ISSN (Online) 2321 – 2004
ISSN (Print) 2321 – 5526

IJIREEICE INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH IN ELECTRICAL, ELECTRONICS, INSTRUMENTATION AND CONTROL ENGINEERING
Vol. 3, Issue 8, August 2015

Role of Modern Flue Gas Analyser in a Thermal Power Plant to Monitor & Control Efficient Combustion Process & Improve Carbon footprint

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Abstract: The concern for Global Warming and Climate change had already made a social impact in the planet earth & corporate strategy on mitigating plan need to be adopted to restore ecological balance & our sustainability. While any economic growth is associated with Industrial developments , which will trigger a new concern to the environment , innovative adoption of various energy efficient processes will ensure better Carbon foot print. In India for any sustained growth the requirement of Power will always increase & new Power Stations need to be set up . While setting up Power stations considerations need to be given for selecting appropriate technology, size & selection of energy efficient process and equipment, optimize the combustion process .Role of analysers for measurement and control plays a major role to optimize the process operation & reducing fuel and energy wastages . Further selection of the appropriate technology for analyser , proper installation practices & control strategy based on the analysis and its response time are the key considerations for successfully implementing automatic combustion Control . This paper aims to describe the challenges in the selection of the appropriate gas analysers for the measurement based on the various technological versions , the analysis of the result & implementation of control to improve Carbon Foot Print .

Keywords: GHS, FGD.

INTRODUCTION

The present Concern for Global Warming and reduction of CO2 emission had made significant impact on the environment & unless mitigating measures are adopted at all levels, the impact will be far reaching. The Planet earth is covered by a Blanket comprising Green House Gas (GHS) which keeps the earth's surface warmer. This blanket allows the shorter wavelength infrared radiation from the Sun to pass through the earth's atmosphere and absorbed by the surface of the earth making it warmer. A part of the wave is redirected back to the atmosphere as larger wavelength, which is mostly absorbed by the Green House gas blanket.This makes the earth warmer . As more GH gas is produced , the earth's temperature will go on rising consequently putting impact on climate change . Climate change will result in more severe floods, droughts in other locations, rising sea level , redistribution of rainfall pattern and prevalence of insects . All theses will make a negative impact on society affecting health & economic development.

It is seen that the major source of CO2 generation is through Power Industry & hence this paper will address the possible mitigating approach that had been taken to improve less CO2 generation.
Further the role of Analytical measurements & their importance in assessing & taking corrective measures for improved combustion and improving other process will also be discussed.

The Process of Improvement that had been conceived for Power Generation Technology was:
I) Energy efficient process & equipment.
II) Adoption of Supercritical Technology to improve conversion efficiency.
III) Oxygen trimming to optimize combustion air
IV) Continuous Emission monitoring & improve operation based on measurement.
V) Efficient Burner design for more conversion efficiency & reduced NOX generation.
VI) New generation flame scanners to analyse the quality of flame.
VII) Research in Oxygen Injection for safe combustion & reduced heat loss by carryover of hot air.
VIII) Research in clean development mechanism.

TABLE I: STATISTICAL DATA ON EMISSION OF GHS

Green House Component	Composition in terms of % of overall GHS emission	Sources of generation
Methane (CH4)	9.0	Agriculture (Livestock) , Coal mining , Organic Waste .
Nitrous Oxide (N_2O)	6.0	Power Generation (Fossil Fuel Combustion) , Industrial Process & Nitric Acid Production .
Fluorinated Gases	3.0	Aluminium Smelters, Refrigerants & Fire Extinguishers.
Carbon Dioxide (CO_2)	82	Power generation (Fossil fuel), Other Industry involving combustion of carbon.

Source: US EPA

The percentage of power generation from Non Conventional Power Plant being insignificant compared to Fossil Powered Plants , are not discussed in this paper .

This paper will focus primarily on the role of Gas Analyser in a Thermal Power Plant , the type of

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measurement & the automatic correction of the Combustion Control Process to reduce extra air and reduce CO2 generation .

The National Ambient Quality Standards indicates the Quality of gas as indicated in Table II

TABLE II

SL No	Pollutant	Time weighted Average	Concentration in Ambient Air		
			Industrial Residential Rural Other Area	Ecologically sensitive Area (Notified by Central Gov.	Methods of Measurement
(1)	(2)	(3)	(4)	(5)	**(6)**
1.	Sulphur Dioxide (SO_2), µg/ m^3	Annual 24 hours	50 80	20 80	Ultraviolet fluorescence
2.	Nitrogen Dioxide (NO2), µg/ m3	Annual 24 hours	40 80	30 80	Chemiluminscence
3.	Particulate Matter (size less than 10µm) or PM10 µg/ m3	Annual 24 hours	60 100	60 100	Beta attenuation
4.	Particulate Matter (size less than 2.5 µm) or PM2.5, µg/ m3	Annual 24 hours	40 60	40 60	Beta attenuation

Source: Central Pollution Board Notification 18th Nov 2009

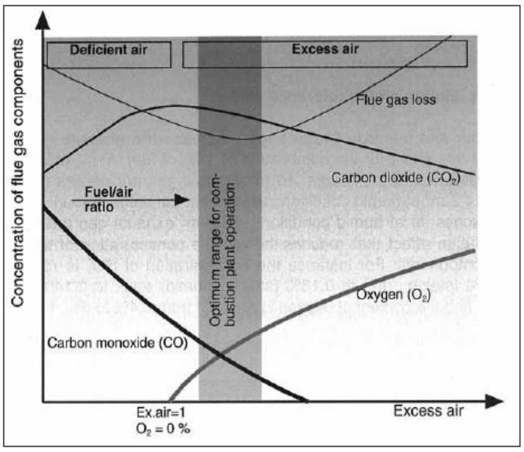
Thus it is imperative that in a Thermal Power Plant , Process Equipment , Instrumentation and Automation need to be selected to achieve emission within the standards as specified .

Release of SOx, NOX and CO2 from the Chimney are the contributors in the formation of Acid rain , that are major concern while the particulate emission spoils the land and crop & poses health hazard to the local inhabitants . Thus their generation within normal stipulated restrictions need to be adhered to.

The formation of SOx is related with the presence of Sulphur in coal .When sulphur content in coal is high, desulphurisaion technique by setting up a separate chemical process to capture SOx from flue gas is implemented . In Indian context , while designing the plot plan, space provision for setting up FGD (Flue Gas desulphurisation) plant in the future is kept in case the FGD is to be installed in future to comply with the more stricter pollution control norms.

The formation of NOX as a byproduct in combustion within the furnace is minimized by modifying combustion adopting low NOX burner. Generally this type of process involves two stage combustion to completely burn the fuel in the second stage . This controls NOX formation . Further over fire Air Dampers also ensures complete combustion at controlled temperature . There are other also not so popular techniques by using Reducing Agents like Ammonia which in presence of excess oxygen converts the oxides of nitrogen to nitrogen gas .This reaction occurs under controlled temperature which need to be maintained with calculated excess air.

The CO & CO2 are byproduct of combustion of coal . The CO which is an undesirable product formed due to incomplete combustion , is controlled by ensuring complete combustion in the furnace by ensuring sufficient air more than that required under stoichiometric condition and adequate residence time. If Oxygen is less , the combustion process will be inefficient and will generate unwanted product like CO and smoke , while if more air is supplied additional heat will be carried over resulting energy loss . Thus a balance on additional air must be achieved . A study of the curve in Fig -1 depicts the balance in the combustion process under various air flow condition .



Source: Flue Gas Analysis in Industry By Testo.

The figure suggests that to implement this we find that both O2 or CO2 may be the controlling parameters to ensure complete combustion & to ensure slight additional air (O2) to ensure safety & also variations in the process conditions. However a careful study reveals that Oxygen should be the controlling parameters as CO2 pattern indicates that at both Fuel rich & Excess air conditions it assumes value which would be misleading for control purposes .

Hence Oxygen is measured at Flue gas at Economiser outlet to control the Combustion Air . In general based on Operational experience excess Air allowed in Pulverised Coal fired plants is 20-25 % while in Stoker Coal fired plants , the same is maintained between 35-40 % . Also the extra Oxygen is maintained as 5- 10%.

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The air flow control is maintained by the Combustion Control algorithm which measures the main steam pressure to detect the load changes with other guiding parameters from the coordinated control system . This in turn adjusts the Fuel & Air flow by cross monitoring to always ensure absence of fuel rich mixture in furnace . The Oxygen measurement trims the secondary air flow by a cascading control function on the secondary air control loop . In practice the control works well with optimizing the Air Flow , while not allowing fuel rich mixture .

By ensuring complete combustions the possibilities of un-burnt fuel has been eliminated , while the particulate like ash which is carried over is captured in the ESP/ bag filter & the new generation control ensures particulate emission from chimney below 50 mg/Nm3.

It is to be concluded that to achieve the desired pollution level reliable and industrial grade accurate Analysers are required & in the present days the same are available with high reliability and accuracy. The key point of the Analysers are described in the Table –III

TABLE III

Analyser Type	Technology of Measurement	Location of Measurement	Desired Process Value	Analyser Range	Analyser Accuracy
SO_X Analyser	Non Dispersive UV Fluorescence (NDUV) ,Non dispersive Infrared (NDIR)	At Stack	80µg/Nm3	0-100 ppm	1.0%
NO_X Analyser	Chemiluminescense (CLD).	At Stack	80µg/Nm3	0-100 ppm	0.4 ppb
CO Analyser	Non dispersive Infrared (NDIR)	Flue Gas at Economiser Outlet	-	0-10000 ppm	0.1 ppm
Particulate Analyser	Nephelometry, Laser scattering , Optical Transmission .	At Stack	50µg/Nm3	0-2500µg/m3	2%
Oxygen Analyser	Differential Oxygen concentration of sample gas and known reference gas at 4500C, produces a DC Voltage across the Zirconium oxide(Pt element at each side). The voltage is a function of the difference of O2 concentration based on Nerst equation .	Flue Gas at Economiser Outlet	Oxygen recommended % in Flue Gas 0-10%	0-25%	1%

Source : Manufacturer's documents .

Thus it is seen that various innovative developments had been initiated for combating pollution & the modern day Analysers provide valuable & accurate measurements for either implementing direct control or provide valuable information for the operator to adjust the various equipment to bring back operation to desired level . With time the environmental regulations are becoming more stringent & research are being carried out to develop new & better ways of measurement , improved control to ensure better fuel efficiency , cost reduction and minimising pollution .

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