

Edition 3

December 2014

WS.PEMS

Predictive emission monitoring of gas turbines,
heaters and boilers



Reliable and Cost-effective solutions for
the process industry and the energy sector



Weel & Sandvig
ENERGY AND PROCESS INNOVATION

Predictive Emission Monitoring System from Weel & Sandvig

On a global scale government regulations require gas turbine operators to measure the concentration of CO, NO_x, CO₂ and UHC in their exhaust stock emissions. This may be done by means of statistically- and model-based PEMS methods.

Weel & Sandvig has installed Predictive Emission Monitoring Systems (PEMS) on gas turbines and boilers since 1998.

Gas turbines typically work with high efficiency but require tight control in order to reduce the risk of failures, performance degradation and to reduce maintenance costs. Therefore most modern gas turbine plants are equipped with a large number of sensors.

The basic concept of WS.PEMS is to utilize



existing information registered by the data acquisition system's gas turbines to predict the emission levels. As such, PEMS is a cost-saving alternative to conventional and more expensive Continuous Emissions Monitoring Systems (CEMS) which measure the emissions continuously.

Prediction of emission levels is possible when combining:

- Data available from the sensors installed as standard on a modern gas turbine
- Physical insight regarding reaction kinetics
- Statistical methods on test measurements

Advantages

Compared to traditional continuous monitoring systems the WS.PEMS offers several advantages:

- Upon installation and tuning to a specific gas turbine or boiler neither calibration, maintenance nor renewal of certain parts is necessary
- Individual costs associated with monitoring—such as equipment, installation, maintenance and operation—are significantly lower compared with CEMS systems

- Set-up of a data connection with existing control system and PC is the only hardware needed (e.g. no sensors in the stack) provided key parameters have been sampled and stored emissions can always be computed—even after for instance shut down of the PC
- Data reconciliation can reveal mismatch indicating errors on installed sensors
- Light and compact installation—especially advantageous in off-shore installations

stallations

- Extension of WS.PEMS with performance monitoring (PM) is obvious and makes out a valuable tool for optimal and efficient operation of the gas turbine.

From installation to data connection to verification...

WS.PEMS is typically installed on a stand alone PC communicating with the existing control system. Several emission sources can be connected to one system.

Data transfer between gas turbine controllers and the monitoring system can be a direct serial connection—e.g. using the modbus protocol—or through a distributed control system like OPC, ABB, Rockwell or others.

After each installation a thorough test is conducted. Actual emissions are measured and compared with those predicted by WS.PEMS.

At any normal operation points the predicted emissions lie within 1-2 % of those measured.

Even in very atypical operation points such as 50 %

load or less, the accuracy is very high.

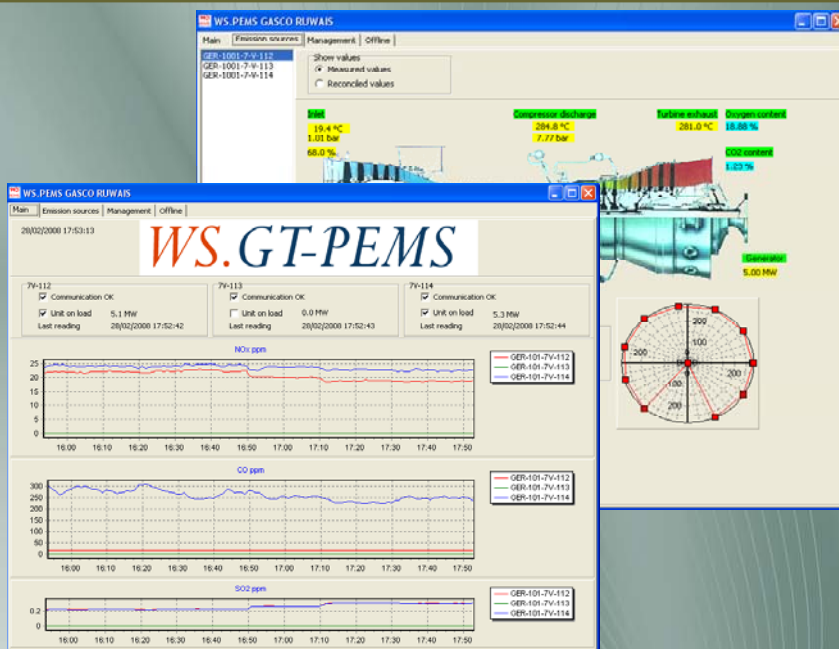
A maximum deviation around only 10 % is to be expected.



WS.PEMS estimates emissions on CO, NO_x, SO₂, CO₂ and unburned hydrocarbons (UHC) using available data from sensors and controllers already installed on the emission source (gas turbine, heater, boiler).

Prediction of emissions is done by a semi-analytical approach based on “first principles” modeling describing mass and energy balances and the thermo-kinetic reactions in the combustion zones.

The model is parameter tuned to the specific gas turbine, heater or boiler.



Data reconciliation

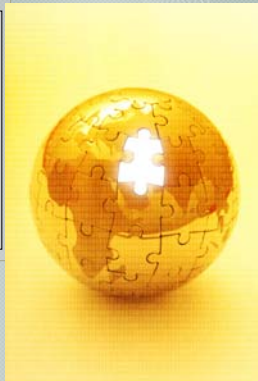
Since most sensors are subject to degradation or drift it is important to calibrate instruments from time to time.

WS.PEMS has an additional build-in feature to ensure high input data quality—*Data reconciliation*. The basic approach is to check input data against energy and mass balances. If energy and mass balances are not fulfilled with the direct measurements WS.PEMS will try to find the best match of corrected input values that fulfill the balances and having as little deviation from actual measurements as possible.

Data reconciliation constitutes an optimization problem where the objective function is the sum of the square of the deviation between measured and estimated parameters (normalized and weighted).

The set of estimated values fulfilling the energy and mass balances with minimum value of the objective function is used in the subsequent emission calculation.

PEMS can be approved by most environmental agencies across the world



Compliant with European and American standards

WS.PEMS is compliant with the major European and American standards for continuous emission monitoring systems.

Each installation is normally tested by independent third party according to the local environmental regulation.

WS.PEMS has been tested against US EPA PS 16 and EN 14181. Of the 40+ installations by Weel & Sandvig none have failed compliant test.



Weel & Sandvig

Scion-DTU
Diplomvej 377
2800 Kgs. Lyngby
Denmark
Phone: +45 2671 0045
E-mail: info@weel-sandvig.dk

ENERGY AND PROCESS INNOVATION

Please check:

www.weel-sandvig.dk

Weel & Sandvig is an engineering company specialized in generation of innovative solutions for the process industry and the energy sector. Our goal is to provide innovative solutions, based on strong technical insight and experience adding more value to customers than traditional solutions. We do this by offering:

- Predictive emission monitoring systems (PEMS)
- Advanced simulators for waste-to-energy plants and for steam turbine systems
- Simulation of complex process systems for improved performance, capacity and control

With our comprehensive experience within analysis and optimization of industrial processes and power plants and utilization of state-of-the-art tools for simulation and optimization we are capable of applying customized, technical analyses — fast, efficiently and systematically.

Our solutions are applied through an exploring and challenging dialogue with our customers, counting companies such as STATOIL, HESS, OCCIDENTAL OIL, GASCO and SAUDI ARAMCO. Through a close cooperation we provide not only better cost efficient solutions but also insight to how the processes work and interact.

Our engineers have decades of experiences ranging from high level research activities to applying practical solutions in a vast variety of industrial sectors including—oil and gas, fertilizers, chemical plants, power plants, food processing and many more.

Contact

For questions or more information, please feel free to contact Weel & Sandvig:

Phone: +45 2671 0045
E-mail: weel-sandvig@weel-sandvig.dk
Web: www.weel-sandvig.dk

Representatives

Saudi Arabia representative:

U - u
0

P.O. Box 8415, Dammam 31482,
Saudi Arabia

T: +966 (13) 83

F: +966 (13) 8

