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Interoperability Requirements of Heterogeneous OCEM Systems

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ABSTRACT

Information integration is the essence of data interoperability[1], as it plays a crucial role in decision making. Instruments used for Online Continuous Emission Monitoring Systems (OCEMS) use various protocols like Profibus DP protocol, Modbus RTU Mode, Modbus ASCII Mode, RS 232, RS 485, TRIOS data protocol, TCP/IP Protocol and many more. Although the very purpose of these systems is same but the procedure followed to measure the parameters differ.

OCEMS Industrial Data Collection Network has been laid down in our country, India, where in more than 3000 industries have installed these systems as per CPCB. Since, Different manufacturers, manufacture these systems, they follow different techniques and manage their systems.

This article is based on study of protocols differing based on methodology used specifically for Particulate Matter (PM) monitoring and the data submission procedure followed.

The data collection from different technologies has to be harmonized from technologies (different) point of view as well as from environmental monitoring methodologies point of view in such a way that a standard format can be created. In order to create this standard format of data generated through different technologies, and to bring the monitored data submission at par, it is proposed to go phase-wise. In the first phase, essential requirements of the system like auditing, along-with the parameter results shall be managed through proposed protocol, which could be called as minimum common protocol. However, in the second phase after understanding all technologies and methods to be followed, a common protocol can be developed, which can be used by all the industries in future. The first phase protocol has been suggested in this article.

KEYWORDS: OCEMS: Online Continuous Emission/Effluent Monitoring Systems, Protocol: defined procedure for calibration and maintenance, data sharing mechanism.

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INTRODUCTION

Information integration is the essence of data interoperability as it plays a crucial role in decision making. Online Continuous Emission/Effluent Monitoring Network has been laid down in our country on the direction of Central Pollution Control Board and Ministry of Environment, Forest & Climate Change, where in more than 3000 industries have installed environmental emission & effluent monitoring systems.

Each industrial sector produces different products using different raw materials through different chemical process, because of which physical conditions of emissions/effluent being discharged from each industry defer. Based on balancing between Best Available Technology's (BAT) available at a cost and the effect on present emission/effluent levels and subsequent benefits after deploying the new technology in general and in quantitative terms collectively, emission/effluent limits are fixed ensuring that specific sector make efforts to introduce better Technology in a time bound manner. Hence, Dynamism in the system is maintained continuously to strive for cleaner technologies introduction, day by day in such a manner that neither production gets affected nor environment condition gets deteriorated and a balance is maintained.

This results into prescribing different standards/limits to different sectors of industries and thereby requiring deployment of different technological instruments having variation of ranges of measurements of different monitoring parameters in the field.

The biggest challenge in the entire process is the correct measurement. Correct measurement requires understanding of physical state of effluent/emission and the process by which these are generated. These factors may affect the measurement technique & Instrumentation directly or indirectly. Secondly these systems are electronics based systems, can only operate in a managed environment as recommended by the Instrument manufacturers beyond which, the measurements have no meaning. Hence, maintaining these environmental conditions at the housing, where systems are operated is equally important. Thirdly, the logical installation of systems at correct location (identified on the basis of principles of monitoring) for the measurement of correct levels and selecting specific technology for specific type of operation in a plant go hand in hand to ensure correctness of measurements. These are some of the issues because of which these systems have become heterogeneous, complex and require incorporation of intelligence in the systems itself.

For correct measurements, it is also important that the state of device is considered before finalizing the action over the data received. This state of instrument can be verified through the defined procedure of timely calibration and maintenance of instruments.

Various techniques are available for the monitoring of particulate measurements (PM) in emission monitoring systems, some of these have been discussed here from the point of view of requirement of heterogeneity and thereby requiring interoperability of methodology so as to consider the correct measurement through system intelligence.

INTEROPERABILITY

Interoperability can be best understood with the live example of cloud computing as on date. In the cloud computing we see that the resources are connected with each other and operate with command software which is called a framework through which any make device gets integrated into the system and works as it is being operated through its own firmware. The interoperability may not be on the lowest level but there is an understanding between the system that it gets operated and the end user gets its result. The cloud computing is done through the networking where if network remains present the devices gets integrated and the user feels if its resources are available for use at any point of time and if network is absent then the resources are lost and no device remains available for the use.

Information integration is the essence of data interoperability which plays a crucial role in decision making. Instruments used for Online Continuous Emission Monitoring Systems (OCEMS) use various protocols like Profibus DP protocol, Modbus RTU Mode, Modbus ASCII Mode, RS 232, RS 485, TRIOS data protocol, TCP/IP Protocol and many more. Although the very purpose of these systems is same but the procedure followed to measure the parameters differ. There is a need to get all these systems operated through a system which can co-ordinate in the similar fashion as is being done in case of cloud computing. The resources remain with the system but become visible through common protocol.

Perhaps this would be an appropriate method where data management protocol of all OCEMS systems follows a common protocol for data reporting and other common purposes while act as an individual system for operating its facilities which are specifically required to operate its procedures specified for a particular methodology.

The actual software development is the continuous process through the use of Building Blocks[2] methodology, Proposed common activities could be:

a. Data Levels as reported from the instrument as results on continuous basis.
b. Auditing Procedure – although different instruments zero calibration procedure will differ but as a cross check procedure a common minimum process can be defined which can fit in with all technologies known today.

c. Span Check Procedure - although instrument span calibration procedure will differ and even in some cases methodology will also differ (like for some in-situ instruments procedure will be different, but as a cross check procedure a common minimum process can be defined which can fit in with all technologies known today.
d. The zero or span check will trigger different methods as applicable in the system through a common command. This requires exhaustive analysis of each instrument and its various models. It will require common protocol development for existing systems and with an option of expansion for new systems to be introduced in future. It will also vary in frequency for in-situ and for extractive type of systems.
e. Basic functionalities which are common like moisture, temperature, pressure of flow monitoring is required in most of technologies which work on the principles of extractive system (cold dry or hot wet) the same may be made the part of the common protocol.

The common protocol could be developed through cloud management system with a concept as above. At the same time other operational activities, should not be disturbed in any case otherwise the entire system will collapse. However, during these takeover conditions (when systems are taken over by the Cloud common protocol), the system would not be available for its routine activities through normal protocol of the analyser.

The supervisor synthesis[3]technology could be considered for an automated software code generation. The proposed approach is systematic and based on process theory. The same could be implemented as a model-based systems and software engineering framework.

RESEARCH METHODOLOGIES

3.1 Methodology available for PM (Particulate Matter) Monitoring in Stack

Various methods available for the monitoring of PMEmissionparameter are:

A. Probe electrification
    a. Charge Induction (AC)
    b. Contact Charge Transfer (DC)
    c. Combination of AC & DC
B. Transmissometry
    a. Ratiometric Opacity
    b. Opacity
C. Scattered light

a. Forward Scattered Light
b. Back/Side Scattering

Each method is getting evolved to overcome its technological shortcomings in a specific type of process in a specific type of industry, however technological advancement is continuous process through which technologists keep on attempting to overcome shortcomings by means of Research and Development (R&D). Hence, issues present in a specific technology today may not be there tomorrow, as by the time the research might have found its way to overcome its limitation.

For example, some of the limitations of a method **Charge Induction (AC)** till date are as below:

i) It is applicable only when stack diameter is in between 0.2 to 4meters
ii) It can measure maximum up-to 1000mg/m3
iii) It can't provide correct results if Stack flue gas has water droplets
iv) It can't be installed in the process where Air Pollution Control Devices (APCD) is Electrostatic Precipitator (ESP)
v) It requires regular sensor contamination check
vi) It can provide correct results if PM size does not vary in the flue gas which can never be ensures as it depends upon the quality of raw material used

Hence, the applicability becomes limited for this technology.

Now the research has found its way and using FARADAY SHIELD the limitation of technology relating to use of this methodology, while using ESP has been overcome. Similarly, various methodologies mentioned here have their own advantages and disadvantages in different situations which can't be overlooked while taking decisions. At the same time this race against time to produce the best at the lowest cost is continued and never ending.

However, discussion herein is limited to that, there should be no variation in results, whether generated using one technology or other. This requires in depth understanding of the subject, basic methods used for correct monitoring of parameter, understanding of factors influencing the results like interferences, process conditions, flue gas composition together with details of methodology by which the parameter is being monitored, and procedures being adopted to reach to a correct result following defined methodology.

At last, the data transfer in such a manner that the received data from one of the technologies be at par with another for comparison with respect to Prescribed Standards. This will enable regulatory bodies to monitor the compliance levels of an industry with respect to Prescribed Standards.

3.2 Instrumentation

Since, there are various methodologies available to monitor emission and effluent levels in a particular type of industry, it becomes necessary to collect not only the data of specific parameter but also of the instrument status, instrument configuration, and other conditions considering which the instrumental process has been regulated to ensure correctness of methodology adopted meeting the specified criteria required to ensure the defined procedures in the guidelines of Instrument supplier and regulators. These guidelines are developed on the basisof standard methodologies required to be followed to monitor the correct results.

Regulator's guidelines for emission monitoring[4]and effluent[5]are available at its website.Standard methods for emission monitoring for PM monitoring is mentioned in the Emission Regulation Part-III[6]are also available at the regulator website for the general public.

Being a complex methodology, where every input as mentioned in measurement techniques and guidelines brings the results close to its correct values,any flaw will lead to severed results, which may deviate it severely.

In view of above the challenge becomes very big and requires correct methodology for Selection of Methodology, Instrumentation, site selection, and operation.

3.3 Core Issue of Methodology & Data Management

Complexity of the system requires effective data management addressing complex issues of the OCEM System. Technologies are available, which have addressed various issues of OCEMS and other issues are being addressed continuously. First of all, it is to be understood that heterogeneous systems are operating in the field and the results obtained based on different methodologies require to be normalized so that these could be compared with the prescribed standards.

This point is further clarified like if we see the Opacity measurement, it is being done in various plants to monitor PM. This is in-situ measurement and based on single pass or double pass the results are calculated by the instruments. However, it is known that there is interference of moisture and hence, moisture corrections are a must before finalizing the results. Similarly, this is an indirect method in which a factor is require to be developed to approximate the results in terms of mg/m3. This requires monitoring of flow else estimation of flow will also contribute error. The glass of opacity monitor need to be cleaned up in suitable interval otherwise the results will be reduced continuously. Unfortunately these results go in favour of industries, hence, the industries are least bothered. Conversion of opacity into particulate is again an issue which requires conversion factors implemented in each result.

Now, when data from such technologies get transferred then, calibration becomes an issue as the system is installed cross duct and for each time calibration, it can't be dismantled. In such circumstances, the errors available in the system accumulate and since, errors favour the industries, the stringent measures are required to be implemented to ascertain that monitoring using proper methodology is done. Hence, different technology requires different set of data along-with actual parameter data with respect to each different technology.

Now in order to accommodate heterogeneous systems a strong data management system is required to be in place. The system should address all the technological issues, standard method following procedures and procedures required for QA/QC so that results obtained become at par with all other technologies and comparable with Prescribed Standards. Data collection requires all these issues addressed before placing the results for the comparison with Prescribed Standards.

RESULTS AND DISCUSSION

The management of heterogeneous systems is a herculean task. Common Protocol could be a reality if it is implemented in phases. Initially the common protocol may cover few points like Auditing Checks of technology, as mentioned in this document through which minimized remote functionality could be managed, which is the common minimum programme to operate OCEMS and calibrate remotely with a specific time period defined in case of in-situ systems. For maintaining uniformity the procedures for zero calibration and span calibration need to be defined and to be followed by all the system providers. This will enable regulators to cross check these systems and commonly obtain the data of relevant parameters. Still the dependence of basic protocol of the system will remain, so as to check the system from maintenance point of view. The common protocol of other parameters irrespective of technology will require selection of parameters essential in each methodology to be made part of it. The exercise would require elaborate understanding of each methodology and coherence of method with standard methods of measurements of each parameter. However, the bigger challenge is to accommodate systems operating on analog based outputs. These systems have to be completely shifted from analog to digital mode which is also quite bigger challenge for the country India.

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