

CONTINUOUS EMISSIONS MONITORING

GENERAL

A continuous emissions monitor is basically a flue gas analyser designed for fixed use and to monitor permanently. Having said this, there are many differences in the construction of the instruments to reflect these differing roles. A portable flue gas analyser must be light enough to carry around all day, yet strong enough to cope with the knocks and general ambient conditions of the industrial workplace. A continuous emissions monitor is fixed to the wall, so weight is not really a major consideration. If it is in a sealed cabinet with its own filter system for cooling air and supply of mains power, then it can be built very much more robustly than the portable flue gas analyser. The continuous emissions monitor (after this it will be referred to as CEMS – Continuous Emissions Monitoring System) is, nevertheless, exposed to the heat and dust of the industrial environment on a permanent basis, so the cabinet and filter system must be able to deal with extreme conditions without letting contaminants through or losing the cooling effect needed to keep the CEMS working at optimal efficiency.

CONSTRUCTION OF A CEMS

As stated above, a CEMS will generally be mounted in a cabinet or will be a sealed unit in some way. Since these analysers are often mounted outdoors, there is a need for mounting enclosures. Due to the environmental conditions in many of these areas, such enclosures have to counteract extremes of heat, cold and humidity, without the electronics inside being affected. This will require heating or air conditioning units to be mounted on the enclosures, insulation against heat or cold to reduce the power drain of the utilities and possibly some form of extra shading from extreme sunlight or snowstorms. Connections to the outside will tend to be waterproof and as well sealed as possible.

INSTALLATION OF A CEMS

A CEMS is usually designed for a particular job or to cover a particular set of regulations. All the wiring will be fixed and the unit is left alone except for periodic maintenance. CEMS units will often be complete with an automatic calibration system. A group of various people will be needed to fit a CEMS. The manufacturer will want to ensure that the equipment is installed correctly. Electricians and technicians for the various utilities will need to complete their part of the operation, and then the signal outputs or data processing system for the CEMS will need to be tested for a period of time. This period of testing can often be several weeks, a month is not uncommon. This allows the operator to be certain that data from the continuous emissions monitor will be transferred and stored under all operational conditions.

OPERATION OF A CEMS

A CEMS will mostly operate unattended. Periodic checks for condition of filters and other general maintenance tasks will be carried out on a fixed schedule dependent on the application and experience of the individual operator. Some continuous emissions monitoring systems will have an automatic calibration function that enables the instrument to switch to locally stored standard gas cylinders and perform a span calibration without intervention. Other CEMS installations will require manual calibration at set intervals.

TECHNOLOGY OF A CEMS

Sensor technology

Continuous emissions monitors have been built using most types of sensor technology. There are systems in use using electrochemical, infrared, ultra-violet, chemiluminescent and other measurements for the toxic gases, whilst oxygen measurements are mainly carried out with electrochemical, zirconium or paramagnetic sensors. All these methods have their own

advantages and drawbacks, be it technological or financial. In earlier days the only common and affordable technology was electrochemical measurement, which led to a very hard life for the sensors. The electrochemical sensors are not designed for permanent use. They require short pauses with fresh air to regain a zero point and regenerate generally. Failure to adhere to this will lead to a very rapid demise of the sensor and a poor quality of measurement whilst the sensor is operating. There are a number of solutions to this problem, the simplest being to switch the sensors to fresh air for a certain proportion of the time. This may, however, cause difficulties with national regulations that insist on an unbroken measurement of the gas concentrations. It may also be a problem when the output signals from the CEMS are used as part of the control system for the burner system, as is becoming more common. The next variation was to have two or more banks of sensors, that are rotated from fresh air to measurement and then back again. The next advantage is that calibration of the sensors can be carried out when they are not in use, preventing any interruption to operation. This system is still quite common and has proved itself time and time again in practice. The major disadvantage is cost. The extra sensors cost money, as does the technology to switch gas inlets and signals between the banks. Nevertheless, these systems are very popular, despite the additional equipment increasing the maintenance needs of the system. Infrared systems were common in continuous emissions monitors long before they were considered for portable equipment. The higher cost for this technology was not such a disadvantage in the CEMS branch, and the advantage of less maintenance needs was more important. Infrared sensors are inherently more stable, although they also require occasional zeroing for good repeatability. The calibration of infrared sensors is also necessary, although they will remain more stable than their electrochemical counterparts.

Cooling Technology

Since continuous emissions monitors are inherently large installations that will not be moved, most of the cooling systems work on the refrigerant principle. These coolers require much less power than the Peltier coolers used on portable equipment, despite their other disadvantages. Some way of removing the heat will nevertheless be needed, as will an outlet for condensate. Permeation dryers are another alternative method of drying the gas when space and power supply are not a problem. These dryers use the different size of the molecules to remove components selectively from a mixed stream. CEMS installations utilising electrochemical sensors will require a certain level of moisture in the gas, which may not be achieved when using the most effective refrigerant dryers. The time spent purging with fresh air should make up for this deficiency and prevent damage. Infrared sensors do not suffer from this drawback and will work best if the gas is completely dry. There are two basic possibilities for the placement of the cooling unit: near the stack, or with the CEMS. This choice will be dependent on the site and how far from the stack the CEMS must be placed.

Sampling technology

This description is concerned with extractive systems that remove a sample continuously from the stack and transport it to an analysis unit. In-situ and cross-stack methods have their own adherents and advantages. A probe of some sort will have to be installed in the stack to provide an appropriate sampling point. A heated filter will be needed to remove the largest particles that would otherwise block the transport line. This filter must be kept at a consistent high temperature to prevent condensation forming. The place must be chosen to allow regular inspection and changing of the filter elements. A differential pressure sensor can simplify the inspection of the filter elements. The gases must be transported to the cooling unit with a heated hose to ensure that absolutely no condensation can occur in transport. Such heated hoses are generally kept at about 180°C to leave some margin for error. Depending on the relative positioning of sample point and CEMS, the position of the cooling unit and hence the

length of the heated hose will be decided. A heated hose requires about 100 Watts of power per metre of length, so long hoses are to be avoided if possible. From the cooling unit to the CEMS a length of standard tubing can be used, saving energy and installation costs.

Data output technology for a CEMS

The data outputs can be analogue, digital, or a combination of both. Digital outputs can be directly fed into a computer programme for data treatment, but do not lend themselves easily to use as control parameters. If the CEMS is to be included in the control system for the burner, then analogue outputs simplify the matter greatly. Current outputs are more appropriate than voltage outputs in most cases, since the distances to be covered are often large. Digital outputs with appropriate software are common with most types of continuous emissions monitoring systems. The data is presented in a form that can be easily understood by laypeople or sent on electronically to the appropriate authorities. One of the great advantages of digital information is that it can be sent by wireless, avoiding the laying of extra data cables. Provided line of sight transmission is given, this can be achieved with very low power levels.