PREDICTIVE OR CONTINUOUS – A GUIDE TO CHOOSING THE RIGHT EMISSIONS MONITORING SOLUTION

Predictive Emissions Monitoring Systems (PEMS) are emerging as a viable alternative to Continuous Emissions Monitoring Systems (CEMS), but they should not be considered a like for like swap in all applications. Gregorio Ciarlo, Product Manager for Predictive Emission Monitoring Systems for ABB Measurement & Analytics, explains this new technology, and examines how it fits alongside established continuous emission monitoring systems

Today's industrial plant owners and operators face a wide range of challenges that affect the operations and productivity of their facilities. One example is the tightening environmental regulations and emission limits that require the continuous acquisition of emission data to monitor and control a variety of pollutants and greenhouse gases released into the atmosphere, which are putting the onus on companies to put sustainability at the heart of their processes.

Failing to provide emission data to authorities can lead to financial penalties, and even forced plant shutdowns. Accurate emissions monitoring is therefore crucial to managing and mitigating the impact that a company's operations have on the environment. For this reason, emissions monitoring is an area where it is increasingly important to ensure that the best possible systems are in place to capture and report data.

Introducing PEMS

Traditionally emissions monitoring is achieved using Continuous Emissions Monitoring equipment (CEMS), whereby a small sample of gas is extracted and measured by a gas analyzer. A wide range of solutions are available to measure different gases, either individually, or using equipment such as ABB's ACF5000, across multiple gases.

These established solutions are now being joined by a new breed of emission monitoring system. Utilizing advanced mathematical modelling techniques, software-based predictive emission monitoring systems (PEMS) are increasingly providing an alternative for monitoring and recording air pollutant emissions.

In gas measuring applications, PEMS can be used either alone or alongside CEMS to improve efficiency and accuracy. PEMS involves dedicated software which provides a reliable real-time estimation of emission properties by means of a mathematical model (e.g. neural networks), using process values such as temperature, flow and pressure as input variables. The software is used to estimate pollutant concentrations, with predictive models exploiting the inherent correlations between process variables, ambient conditions, and emission properties (NOx, SO2, CO, CO2). From this, the system uses AI to provide emission estimations with an accuracy comparable to conventional hardware analyzers. Crucially, PEMS improves system uptime. A typical CEMS can generally be expected to achieve 95 percent availability, while the use of PEMS increases this to 99.5 percent.

As a means of measurement, model-based emission monitoring provides several key advantages, including:

- Recognition as an accepted measurement technique by international environmental regulations and standards.
- Ability to offer increased emission data availability up to 99.5%
- Lower capital investments and reduced ownership costs, with minimal maintenance needs and not requiring consumables and spare parts.
- Easy integration at plant – no measurement hardware or sample handling system is required in a PEMS, freeing up space and minimizing disturbance to plant operations while reducing physical requirements for maintenance to zero, with no compromise on accuracy.
- As a back-up for CEMS systems, PEMS can help identify possible malfunctions and provide an alternative measurement when the analyzers are in maintenance
- They can provide an overview on the process, highlighting anomalies and providing a preliminary evaluation of excess emissions

Predictive emission monitoring systems (PEMS) are increasingly being used for monitoring and recording air pollutant emissions.

Crucially, the suitability of PEMS for emission measurement has been recognized by various regulatory authorities around the world, and recent changes to permit their use is opening new possibilities for the effective measurement and control of emissions.

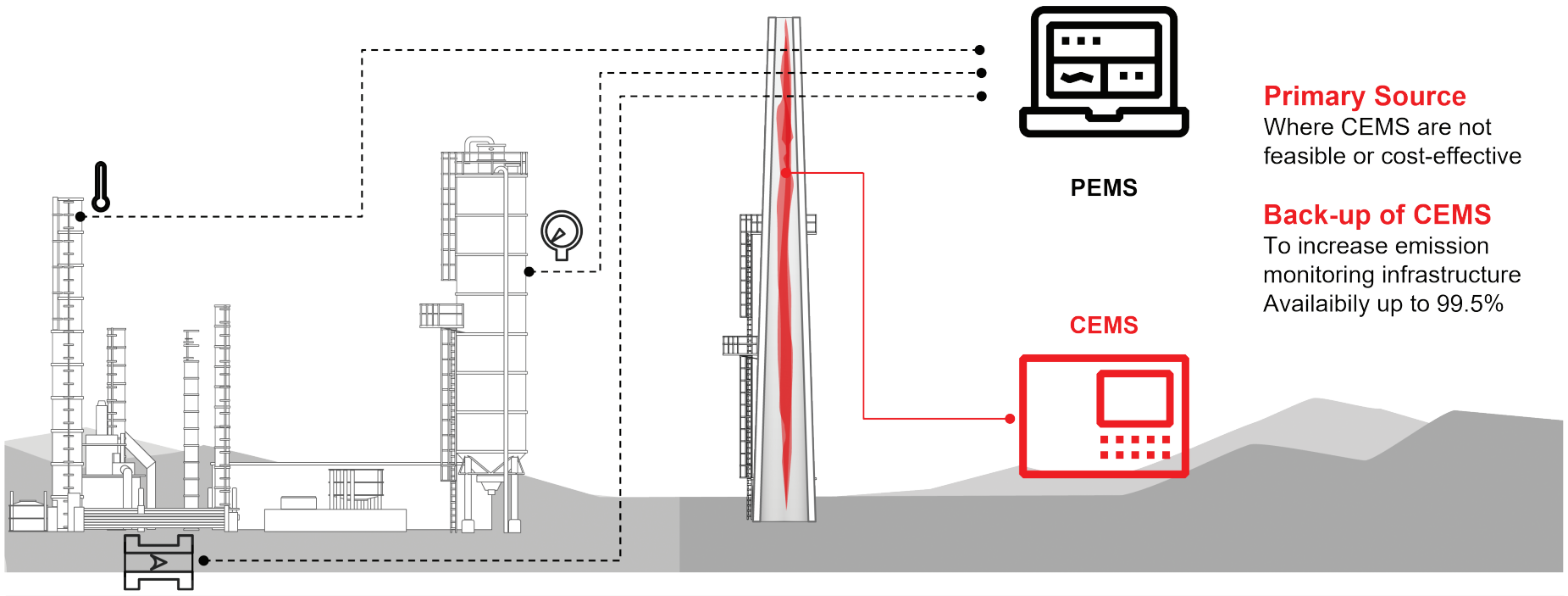
These advantages are seeing PEMS playing a widespread role in the future monitoring of emissions from industrial plants, with a corresponding growth in take up as its benefits are realized. According to the ARC's 2019 report 'Emissions Monitoring Systems Global Market 2018 to 2023'[1], shipments of PEMS solutions are projected to grow at a CAGR of around 6.8 percent, from USD 29.5 million in 2018 to USD 41.1 million in 2023, with growth driven by a combination of increased environmental awareness and stringent environmental regulations to achieve targets such as those set by the 2016 Paris Agreement.

How to choose between PEMS and CEMS

The choice of whether to use PEMS or CEMS will depend on a vareity of factors including process layout, equipment and operative conditions. Ideally, an effective solution portfolio should include both software and hardware-based emission monitoring strategies, providing the ability to cover the whole range of possible applications. For example, the model-based nature of PEMS means it may have an edge when applied to boilers, gas turbines or furnaces where conditions are relatively stable, while conventional CEMS are to be preferred in applications with more changeable conditions such as waste incinerators or the most complex industrial processes such as those in the chemical industry.

Whilst a PEMS can be used as a standalone solution, or as a back-up for CEMS, it should not be considered as a direct replacement. To that end, CEMS still very much have their place in the modern plant.

Many companies offer either CEMS or PEMS solutions, but very few can do both. ABB is an example of a company that has



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coupled its comprehensive CEMS offering with its digital expertise to provide a wide range of solutions for all environmental applications. This helps operators to comply with regulations, reduce costs and maintenance, optimise emission monitoring, and improve system uptime.

Benefits of PEMS

A key benefit of a PEMS system is cost. Compared to an equivalent CEMS, PEMS can typically reduce lifecycle costs by up to 50 percent over a space of five years. This is because the lack of any measurement-related hardware means that the purchase cost is much lower, and with no physical equipment required apart from a PC from which to operate the software, there is no need for continual equipment maintenance beyond adjusting the software model and calibrating. A PEMS also does not need replacing as any changes can be managed through updates to the software, server or operating system.

Another benefit is speed of implementation. PEMS can be installed more quickly, with less training required to be able to use the system. As long as the system has an online connection, it can be operated remotely either by in-house staff or a third party.

While a CEMS can flag up excess emission levels, it typically does not provide any insight as to why they have occurred. In contrast, a PEMS can use dynamic set points to trigger alarms based on information inferred from historical events. The more data the system parses over time, the more accurate it can become.

ABB's PEMS applications take this a step further by utilizing Inferential Modeling Platform. This is the product of decades of experience in emission monitoring and modeling applications to provide an easy-to-use, powerful and efficient tool to develop and deploy advanced mathematical models and to deliver the specific functionalities prescribed by the environmental regulations (e.g. US EPA Performance Specification 16, EU TS-171198). Its Sensor Validation system pre-analyzes the input values before feeding to PEMS models, preventing the PEMS from inputting faulty variables that could affect the quality and reliability of the system's operation. This makes it possible to verify in real-time that PEMS inputs are consistent and, where applicable, replace faulty values with reconciled ones to maintain high accuracy. This advanced sensor validation system allows to keep PEMS output quality assured and further increasing the availability of the system.

A PEMS example

ABB's PEMS solutions have been implemented at various sites around the world. In one application involving a major oil and gas company, the solution is being used to help measure gas turbine emissions. In this application, a temporary CEMS analyzer was used to acquire proper emissions data to help develop and design the appropriate models for PEMS, with process data simultaneously being collected directly from the plant distributed control system (DCS). The data collected was designed to cover the widest range of process conditions.

Data processing, model design and offline validation and site implementation activities were executed using the ABB proprietary software Inferential Modelling Platform.

Data processing is a key task during the development of an empirical model and involves crucial steps.

After the optimal sampling rate was identified to ensure an adequate set of representative records were available for modelling purposes, sophisticated statistical and mathematical techniques were then applied to select the most relevant parameters to be included as input variables for the models. Neural Networks algorithms were used for model finalization as they proved to be the most efficient and robust in terms of accuracy and reliability.

The final PEMS system was integrated with the DCS and other plant automation infrastructure.

To enable the relative accuracy of the PEMS system to be determined, the installed system was then subjected to an Environmental Protection Agency (EPA) assessment and certification process by an authorized third-party company. During this process, emissions estimations by PEMS were compared to values measured by CEMS at different operating conditions. As the performances for each emission were compliant with EPA regulation, the system was certified and accepted by the customer.

Summary – consider your emissions measurement requirements

Obtaining proper, accurate and reliable information about emission levels is crucial both for determining strategies for keeping emissions within regulatory requirements and in the ongoing effort to tackle climate change.

PEMS can take on the duties of a CEMS in certain circumstances, but they are not a direct replacement for all applications. PEMS should instead be considered as a complement to the traditional CEMS. Depending on application and local constraints, best practice may require the installation of a CEMS, PEMS or a combination of both. For stable processes with little variance, a PEMS can do the same job as a CEMS at a fraction of the cost, while in more complex processes they can dovetail effectively to improve accuracy and uptime.

Industrial companies should contact a trusted emission monitoring system supplier to assess the best options for their plants and operations, which may often be a combination of both CEMS and PEMS.

For more information about ABB's PEMS solutions, visit: https://bit.ly/ABB_PEMSys

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