MEASUREMENT & ANALYTICS

Predictive Emission Monitoring Systems (PEMS)

FAQ – Frequently Asked Question

Accurate, compliant, machine learning-based solution reducing lifecycle costs.

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01 PEMS provides same accuracy as conventional CEMS solutions with extended availability (up to 99.5%).

Introduction

The document is aimed at providing ABB colleagues an overview on Predictive Emission Monitoring Systems (PEMS), explaining in a quick and immediate form the ABB offering, expertise and providing the main hints to the most common requests and clarifications possibly raised by Customers.

The document is specifically addressed to ABB sales force in order to provide an initial guidance to familiarize with the technology and the related characteristics.

The document is structured as follows:

- Section 1 provides the basic definition of PEMS technology and related characteristics
- Section 2 details ABB capabilities and solution
- Section 3 covers basic scope of supply topics
- Section 4 is related to PEMS applicability as an alternative/back-up to CEMS

General overview & definitions

What is PEMS?
The acronym PEMS stands for Predictive Emission Monitoring Systems and designates software analyzers able to provide a reliable real-time estimation of emission properties by means of a model, which uses process values (e.g. temperature, flow, pressure) as input variables.

How does PEMS work?
PEMS models developed off line are installed at site and during operation, they are fed with real time process parameters gathered from the plant control system. PEMS software processes the input variables and generates the emission estimations.

Are PEMS approved by the environmental legislation?
PEMS are widely recognized (e.g. US-EPA, Europe, Middle East) as a source for emission monitoring: depending on the local legislation, they can be used as a primary source of monitoring or as a backup of traditional analyzers.

Can PEMS be used in Europe?
Yes, a new technical specification (TS-17198) has been published in 2018, defining the initial and ongoing requirements for PEMS application both as primary source or as a back-up of conventional CEMS.

What are Sensor Validation (SV) and Model Integrity Test (MIT) functionalities?

- MIT allows to verify models consistency over time ensuring that model structure has not been changed after its verification and validation. This is obtained by injecting periodically a set of known inputs and verifying that the same expected output is obtained
- Sensor Validation (SV) algorithms are used to identify a possible sensor fault and to provide a reconstructed value to be fed to the model, thus preserving PEMS accuracy.

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What are the typical target units/processes where PEMS can be applied?
PEMS are solutions applicable across the industry. Although ABB has successful references also on complex process units (FCC, SRU, etc.), the most typical targets for PEMS are related to units like gas turbines, boilers, furnaces, internal combustion engines, etc.

What kind of pollutant emissions can be monitored?
PEMS are perfectly suited to estimate all the most common pollutant from process industry: NOx, SO2, CO, CO2, Flue gas flow, etc. For some specific contaminant, as particulate, care should be taken to check the characteristics of the analytical instrumentation.

What are the requirements for PEMS solutions?
Plant shall be properly instrumented (temperature, pressure, flow sensors monitoring the main units involved) and automated (DCS or PLC). In addition, the fuel gas used shall have a stable or real-time measured composition.

Which are the basic elements within a PEMS?
A PEMS application is made by two essential components:

- A PC (typically a Server, but also a workstation could easily cover all the requirements) hosting PEMS software. The PC must communicate with plant control infrastructure to gather input values needed for emission estimation and to write predicted values.
- The PEMS software, a software toolkit that runs the models and provides the estimation of emissions.

Depending on the application, a Data Acquisition System (DAS) may be required: for typical applications where PEMS are used as a backup of CEMS, the DAS of the existing Emission Monitoring System (EMS) can be used.

Why should a plant-owner select PEMS?
PEMS technology provides a number of inherent advantages compared with traditional hardware-based analyzers.
First of all, PEMS are a very cost-effective solution both in terms of initial investment and lifecycle costs. In addition, they neglect any unexpected costs due to unforeseen or unpredicted issues with the CEMS, thus providing a certainty on cost crucial for plant owners and operators.
In addition, they provide several other advantages in terms of extended data avail-ability, easy and quick deploying time with minimal disturbance and invasiveness to the process, not requiring dedicated infrastructure in order to extract, process and analyze the sample.

ABB Solutions for PEMS

Does ABB have a field-proven solution to offer for PEMS applications?
Yes. ABB has developed and applied a proprietary software tailored for PEMS solutions: ABB Inferential Modeling Platform (IMP). This tool has been upgraded over the years in order to cover the requirements of international legislations.
IMP is structured in two modules:

- IMP Model Builder (IMP-MB) for data processing, model building and testing and off-line simulations; this is the tool used by ABB PEMS engineers for internal development.
- IMP Real Time Server (IMP-RTS) – the software installed at Customer's site for field deployment and real-time execution.

Does IMP include latest functionalities required by regulations?
Yes. IMP has been specifically updated in order to meet the latest requirements coming from environmental legislation.
State-of-the-art Sensor Validation routines have been embedded in the software in order to enhance model robustness in case of input variable failures.
In addition, Model Integrity Test (MIT) functionality has been introduced to meet European TS-17198 specification.

How does ABB Inferential Modeling Platform interact with control systems?
IMP is connected with plant control systems (DCS, historians, etc) by means of a standard OPC connection, where IMP-RTS acts as OPC Client and the DCS (or other control platform) as OPC Server. The same protocol is used to transfer emission estimations from IMP to the plant control system or any other data repository used by the Customer.

How does IMP behave in terms of cybersecurity?
Latest release of IMP has been verified in accordance with internal ABB cybersecurity procedures in order to ensure that it complies with present requirements and industry standards.

Which references can ABB boast?
ABB flagship product IMP has been successfully implemented in model-based applications as well as real-time quality estimation solutions in power and process industries in five continents.

PEMS applications developed by ABB has been positively tested and certified in accordance with US-EPA and European regulations.

ABB has installed model-based strategies for environmental purposes on Turbo-compressor stations, sulfur recovery units, FCC and other refinery units and even on a polymer plant.

In addition, ABB has recently been awarded also a PEMS feasibility study from a major O&G company, proving that ABB has the proper competences and know-how to support Customers in PEMS implementation since the very early stages.

PEMS projects scope of work

What are the different phases in a PEMS project?
The first step of a PEMS project is represented by the kick-off meeting (KOM) at customer site in order to gather information about plant operations, available instrumentation and plant control architecture. KOM requires the presence of plant personnel.
After KOM, PEMS applications are developed through a series of phases:

- Data collection is crucial to obtain the set of data needed for models development: the variables included in the dataset are both relevant process variables (e.g. temperature, pressure and flow) and the emission values;
- Design and testing are the steps devoted to off-line model creation and validation: through advanced mathematical techniques included in IMP, ABB engineers are able to identify the key variables and train the models.
- Final commissioning involves the installation of the IMP Real Time Server on the PEMS PC and the on-line deployment of predictive models.

Is any project step performed at customer site?
Only a fraction of the project has to be performed on-site: this is limited to the initial data collection and the final commissioning, while all the other steps can be performed by ABB technicians and engineers at their office.

Is there any difference in project development if PEMS are designed as a primary source instead of as a back-up of traditional CEMS?
The main difference between the two cases is represented by the data collection step: when PEMS are developed as an integration of an existing EMS, emission data are already available and normally stored in the EMS database. In this case, it is sufficient to extract and merge them with process values read from plant historian in order to have an adequate dataset for model building.

On the contrary, if PEMS are designed to be the only monitoring system, it is necessary to arrange a measuring campaign for the collection of emission data; this requires installing a temporary analyzer at plant site for a few days (typically 10-15 days) to obtain the baseline emission data, which will be used to build the mathematical model. Emission data have to be merged with process parameters values to complete the set of information needed for model building.

PEMS & CEMS

Can PEMS work as an alternative to hardware analyzers?
PEMS can be used both as a back-up of traditional hardware analyzers and as the only emission monitoring system, depending on application, local regulation and site constraints.

Can PEMS be sold in place of traditional CEMS solutions?
PEMS should be considered as a complement to the traditional CEMS. Depending on application and local constraints, good engineering practice may require installing CEMS, PEMS or a wise combination of the two technologies. More and more, complex large projects will include traditional HW-based CEMS side-by-side with PEMS for selected units.

One of the main interests for plant operators, enforced by legislation, is to increase the availability of their EMS: through the adoption of PEMS as a back-up of traditional hardware analyzer, EMS uptime can be increased up to 99.5%.

ABB is pleased to make available its comprehensive portfolio and its extensive experience and competences to design together with the Customer the best possible solution independently from technology or commercial shortages.

How does PEMS compare with HW-based CEMS in terms of price?
When applicable PEMS are consistently cheaper than CEMS. The CAPEX saving is only the initial part of the benefit: even larger savings are obtained during process operation because of the limited maintenance activity (typically 1 week per year) and almost no consumables. The life cycle saving, over a 5-year time-horizon can easily exceed 50%.

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