4 laser modules can be accommodated
- No. of measurement paths Maximum 8 measurement paths (multiplexing)
- Output signal Analogue output 4-20 mA, (isolated < 400V; capacity 900 ohm)
- Digital output Relay C:C (max 250 VAC, 2 A), Degree of protection IP 20
- isplay LCD, 6.4" , PC Industrial standard, PC104, Modem Internal, Hayes compatible
- Hard disk capacity Minimum 2 GB, Power requirements 115/230 VAC (+15/-10%), 50/60 Hz
- Power consumption 110 W, Dimensions (L×W×H) 470×440×200 mm (19" rack), Material Aluminium/steel

Applications

- Monitoring of NH3 slip in DeNOx systems
- Monitoring NH3 emissions from Chemical/Fertilizer industry
- Monitoring of HF emissions, before/after scrubbers, from Aluminum Smelters/Chemical factories/Fertilizer plants/Semiconductor Plants.

11 GLens: The Next Generation Lens for Effective Pollution Control

by Mr. Sudheesh Narayanan, Knowledge Lens
sudheesh@knowledgelens.com

Introduction

"**The proper use of science and technology is not to conquer nature but to live in it and make it sustainable for future generations**". Environmental pollution is a real problem today and there is an urgent need to effectively control it. To control the pollution we should have an effective means to monitor in real time and then putting effective control measures in real time. Also, there is a need to look at the broader aspect of pollution control and make policy decisions to address the same. The need of the hour is to have a next generation platform that leverages the power of technology to harness the intelligence from the various online monitoring systems and make real time intelligent decisions to effectively control them.

The Current Challenges

To monitor the Industry emissions in real time, there are multiple platform available today which enables online monitoring, however the need is to have a Highly Scalable Platform that can not only address the need for the currently regulated 17 Category industries but a platform that can expand the needs to all the polluting industries across the country. Having a consolidated view across the country, state using which informed decisions can be made instantaneously.

With the concept of Smart City taking centre stage in the country, the amount of sensors that will be deployed to monitor and control environmental parameters is estimated to be in millions. The need of the hour is to have a plug and play platform where new sensors could automatically join the grid and contribute seamless for effective pollution control.

The current data gathered for online monitoring is used for only complying to regulatory standards, however, the strength lies in the leveraging this data and make the use of the new advances in Data Sciences and Big Data Analytics to make real time decisions and controls to effectively control pollution. For example, establishing the correlation of traffic impact on Pollution, there could be intelligent traffic routing during peak hours to reduce environment pollution at various strategic points by reducing the traffic jams. Informing individuals on the current pollution levels and warning would influence Carpooling and other green initiatives.

Data is in plenty but quality of data is another key challenge when dealing with the sensor or analyser data. Automated pattern mining and establishing automated quality validation on the data can now be easily implemented using machine learning algorithms. This will enable analysis of this

Big Data and enable automated data validation so that the regulators and decision makers can focus on key decision making rather than scanning through this large pile of data to find the real data quality issues.

Another key challenge is with respect to pollution prediction. Today we have the data about current pollution or historical pollution but we are not able to accurately predict or forecast the pollution levels based on the previous observations. Once we are able to successfully predict and forecast, there is a good possibility of influencing these levels leveraging the citizen and industry participation.

The Solution

GLens is the next generation real time platform for online monitoring of Emission, Effluent and Ambient Air Quality. The product GLens (Green Lens) focuses on online monitoring and leverages the latest advancement in the field of Big Data Analytics and Data science to help in effective pollution control.

The key focus of GLens is not just to accumulate the data from various Industry installed analysers and enforce regulatory compliance. The goal is to leverage this data and enable advance analytics on the data and provide a single window for decision makers to make effective pollution control. Providing environmental prediction and forecasting across various dimensions, and providing real time pollution control measures are the key goals.

The product today has made a significant step towards this by providing the following next generation capabilities out of the box

- Real Time Pattern Mining to find anomalies in the data
- Real Time Pattern Search for pre-defined exceedance patterns in data
- Identify and correcting data quality issues automatically by performing deep analytics on the data
- Detecting data integrity issues automatically using pre-build algorithms.
- Leveraging Machine learning to forecast the pollution levels
- Automated control of actuators for effective pollution control

Apart from this the product is already running successfully at various pollution controls boards with some of the key differentiators

- Open API based plug and play model for industry analyzers
- Remote configuration and diagnostics of the industry analyzers
- Automated audit trail and data annotation based on industry events
- Remote calibration of the analyzer automatically at pre-defined intervals
- Integrated workflow for industry collaboration in real time
- Automated SMS , Emails Alerts for exceedances as per industry thresholds.

About the Author

Sudheesh Narayanan, Founder & CEO Knowledge Lens

A seasoned innovator and big data expert who conceptualized and built numerous products in Big data, cloud and IoT. He a leading thought leader in Big data space with first book published on Hadoop Security and has filed two patents in the area of big data analytics and cloud. Enriched with more than 17 years of experience in product development, IT services and competency development, Sudheesh has earned immense expertise in Big data analytics, Social media mining, Machine learning and IoT.

Offices: Bangalore (Headquarters), Cochin and Oregon (U.S.)

Verticals: Healthcare & Pharma, Government, Hi-Tech and Financial Services

Offerings:

Solutions: GLens, iLens IoT platform, Big Data Predictive & innovation Workbench, Smartcity Platform and Unstructured content and knowledge discovery

Services: Big Data Analytics, IoT, Cloud, Mobility & Security

Products:

GLens: Knowledge Lens joined hands with environment experts in India and abroad to build GLens, a real-time pollution monitoring tool indigenized for Indian market that collects live data from numerous industries, analyses it in a centralized place and present it to the pollution board across India to take corrective actions. The platforms unique pattern mining engine makes the data validations and data quality analytics really simple.

Hadoop Lens: Transferring data across big data platforms becomes a nightmare, especially when they are secured and locked down. HadoopLens, a large scale Hadoop cluster migration, backup and archival product encompassing an array of utilities, is one the fastest in the market that can transfer petabytes data across platforms at lightening speed.

Smart City Lens: This city residents engagement initiative that amalgamates the power of cloud, IoT and Big Data to connect the entire city and help people report issues like water leakage, pot holes on road, air pollution, open drains and suspicious activities as well as suggestions with three simple steps through social feeds, emails, SMS and mobile apps.

iLens Cloud Event Listener captures all these messages and sends them to the processing platform which de-duplicates, mines and classifies the data. Finally all this intelligence is transferred to the event management platform to make a collective decision on what really needs to be changed. This highly scalable cloud based platform provides real time status for all logged issues, discovers location from social media content and auto-routes events based on configured rules.

12 Continuous Emissions Monitoring Solutions Rosemount Analytical: The Smart Choice for CEMS

By Nilesh Malpure, Emerson Process Management (India) Private Limited
gc.csc@emerson.com, nilesh.malpure@emerson.com

Visualize: Visualize a solution that simplifies the way you handle regulatory compliance

With our continuous emissions monitoring systems, Rosemount Analytical designs and engineers the right system for your specific needs, and provides startup and commissioning support, training, and ongoing maintenance contracts.

Designed in consideration of CEM regulations, the Rosemount Analytical continuous emissions monitoring system helps you meet data reporting requirements and emissions compliance. Our systems monitors:

- Sulfur Dioxide (SO)
- Nitrogen Monoxide (NO)
- Nitrogen Dioxide (NO)
- Carbon Dioxide (CO)
- Oxygen (O)
- Carbon Monoxide (CO)
- Total Hydrocarbon (THC)
- Hydrogen Sulfide (H S)
- Opacity

Our CEMS solutions range from pre- engineered, packaged systems to more complex custom-engineered systems that measure multiple gases using data acquisition and handling. They are designed to perform the zero and span checks automatically and unattended. Automatic calibration makes it less costly and time consuming to meet the environmental requirements for daily validation of the system.

With our CEMS products, the goal is to safeguard the environment and adhere to new, complex regulations, while continually improving business processes.

With field-proven reliability, low total cost of ownership, application flexibility, and superior performance, the Rosemount Analytical continuous emissions monitoring system is the smart choice to help you manage your business in today's tough regulatory environment.

Our solutions encompass

- Industry-Leading Analyzers
- System Design
- Project Coordination and Management
- Startup and Commissioning
- Ongoing Maintenance and Support

Analyze: Analyze the range of emissions for accurate, reliable compliance data

Unique Features

X-Stream for Hazardous Area

- Up to five component gas analyzer featuring NDIR/UV/VIS Photometer, paramagnetic and Electrochemical O2, thermal Conductivity and moisture sensors
- Enhanced performance with IntrinzX technology, Flameproof Gas Analyzer
- Modern communication capabilities including web-browser accessibility
- Automatic sensitivity control
- Fast stabilization
- Long term stability
- Enclosure protection Type 4X; IP 66 acc. EN 60529 for outdoor installation
- Ambient Temperature Range 0-50 Deg C
- Wide dynamic range in single Analyzer upto five measurements

X-Stream for Safe Area Analyzer

- Up to five component gas analyzer featuring NDIR/UV/VIS photometer, paramagnetic and Electrochemical O2, thermal Conductivity, and moisture sensors
- Enhanced performance with IntrinzX technology

- Separate Benches for each parameter
- Modern communication capabilities including web-browser accessibility
- Automatic sensitivity control
- Fast stabilization
- Long term stability
- Enclosure protection Type IP20



Rosemount Analytical's X-Stream offers multi-component, multi-method analysis utilizing infrared, visible, ultraviolet, thermal conductivity, paramagnetic, and electrochemical sensor technologies, as well as trace oxygen and moisture

Optimize: Optimize process performance to ensure emissions compliance

Rosemount Analytical applies a straight extraction sampling technique, where the sample is continuously drawn from the gas stream through a filter to remove particulates, and is then sent through a conditioning system to remove moisture and other inconsistencies. Finally, the conditioned gas is sent to the analyzer(s) to be evaluated for numerous parameters, which are collected and compiled by a data acquisition system, for customizable reporting and full compliance with regulating bodies.

Diluent Gas Monitoring

Rosemount Analytical's CEMS technology can be a paramagnetic technique with a fast response and a wide dynamic range to measure oxygen as a diluent gas in ranges varying from 0-1 % to 0-100 % (full scale). It includes a corrosion- resistant, long-life cell with a rugged, self-tensioning suspension. Carbon dioxide can be measured as a diluent using the nondispersive infrared technique that includes a wide dynamic range of 0-1% to 0-100% (full scale).

Flow Monitoring

Rosemount Analytical's CEMS solution offers third-party flow monitoring equipment to measure the rate of exhaust gases being sent through the plant's ducts and stacks before being exhausted into the atmosphere. Data can be calculated using direct in-stack measurements or indirect, built-in calculations based on fuel usage or other process parameters.

Pollutant Concentration

With Rosemount Analytical's CEMS technology, stack gas is continuously sampled and monitored for NOx, SO , and CO pollutant concentrations using user- selectable, full-scale ranges from 0-10.0 ppm to 0-10,000 ppm.

Hydrocarbon Analysis

Rosemount Analytical uses a flame ionization detector to accurately measure the total hydrocarbon content of stack emissions over a wide selection of user-selectable, full-scale ranges from 0-1.0 ppm to 0-10 %.

Data Transfer and Reporting

Rosemount Analytical's CEMS use cloud server for data acquisition & transferring the same to SPCB/CPCB that provide superior data handling and display functions. The extensive, real-time and instantaneous data available in the server & pollution control board. Data aquisition is coupled with operator interface capabilities, make it a valuable operations tool, providing information for avoiding excess emissions and reducing out-of- compliance occurrences.



Rosemount Analytical's CEMS offer superior data handling and display functions to help plants avoid excess emissions and reduce out-of-compliance occurrences

Benefits of a Rosemount Analytical CEMS Solution

- Reduced costs
- Improved performance
- Proven reliability
- Compact size
- System expandability
- Reduced time for Installation, testing, startup, & service

Industry Applications

Gas Turbines

Our CEMS are ideal for the low emissions requirements of gas turbines.

Cogeneration Facilities

Depending upon the geographic location, type of fuel burned, and plant size, any or all of the following parameters may be monitored: CO, O , CO, SO , NOx, THC, NH, and opacity.

Refining

Process heaters and FCC units often require enhanced sample handling features that are a Rosemount Analytical specialty.

Utilities and Municipalities

With emissions allowances being a potentially valuable commodity, accurate and reliable CEMS are a necessity.

Industrial Boilers

Depending upon the size and location of the plant, CEMS may be required.

Commercial and Institutional Boilers

Typical measurements include CO, SO, NOx, O_2 and opacity.

Metal & Minerals

Typical measurements include CO, SO2, NOx, O_2 and opacity.

Pulp and Paper & Many More applications

Pulp and paper facilities may be required to measure SO, O, CO, NOx and opacity in a variety of emissions sources, including power and recovery boilers.

Engineering & Service: Advanced Engineering & Services for a one-of-a-kind CEMS solution to fit your needs

The keys to a successful project are the proper execution strategies, a knowlegable and committed project team, and world-class products and services. Rosemount Analytical has more than 20 years of experience designing, engineering, and executing CEMS projects that ensure our customers meet stringent, ever-changing environmental regulations. We partner with each customer to clearly understand and engineer a solution that meets their specific needs and budget requirements.

Continuous Emissions Monitoring Project Management Overview

Rosemount Analytical has highly experienced teams of world-area dedicated CEMS experts who are responsible for the project management and implementation of CEMS projects of all sizes and scope. We use detailed work processes for planning, design, engineering, implementation, delivery, and support to ensure that CEMS projects are delivered on time and on budget.

Our CEMS project teams adapt their processes and execution tools to each project's unique requirements. By combining industry-recognized analytical solutions with unparalleled industry expertise, Rosemount Ana- lytical offers a low-risk CEMS solution that ensures full regulatory compliance. Our CEMS project management process:

- Ensures that the analytical design meets time, budget, and regulatory requirements
- Offers more accurate data analysis and communication
- Ensures compliance with environmental regulations

Planning & Initial Engineering

Project Identification & Scope

- Develop project team
- Hold kickoff meetings
- Define project objectives
- Review project scope
- Develop initial project schedule

Initial Engineering

- Develop implementation and procurement plan
- Handle data collection and analysis



Dependable Sample Handling Can Make the Difference

Rosemount Analytical's modular sample handling system combines moisture removal, sample and calibration valving, flow regulation and power distribution in a compact, wall-mounted enclosure.

Daily calibration and other routine tasks are performed automatically by the analyzer. All system functionality can be manually initiated for troubleshooting purposes and testing. The analyzer eliminates the need for the integration of a separate PLC or external control system.

Design, Implementation, & Testing	Installation, Commissioning, & Startup	Lifecycle Support
Design ● Develop application design ● Design sample handling system ● Develop system integration plan **Implementation** ● Manufacture analyzers ● Build sample handling system ● Procure required third-party equipment ● Integrate complete system **Testing** ● Conduct electronics testing ● Conduct application testing ● Conduct sample handling system leak testing. ● Handle overall quality assurance ● Supervise installation ● Offer technical support **Commissioning** ● Supervise or handle commissioning as required	**Installation** ● Integrate historical data **Startup** ● Manage tuning ● Handle site acceptance testing ● Provide as-built documentation ● Provide spare parts as specified	**Training** ● Formal on-site training ● Informal on-the-job refresher training **Maintenance** ● Scheduled on-site maintenance services ● Emergency on-site maintenance services ● Emergency spare parts support **Sure Service Contracts** ● Custom support agreements to meet your specific needs

13 Controlling Fugitive Emissions at Source

By M.A. Patil, FICCI
ma.patil@ficci.com

Typical Fugitive emission sources in various industry sectors are as below:

- Transfer Points - cement, sponge iron, Foundries, boilers
- Induction Furnaces - steel, lead, brass, zinc,
- Crushing - stone, coal, Iron ore,
- Screening - Dal mills, rice mills, stone crushers,
- Loading/ unloading - Clinker, flyash, cement, gravels
- Stock piles - clinker, limestone, coal, gravel, dust

Fugitive Emissions occur due to following activities:

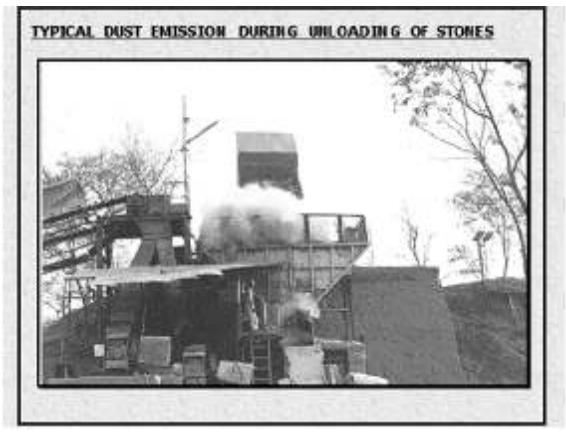
- Vehicle movement - dust from roads get air borne
- Crushing - fine dust generated, gets air borne
- Free fall - from crusher to belt conveyor, from one belt to other belt, dust gets air borne.
- Screening - dust gets loose and get air borne
- Bulk material handling
- Storage stock piles : Open area wind erosion - wind blows away dust
- Loading / unloading of stones
- Scrap Melting operations

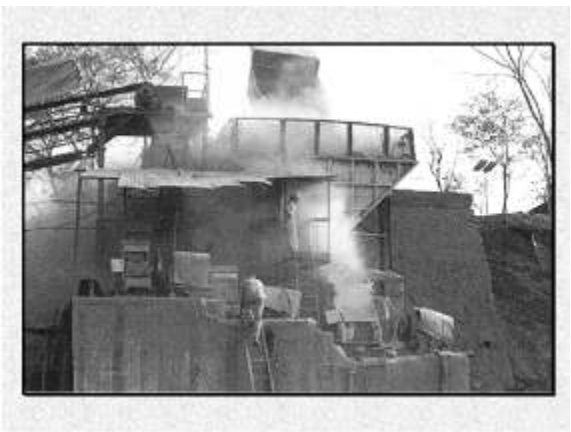
How emissions spread with distance?

As the height increases, dust/ gases spread to larger area. The actual area of dust generation at source is quite small, but as the dust rises upwards, it spreads to a larger area in all directions. For Steel melting Induction Furnaces, the dust extraction hood size becomes bigger and bigger (as it goes away from furnace). The Volume (m3/hr) to be sucked increases, thereby Fan power (HP) increases and also the size of APCD increases. It Calls for Higher investment, higher operating cost and that too at a cost of workmen first getting exposed to the fumes, before gases are sucked.

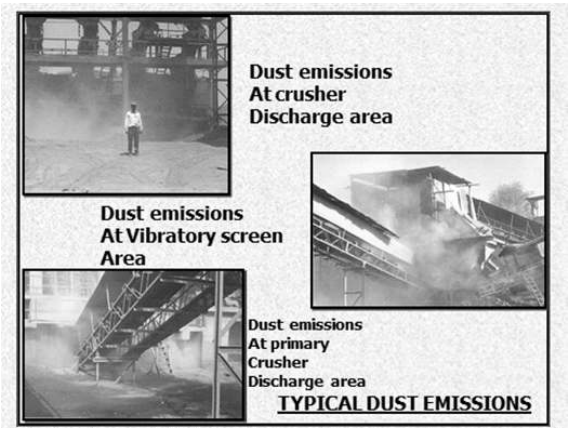
The actual point (origin) of dust generation and how the dust spreads with time is shown with a few photographs for 2 cases below, a stone crusher and an Induction Furnace.

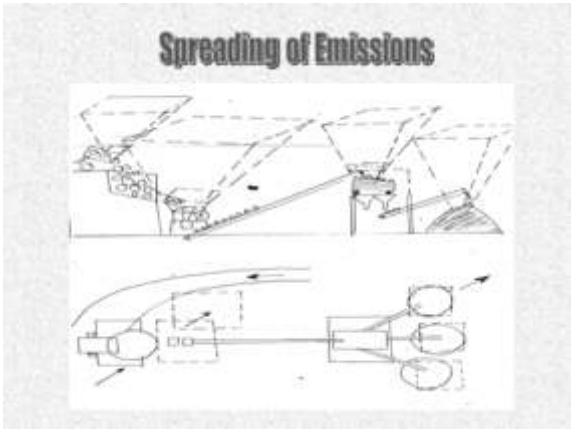
Picture of fugitive emissions from unloading of stones in a stone crusher & how the dust spreads



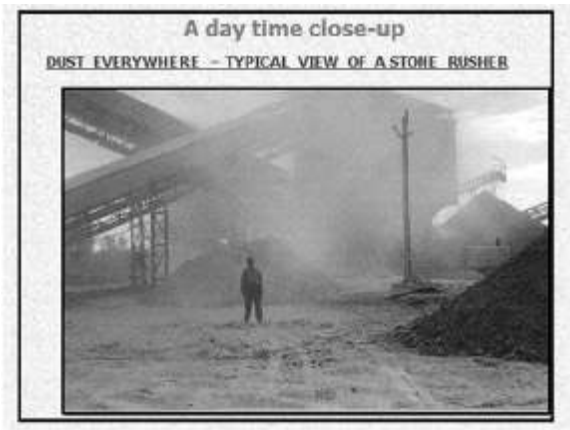


Fugitive emissions from other areas (crusher, transfer points, screening etc)



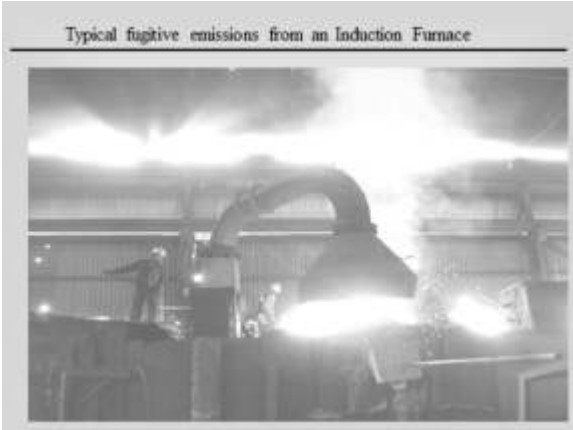


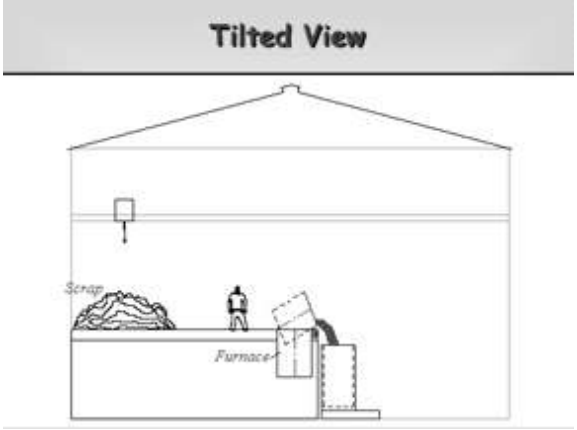
Dust spreads all over, giving an impression of "Dust from every where, where to control?"

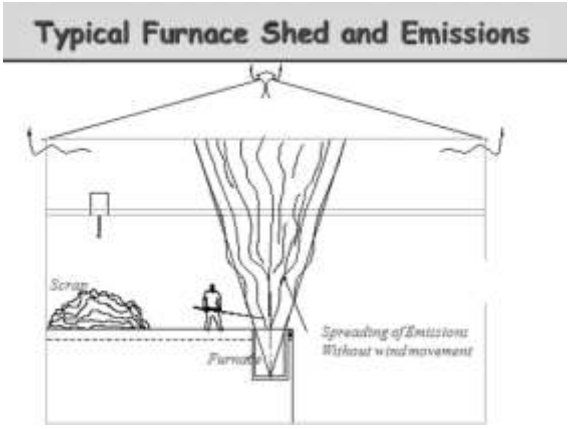


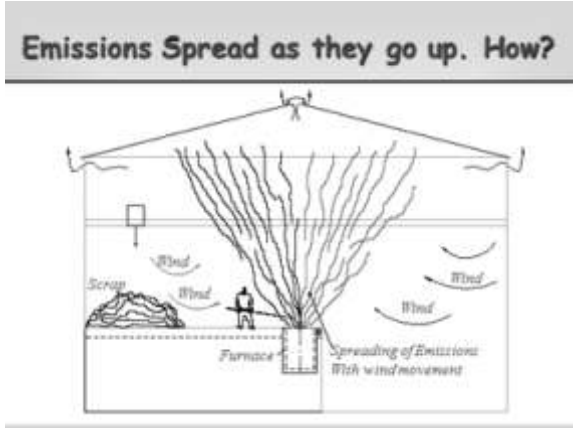


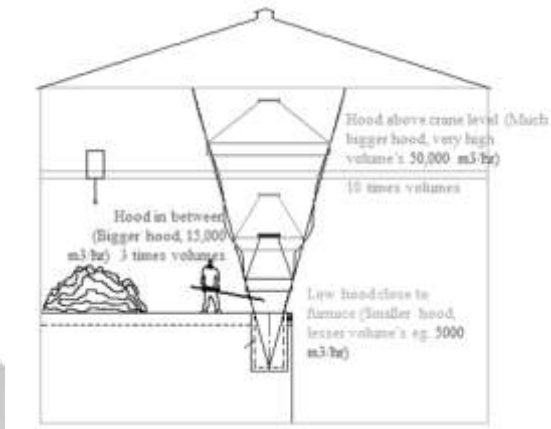
Picture of fugitive emissions from steel melting Induction Furnace & how the dust spreads











Affected Parties by Emissions

Worst affected - Crane Operator
- Shop floor Workers

Other affected - People in the vicinity
- Flora Fauna etc.

Other effects - Corrosion of shed steel structure
- Dust Deposits everywhere

Methods of controlling fugitive emissions :

There are 2 Methods of controlling fugitive emissions, WET type dust Suppression system (by spraying water) or DRY type dust Extraction cum Bagfilter type control system. It is always challenging to decide "How to control fugitive emissions?". Whether to control close to Source, Or At some distance away? Which is better? Cheaper? Unlike stack emissions, there are Limitations in controlling fugitive emissions because there are no Standard designs/ modules available from any APCD suppliers. For each fugitive emission problem, there has to be a tailor made site specific design of the control system

WET type dust Suppression Method :

By this method, the fugitive dust is suppressed at source itself by spraying water. The Key features of dust suppression scheme are, How much water is required? How fine the spray should be? How many spray locations? Where to spray? Which locations? Avoiding choking? Sometimes, it is thought that sprinklers could be useful in suppressing fugitive dust emissions. Dust is first allowed to spread, only then it comes in contact with sprinkler water and hence it is not effective suppression. Too much water logging on the floor area creates Muddy road conditions. Sprinklers require too much water hence, high operating cost and expensive.

Typically, in industries like Cement, sprays are installed in limestone unloading area. But, are not found quite effective in many plants due to certain design Problems like:

- Lack of Containment enclosure - AS WIND BLOWS, SPRAYS ARE ALSO BLOWN AWAY FROM TARGET AREA
- Excessive water usage - TOO MUCH WATER SPRAYED, UNSUSTAINABLE, Problems like CHOKING, jamming etc are common.
- Result - INEFFECTIVE CONTROL OF DUST

The Dust Suppression System should typically include following components - A Closed Water Tank, Softening Treatment to Hard Water, a Pump, an On-line self cleaning Type twin micro filter, a Pressure Gauge, Connecting Pipelines (preferably PVC) & Regulating Valves, a Control Panel, a Flow Meter and the Water Spray Nozzles.

Why many existing dust suppression systems do not work properly ?

Typically the water tank located at elevated level, water taken by gravity to various points through GI pipes. Perforated pipes shovers used for spraying water over dust generating points. Sprinklers installed, wets nearby ground, but hardly suppreses airborne SPM. Excessive water consumption, wets material excessively, therefore hardly operated. Too many spraying points (>15 to 20) at unwanted/ineffective locations choking of holes/nozzles because no filter. Hard water leads to salt formation & choking.

How dust emissions from a stone crusher can be controlled?

- Various Solutions/ Alternatives
- To Be Decided on Cost Economy Aspects

Alternative - 1

- Enclose all dust generating sources/points air tight – so that no dust comes out.

Practical Aspects:-

- Dust is generated from many locations.
- Air tight enclosures not possible.
- Source window/openings need to be provided.
- Some gaps remain – not practical to seal and hence,
- Not a feasible solution.

Alternative –2

- Enclose dust sources to the extent possible.
- Extract/suck the dust, with the help of an ID Fan.
- Capture the dust particles in efficient air pollution control equipment.

Practical Aspects:-

- Requires substantial additional electricity.
- Dust generating location spread over a wide area – long ducting, too many branches.
- Capturing fine dust (< 10 micron) requires bagfilter type equipment.
- Cyclone/settling chamber etc are alone not sufficient to capture dust.

Cost:-

- High investment cost.
- High operating cost

Benefits:-

- Dust free product, better quality.

Alternative - 3

- Provide enclosures to the extent possible to key locations
  - Crusher Discharge, Vibratory Screen, Transfer Points
- Spray Water at key locations to suppress dust

Practical Aspects:-

- Enclosures, only for key location, possible.
- Spraying at various, distant locations, possible by laying water pipelines, with pump.
- Dust gets suppressed, remains within the product.

Cost:-

- Low investment, low operating costs.
- As dust remains within the product, the product quality not as best as with dry extraction cum bagfilter arrangement.

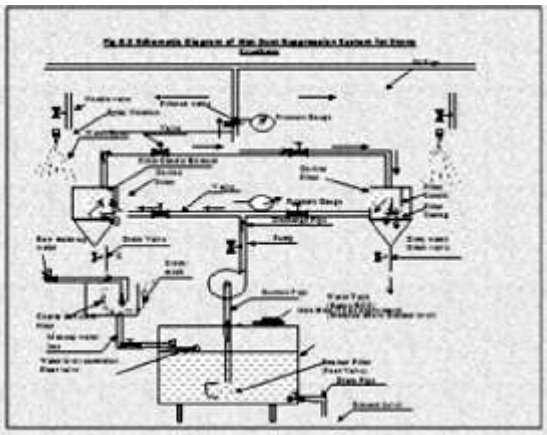
Typical components of Dust suppression system for Control of Fugitive emissions in a stone crusher :

Dust Suppression System

Components -

The wet type dust Suppression system has following hardware components:

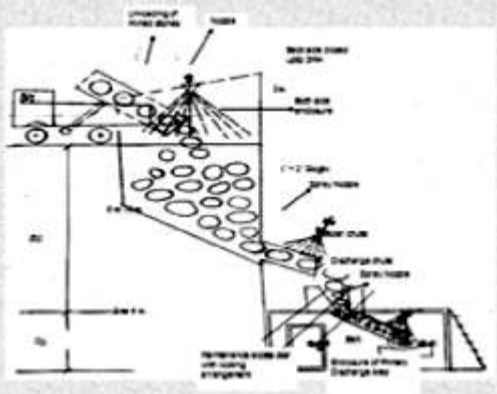
1. Closed Water Tank
2. Softening Treatment to Hard Water
3. Pump
4. On-line self cleaning Type twin micro filter
5. Pressure Gauges
6. Connecting GI Pipelines & Regulating Valves
7. Control Panel
8. Water Spray Nozzles
9. Flow Meter



COMPONENTS OF DUST SUPPRESSION SCHEME



Water spray locations at unloading & crushing points





Dust Control System design for various sizes of Stone Crushers

Sr. No.	Crusher Category	Typical Machinery	Typical Production Capacity TPH	Number of Must Spray Locations Number	Optional Spray Locations Number	Water quantity (max.) Lit/Hr
1.	Small	Single Jaw, Single Screen, Manual Feeding & conveying	5-10	2	One	150
2.		Single Jaw, Single Screen, Mech. Feeding & Conveying	10-15	3	-	200
3.		Two Jaws, Single Screen, Mech. Feeding & Conveying	15-25	4	1	250
4.	Medium	One Primary & Two Secondary Jaw, 2 Screens, Mech. Feeding & Conveying	25-60	5	2	300
5.		Two Primary, Two Secondary Jaw, 2 Screen, Mech. Feeding & Conveying	60-100	6	2	400
6.	Large	1 Primary, 2 Secondary, Two Tertiary Jaw, 2 Screens, Mech. Feeding & Conveying	>100	7	3	700

DRY type: Extraction cum Bagfilter type control system :

The system has 2 parts, Dust Containment & Extraction part (which has to be designed for case to case) and the Control system part (i.e Bagfilter, for which standard modules are available for a given flow/ volume). Objective of Part I is " Capturing maximum emissions for maximum possible time" and that of Part II- is "Separating maximum dust particles from the captured emissions". Both parts are equally important

Many a times, dust extraction cum bag filter systems are installed, but still there are substantial fugitive emissions seen. What may be wrong in Dust control system designs? In the EXTRACTION SIDE, it could be Improper Design, Layout, Duct balancing, Improper Duct sizes, improper branch connections, improper enclosures, hoods at extraction points, etc. In the CONTROL SYSTEM side, it could be Improper Design of APCD, High pressure drop across Bagfilter, Partial Choking, Torn Bags, etc.

Most Appropriate method for controlling fugitive emissions from Induction Furnaces :

For controlling fugitive emissions from Induction Furnaces, water spray type method cannot be used. The only appropriate method is "dust extraction cum bag filter type control system". However, it is challenging to decide Where to install the hood? Typically, the dust/ fume extraction hood could be placed at either of the 3 heights/ locations :

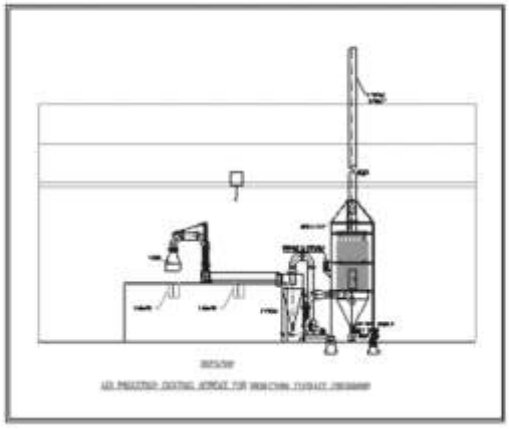
- At a low height above the furnace (below nose level of workmen)
- in-between crane and furnace (above head level of workmen)
- above the crane level.

Which hood is more appropriate? What are the cost-economic issues? Hood close to furnace, it obstructs scrap feeding etc.? What is the problem in having a Hood at higher height?

Conclusion :

KEY TO EFFECTIVE CONTROL OF "FUGITIVE EMISSION" is to CAPTURE OR SUPPRESS AT THE EARLIEST POINT, ELSE PAY HEAVILY, LOOSE GOOD IMAGE. End of the day - what we all want? A Green & Clean Environment, better living conditions.

Dry type Dust Extraction cum Bagfilter system for controlling fugitive emissions from Induction Furnace



Dust/ Fume Extraction hood arrangement for Induction Furnace (less than 2 feet away, movable hood, with cut in front)



Mechanical Shaker type Bag filter – a low cost but effective option



14 Performance Upgradation of Improperly Operated Air Pollution Control Systems (which also adversely affect Productivity & Consume more Energy) - Situation Analysis

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As the stack emission standards are getting stringent day by day, many industries are directed by concerned State Pollution Control Boards (SPCB) to install "more efficient Air Pollution Control Devices (APCD)". For applications like process steam boilers (1 to 50 TPH involving combustion of coal/lignite/ agro waste fuels), this generally calls for installing an "add on APCD", it could be either a Bagfilter or a Venturi Scrubber (in addition to the existing APCDs like settling chamber, cyclone, multiclone, spray tower etc) . For bigger boilers, like cogeneration boilers (50 to 250 TPH) already having ESP, it may call for "adding more field" in ESP or augmentation of ESP.

Which is the proper APCD?

- Cyclone?
- Scrubber?
- Bagfilter?
- Any other?

Decided mainly by particle size distribution and control efficiency required..

Typical Pressure drops across various APCDs:

- Settling chamber/ ESP = 10-20 mmWC
- Single Cyclone = 25-60
- Multiclone = 60 - 100
- Bagfilter = 125 - 175
- Venturi Scrubber = 150 - 300 or more

Selection of APCD by Particle Size : Case - Steel Melting Induction Furnace emissions :

- Majority of dust particles are fine in size (90% particles less than 10 micron size).
- Cyclones - could be used only as pre-collectors or spark arrester.
- Scrubber -Due to non wettable nature of dust particles, difficult to scrub. Efficient scrubbing requires High pressure drop (> 400 mmWC). Also, Waste water & sludge problem, dirty working.

Appropriateness of scrubber as an APCD :

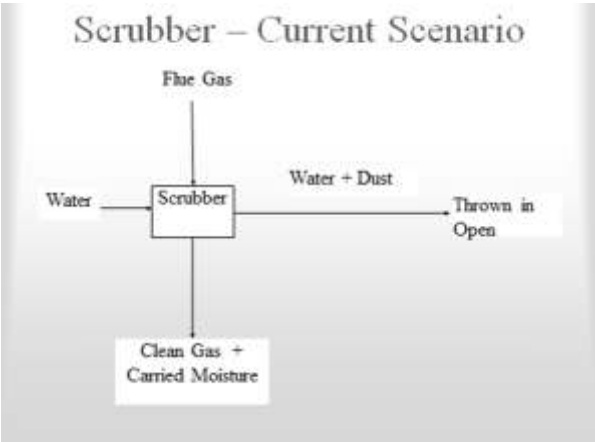
"Scrubber" is a very vague word to describe as APCD. A vessel of any size with some water spray (one or many) is a scrubber, the pressure drop can be from 1 inch to several inch.

The efficiency of a scrubber can be anything (say as low as 20-30% to even 80-90% in case of proper ventury scrubbers. Basically, each dust particle should be made wet, that means the water droplet should be small enough like the dust particle (in micron size) and the dust particles should be wettable (oily particles do not get wet by water).

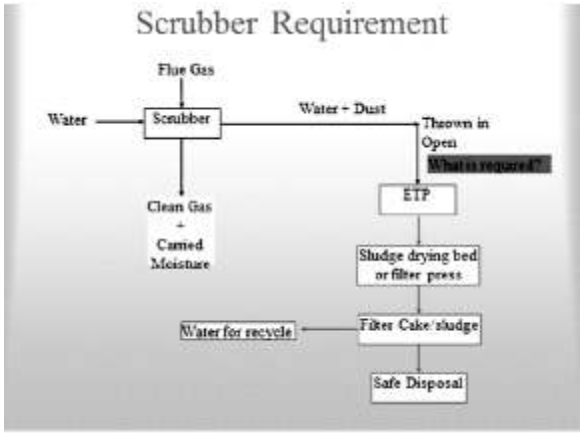
Problems associated with Scrubbers :

A scrubber, even if it captures the particles, it converts the air problem into a water problem. The dust particles in water need to the separated and taken out every hour, periodically. Even the water gets polluted, dark black in colour, oil in nature. It requires an ETP to clean this water. The moist gases lead to corrosion of all steel items, including ID fan empeller blades, chimney etc.

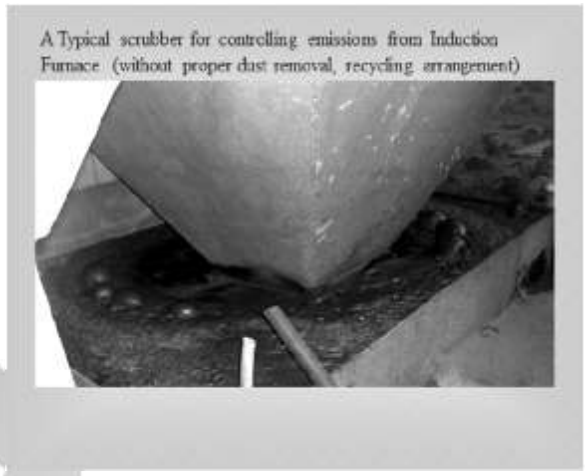
Oily dust (soot) being non-wettable cannot be captured even in best of the scrubbers like "Venturi Scrubbers" with pressure drop from 400 to 600 mmWC. Removing slurry, handling of slurry is problematic. Even disposal of slurry or wet dust is problematic. Some soluble heavy metals can pollute the soil, ground water. So, scrubbers are not suitable for industrial furnace emissions.



What is additionally required in scrubbers, is a proper Effluent treatment plant, with filter press to remove the solids and allow cleaner waste-water for recycling.











Situation Analysis of 6 TPH Lignite fired Process Boiler with add on APCD:

As the "add on APCD" has additional pressure drop, the industry needs to change the existing Induced Draft (ID) Fan to that of higher capacity, to overcome the "extra pressure drop" across the add on APCD, while the "Gasflow (m3/hr)" requirement remains the same. The Gasflow is decided by the quantity and type of fuel fired per hour.

To overcome the friction losses and pressure drops across APCDs, the ID fan is required to provide desired static pressure (SP), apart from the desired gasflow rate in m3/hr. (ID fan has 2 variables, Static pressure (mmWC) and Gasflow (m3/hr)). An ID fan gives a particular quantity of gasflow at a particular static pressure (say eg, 7000 m3/hr at 150 mmWC).

If the static pressure requirement reduces (may be due to a filter bag getting torn or bypassing of the APCD etc), the fan will give proportionately higher gasflow (e.g. 8000 m3/hr at 100 mmWC). Vice versa, if the static pressure requirement increases (may be due to choking in APCD etc), the Gasflow would proportionately decrease (eg 6000 m3/hr at 200 mmWC or even 3000 m3/hr at 250 mmWC).

The Static Pressure requirement (?P) of the ID Fan is calculated as below:

- With only a APH + Multiclone + Ducts/ bends from boiler to stack
- △P = 20 + 75 + 50 = about 145-150 mmwc

If bagfilter is to be added, an additional pressure drop of about 150 mmWC is required to be developed by the ID Fan.

So, the new SP = 150 + 150 = 300 mmWC

So the new ID Fan specifications would look like, as below:

- Old (existing) ID Fan = 7000 m3/hr, 150 mmWC
- New ID fan = 7000 m3/hr (same), 300 mmWC (higher SP)

Existing bagfilter situation analysis:

Some industries have installed Bagfilters as an add on APCD. The ?P across BF varies from about 125 to 175 mmwc , When the bags are clean, the ?P is lower (about 125), while when the bags are dirty (dust laden), the ?P would be higher (about 175). The Desired gasflow is say 7000 m3/hr. The ID Fan damper setting is done accordingly, say to get desired 7000m3/hr.

When bags are clean, the extra 50 mm static pressure sucks more gasflow (say 8000m3/hr) and when the bags are dirty/ dust laden, the gasflow reduces (say 6000 m3/hr).

During a Normal operation of a properly operated Bagfilter, the cleaning of bags is done periodically/ frequently. Hence the variation in gasflow is only for short time, both on plus/ minus sides. Gasflow will be as desired 7000 m3/hr (plus/ minus 5 to 10%, repeating every cleaning cycle).

What happens when APCD is Bypassed? Does it affect energy efficiency? What happens when APCD gets choked? What happens when only "one of the filter bag" gets torn? How it impacts energy efficiency?

- The Gas Law is, "Gas always follows the least resistance path". So, most gas volume passes through "one torn bag" (say 80 % from one torn bag, rest 20 % through other bags) and therefore, the ?P across bagfilter drops (Say from 150 mm to only 50mm).
- **What would happen to Energy Consumption/ Combustion?** The reduced ?P by 100mm increases the air sucked from boiler substantially, Say, from desired level of 7000 m3/ hr to 10000m3/hr (or more). Also, stack emissions would increase substantially, as most gases are bypassing the bagfilter, giving rise to black/ grey colour smoke in the stack emissions.
- A Bag can get torn anytime/ any day. As the bagfilter is closed from all sides, one can't see the bags, unless one opens the enclosure casing, so it mostly goes unnoticed, for long time. Boiler keeps operating with higher gas volumes and hence much higher excess air %. Thereby, higher fuel consumption and higher stack losses.
- To improve the boiler efficiency, typically, an energy auditor suggests "As excess air is quite high, reduce excess air, improve CO2 %. Maybe, install ID Fan along with Oxygen controller based VFD?". Can this solve the problem? Achieve improvement in boiler efficiency?
- Generally, for assessing boiler efficiency, the measurements done are ID Fan motor (current, PF, Voltage, KW), O2/ CO2 % in stack (or boiler outlet), Temp. of Gas, Fuel feeding rate(kg/ hr or kg/day), Feed water quantity (kg/hr or kg/ day & temp), Blowdown quantity (or duration or estimate) etc. And we calculate Excess Air %, ID Fan efficiency, Stack Losses, Maybe unburnt losses and the Boiler Efficiency.

- **How does the industry improve boiler efficiency & also control the pollution levels, in a case of torn bag?**

To identify the root cause and to evolve a solution to the problem, various measurements should be conducted at various locations like boiler outlet (APH inlet), APH outlet (or APCD 1 inlet), Bagfilter Inlet, Bagfilter Outlet, at stack, etc. The following methodology could be followed:

- Measure Pressure drop across various equipments (APH, Multiclone, Bagfilter)
- Calculate Static Pressure of ID Fan (Inlet side + Outlet side)
- Draw Trend (Graph) of reducing CO2 (or increasing O2) between boiler to stack
- Calculate Gas volumes at various locations & temp, (convert them to NM3/Hr at 25 C)
- Calculate 'Leakage Volumes" at APH, APCD 1, Bagfilter, etc
- Calculate excess air based on Stack O2% and APH Inlet O2%

Scientific Method for Measurement of Gas Volume :

The Gas Velocities must be measured scientifically, at "Traverse points" (used for ISO Kinetic sampling, as per USEPA Method). S-type probe shall be inserted through port hole inside the duct, at 90 to gas flow direction. Measure cross section Area at the sampling location correctly. (Even if the data is given by client, cross check physically). Velocities vary at all points and hence take an average of all traverse points. Comparison of flows (& calculation of leakage volumes etc) should only be done on Nm3/hr basis (converted to 25 C).

Analyze the problem in APCD; rectify it to achieve improved Combustion efficiency:

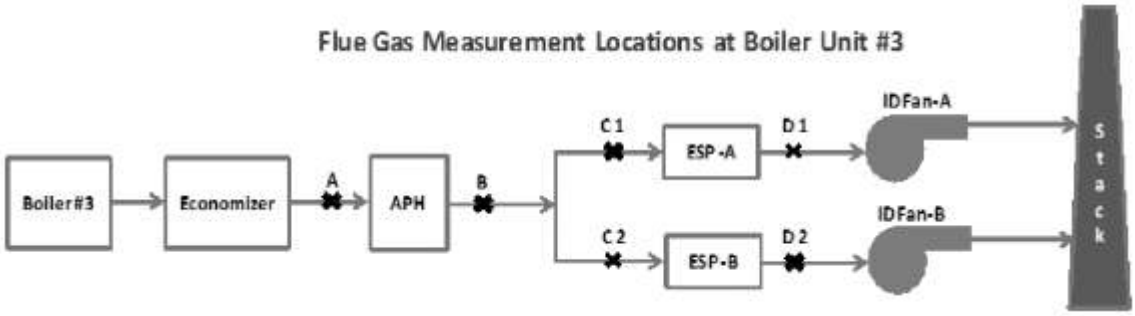
Whether it is a 2 Ton Boiler or a 200 Ton Boiler, the Methodology remains the same (as discussed above). Even whether it is Boiler, Furnace or dryer or whether it is coal fired oil or gas fired, methodology remains the same.

Situation Analysis of a 200 TPH Coal fired Captive Power Plant Boiler with ESP :

Steam is generated at 68 kg/cm2 pressure from a 200 TPH pulverised coal fired boiler for power generation and process heating. As reported, the flue gas temp at stack was in the range of only 120 degC (close or below dew point) and the ESP efficiency was not satisfactory and there was corrosion issues in the ESP, ducts etc. The unit was thinking to augment the ESP with an additional field to increase ESP efficiency.

Field measurements were conducted at various available portholes (before APH, after APH, ESP 1 & 2 Inlets & Outlets and at Stack). Measurements were conducted for gas composition (O2, CO2, CO) & gas velocity in m/s and gas temperature.

Based on the measured parameters like gas velocity & O2 % at various locations on Boiler-3, it was observed that there is air ingress in flue gas path from APH (Air Pre heater) to stack. The schematic of the flue gas path in boiler and measured gas flow rates is shown below:



Parameters	Unit	APH		ESP A		ESP B	
		A	B	C1	D1	C2	D2
		APH Inlet	APH Outlet	ESP A Inlet	ESP A Outlet	ESP B Inlet	ESP B Outlet
Gas Temperature	°C	367	153	147.4	138	144	133
Measured CO2	%	14.9	11.27%	12.16	10.47	11.975	11.3
Measured O2	%	5.2	8.3	8.1	9.9	8.3	9
Percentage Leakage	%	24%		16%		6%	

- The total air leakage/ingress in boiler is 46 % of the total air volume handle by ID fans
- The air ingress in APH is about 24% of the total air volume handled by ID fans
- The air ingress in ESP A is about 16% of the total air volume handled by ID fans while in ESP B, it is 6 %.

Effects of Leakages in APH and ESP on ESP Performance and extra energy consumption by ID , FD and PA Fans :

The performance of APH was analyzed based on flow rate of flue gas before & after the air pre heater. It is observed that there is a increase in flue gas flow rate in Nm3/hr and also the corresponding increase in O2 % from APH Inlet to Outlet. This clearly indicates there is air leakage in the system. This air ingress could be due to improper sealing or punctured APH tubes because of corrosion. The air ingress leads to reduction of heat recovery in APH. The air ingress increases the load on ID fans due to which power consumption of ID fans also increases.

A leakage of 16 % & 6 % is observed respectively in ESP-A & ESP-B .This could be through the hopper bottom (due to improper water seal) or through manhole door packings or leakage in the enclosure packing materials etc. Any leakage in the ESP adversely affects the efficiency of ESP due to increase in flow and thereby increase in gas velocity. Practically the leakage should be reduced to about 1%.

It was recommended to arrest the existing air ingress/leakage in APH & ESP till allowable limit to reduce the present power consumption of ID fans & to improve ESP efficiency.

The estimated cost benefit by arresting the air leakage in APH & ESP is given below:

Table : Cost Benefit of reduction in ID Fan through reduction in leakage		
Parameters	**Unit**	**Value**
Present Power Consumption by ID Fans	kW	389
Present Total Leakage	%	46%
Allowable Leakage	%	12%
Reduction in Power Consumption	kW	132.2
Percentage Reduction in Power Consumption (132.2/389)	%	34
Annual operating hours	hrs/yr	7200
Annual Reduction in Energy Consumption	kWh/yr	951782
Electricity unit cost	Rs./kWh	4
Annual Cost Savings	Rs./yr	3807130
Investment	Rs	800000
Payback	Months	3

Table : Cost Benefit of reduction in FD & PA Fans by reduction in leakage		
Parameters	**Unit**	**Value**
Present Power Consumption by FD & PA Fans	kW	575
Present Total Leakage	%	24%
Allowable Leakage	%	10%
Reduction in Power Consumption	kW	81
Percentage Reduction in Power Consumption (81/575)	%	14%
Annual operating hours	hrs/yr	7200
Annual Reduction in Energy Consumption	kWh/yr	580003
Electricity unit cost	Rs./kWh	4
Annual Cost Savings	Rs./yr	2320013
Investment	Rs	700000
Payback	Months	4

In addition, the Increase in stack temperature above due point resulted in avoiding corrosion in ESP. The flue gas temperature at stack (ESP Outlet) was found to be only 119 oC. The estimated dew point temperature for about 0.4 % Sulphur in coal & 85 % moisture in fuel and 80 % RH is about 130o C.As the stack temperature is lower than the dew point temperature & due to presence of SO2 in the flue gases, it may result in corrosion of following items (especially mild steel item)

Table: Effects of Corrosion on various items

Item	*Corrosion of*	*Expected Adverse Impacts*
ESP	Collecting plate wires enclosure casing	Corrosion may lead to rusting of steel plates/wires forming resistive layer, which will reduce efficiency of ESP & also reduce life of the components
ID Fan	Impeller blade & casing	Impeller blades may get rusted, eventually may get damaged, reduce life, reduce efficiency
Stack	Steel Surfaces (if any)	Corrosion of exposed steel structure in stack may reduce life in stack

The direct savings cannot be estimated, however, the benefits would be in terms of "reduced corrosion".

In overall, due to identification of specific leakage locations through measurement of O2% and Gas Volumes at "intermediate locations" between APH and ESP, it became possible to take necessary measures to minimise the leakages. It resulted in 3 benefits, as below.

(1) Increase in flue gas temp above dew point, thereby reduced corrosion in ESP, ducts, stack, etc thereby increased life of ESP.

(2) The ESP efficiency increased because of "Reduced gas volume, thereby reduced gas velocity in ESP" and there was no need to add extra field in ESP.

(3) It saved substantial electricity consumption of the ID, FD and PA Fans (due to reduced volumes to be handled) to the extent of Rs. 62 lakh per year.

Conclusion:

- For improving performance of APCD, a systematic study of the entire system should be first undertaken before adding on or replacing an APCD
- Analyze the problem in APCD, Follow the suggested methodology
- Measure pressure drop, gas volumes, Oxygen % at intermediate locations

- Identify leakages like torn filter bags, seal it or change the torn bag (do not bypass)
- Always install a U tube manometer to display pressure drop across bagfilter/APCD
- Calculate excess air %, control it
- Operate APCD keeping in view to achieve improved Combustion efficiency
- In many cases, it is possible to upgrade performance of existing APCDs, with requisite modifications.

Notes

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