Continuous Emissions Monitor Systems

CEMS versus PEMS

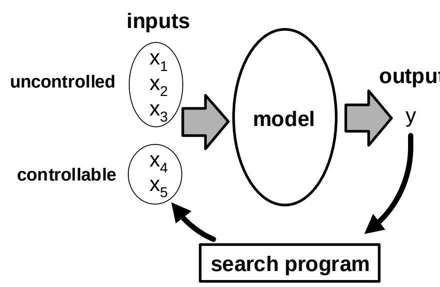
Predictive Emissions Monitor Systems

Both CEMS and PEMS provide emissions readings on a continuous basis, but by different means. CEMS measure physical or chemical attributes of stack gases directly. With regular maintenance, CEMS can be accurate and reliable, and are necessary to meet federal, state and local regulatory requirements. However, CEMS represent a large expense that does not make processes more efficient or profitable. In addition, CEMS cannot predict the future or the consequences of contemplated process changes. The only way to do these is to use a mathematical model.

ISSUE	CEMS	PEMS
Cost	Very expensive to purchase and maintain.	Less expensive (50% to 75%) than CEMS.
Maintenance	Periodic inspection of the instrument and equipment is required.	No additional instrument maintenance (above the normal process sensors) is required.
Calibration	Monthly	Yearly or better
Accuracy	CEMS are the standard to which PEMS are measured.	PEMS are initially calibrated using CEMS. The CEMS are removed when the PEMS becomes operational. PEMS are less accurate than CEMS when the latter is well maintained and calibrated.
Uses	CEMS just alarm approaching or exceeding an environmental standard.	PEMS can alarm, but also be used to predict future outcomes and optimize processes in real-time.

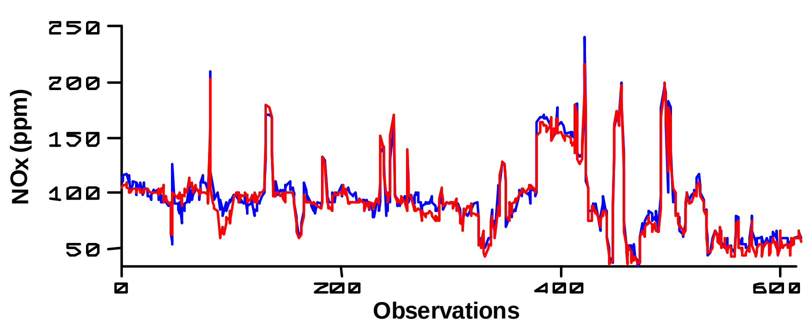
Because of reliability and cost issues, the EPA allows CEMS to be replaced by PEMS. PEMS are "virtual sensors", which use empirical mathematical models to predict values of variables that are difficult or expensive to measure. The models are developed empirically from sample data collected by CEMS, which are installed in a stack for a trial period and then removed when the PEMS becomes operational. Empirical methods include ordinary least squares, polynomials, and artificial neural networks (ANNs). CEMS and PEMS are compared in the table above.

A PEMS model gives it the capability to do "what ifs", that is predicting the consequence of taking a control action to change the course of a process. The figure at right shows that input variables fall into two categories - those that can't be controlled and must be tolerated, and those that can be controlled to compensate for fluctuations in the uncontrolled inputs. A model can also be "inverted", such that for a given set of uncontrolled inputs and a desired output, a search program can iteratively determine values for the controlled inputs to yield the desired output. If variables such as quality, yield, and throughput are also measured, the PEMS can be used to predict and control the process to maximize these parameters to great financial benefit.



Conclusions

In general, CEMS set the standard for measurement accuracy if maintained and periodically recalibrated. However, they are expensive to buy, install, and maintain, and offer little operating benefit. PEMS may be less expensive, and can be used to achieve considerable savings through model-based advanced control and process optimization. They are inherently less accurate because anomalous events, such as a stray sulfur cake falling into a boiler, would go undetected.



The NOX predictions (red) for a waste fuel incinerator match the CEMS (blue) with 95%+ accuracy - good enough for EPA Relative Accuracy Test Audit (RATA) certification.

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