A Complex CEMS Architecture with FT-IR Technology for Emissions Monitoring in Co-firing Plants

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Incineration plants can be successfully used with both coal (fossil fuel energy sources) and biomass (renewable energy sources), resulting in decreased costs and emissions to the atmosphere. Continuous monitoring of pollutant gas components is mandatory for such plants according to European directives 2000/76 and 2001/80; for this reason, only automated measuring systems can be used which are compliant with the EN 15267 European standard.
Three Loccioni GCSs (Gigas CEM Systems), with TÜV certification according to EN 15267 for all gas components have been successfully used in a co-firing plant, with a complete integration between redundant hardware and validation software.

In our industrial society a huge amount of energy is needed for human activities, and a great effort has been done for many years to find out new and more efficient energy sources.

Traditional sources, such as oil or coal, have been exploited since the 19th century and will not be present in our future for long, as their availability is not infinite; they are becoming more expensive and controversial for their negative environmental impact.

Acid rains and poor air quality are an example of emissions to the atmosphere of pollutant gases (SO_x, NO_x) and small particulate matter (PM10, PM2.5), respectively.

In this article, we will discuss a co-firing plant, an interesting combination of fossil and renewable energies; we will speak about emissions to the atmosphere, their monitoring and the importance of commonly accepted standards to do that.

Finally, a description of a complex, fail-safe CEMS (Continuous Emissions Monitoring System) architecture with TÜV-certified FT-IR technology in such a plant is given.

Biomass Incineration in Co-Firing Plants

Waste incineration is often chosen as a solution to avoid landfills, using the waste as an energy source. With the term "biomass" one can mean any type of substance produced by or from living organisms; in this article we are interested in those materials which are discarded as a waste of agriculture and breeding activities, for example residues from mowing or wheat straw.

A biomass-coal co-firing process is usually found in plants originally designed for coal combustion and then adapted to burn a certain type of biomass.

Using a small fraction of biomass instead of coal can be a cost- and performance-effective solution for an energy combustion plant but it is very important to pay attention to a number of variables*: fuel preparation, storage and conversion, components fouling and corrosion, interaction with abatement equipment, fly ash production and utilisation. Regarding pollutant emissions, exhaust smokes produced by mixed coal-biomass fuel usually contain SO_x, NO_x, N_2O, CO, CO_2, CH_4, NH_3, HCN and HCl. It is imperative that each one of these dangerous components is monitored; in advance, their emission limit values can differ from those of a traditional combustion plant.

In fact, concentrations of those gas components can be lower or greater than those of pure coal, depending on biofuel quality, co-firing ratio and other site-specific factors.

FT-IR technology is often the best choice for these applications because it allows a simultaneous, multi-gas analysis with only one measuring instrument; each one of the gas components listed above absorbs an electromagnetic beam in the mid-IR frequency range with a particular absorption spectrum, and from that their concentrations are calculated using a so-called "quantification method".

Standard EN 15267

The EU adopted a common and rigorous legislation to which combustion plants and waste incinerators are subject: directives 2001/80 and 2000/76, respectively.

They prescribe a maximum value for pollutants concentrations that can be emitted to the atmosphere, if a continuous monitoring for a pollutant element is needed or not and so on; this value is linked to the total uncertainty of the measuring system, so that authorities and people are sure that in no case the pollution is greater than accepted values.

In response to EU directives, attention has moved to the measuring system itself, in particular to the way the uncertainty has to be calculated, ensured and to hold steady.

In-force European standard EN 15267 deals about CEMS and summarises the main facts of this problem: part 1 is a general one, part 2 is devoted to the quality management system involved with the CEMS, while part 3 states detailed procedures to carry out tests and stringent performance criteria. In the EN 15267-3 standard performance criteria and parameters for QAL1 calculations are at last defined in a more rigorous and clear way than older standards EN 14181 and EN 14956, and the responsibility to assess compliance to them has been assigned to independent test laboratories.

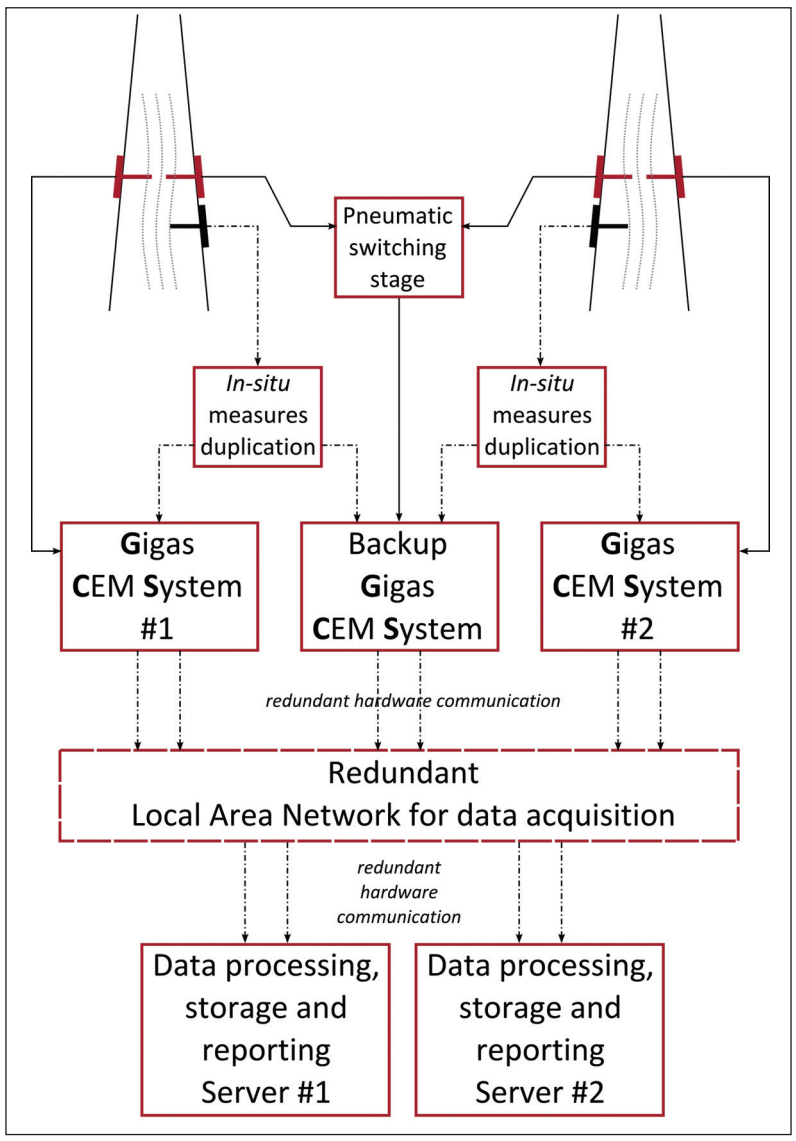

Figure 1: GIGAS FT-IR CEMSs with hardware redundancy and software integration

With the EN 15267-2 standard a CEMS manufacturer has to use and maintain an effective quality management system for its product, by far stricter than according to ISO 9001: an EN 15267 certified CEMS has to be controlled in any part of its lifecycle and in any detail; its documentation has always to be up-to-date and checked.

Figure 2: Loccioni Gigas CEM System

Design changes of the certified CEMS must be officially listed and made known to the relevant bodies involved in the certification, so that they can prescribe additional tests to confirm the compliance.

FT-IR CEMS Architecture

In Figure 1 a complex architecture with three Gigas CEM Systems for emissions monitoring in a co-firing plant is shown: in this configuration there is one GCS per exhaust gas stack, plus one more GCS connected with both stacks as a backup system.

Loccioni Gigas CEM Systems have been certified by TÜV Rheinland according to EN 15267 with six months maintenance interval for all gas components: this means that developed FT-IR technology has excellent performances, not only as nominal values or performances of individual components but also as global, on field-proven robustness, reliability and precision.

Loccioni GasCalc (resident analysis software) allows the operator to have a quick and easy control of any part and operation of the GCS, and is fully integrated with Loccioni SAVED (acquisition and validation software).

Hardware redundancy has been chosen at any stage (sampling, analysis, data communication) to achieve fail-safe functioning, so that even external problems can not result in monitoring discontinuity and data loss; SAVED has therefore a lot of additional tasks, for example the synchronisation between the two servers, the management of switching within LAN (in case of communication fail) and between the GCSs (in case of instrumental fail).

The plant can also work in two states: normal combustion (coal) and coal-biomass co-firing; as stated previously the applicable European directive changes (first of all emission limit values to be considered) and many other software parameters have to be automatically updated.

Conclusion

Biomass-coal co-firing plants have become an interesting possibility of combining traditional and renewable energy sources; for that an adequate choice of the biofuel type and process modifications are to be chosen.

In any case emissions monitoring is required and defined by European regulations: directives 2000/76 and 2001/80 regard plant emission limit values, while Standard EN 15267 is the test-bed for a CEMS to be approved and applied in the plant.

In the described application one combines the reliability of a TÜV-certified Gigas FT-IR CEM System with a robust, specifically customised integration of supervision software, plant features and redundant hardware: in this way we ensure the commitment of limiting the impact of our activities on the environment.

Figure 3: Particular of the GIGAS FT-IR analyzer inside GCS

** Refer to the publications by IEA Bioenergy Task 32, http://www.ieabcc.nl/.*