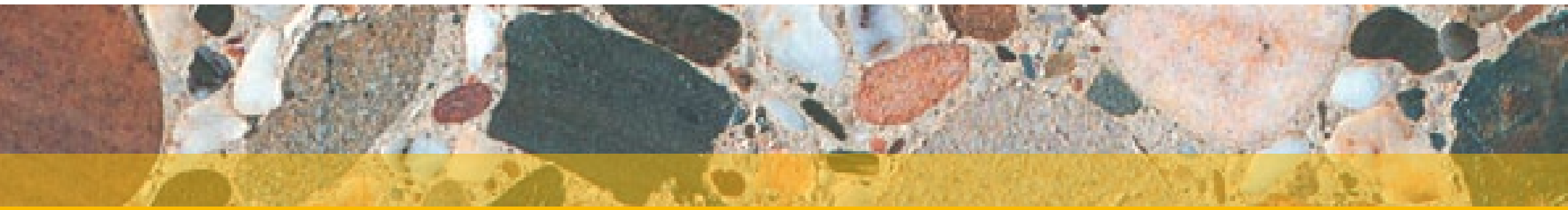
ecra

european cement research academy



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NEWSLETTER

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- Monitoring of Industrial Emissions
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Continuous monitoring of specific industrial emissions

Mercury and other gaseous components are in focus for newly developed continuous emission monitors

The implementation of stricter environmental standards in Europe is a driving force in the latest developments in the field of continuous emission monitoring systems (CEMs). A major example in this context is the continuous monitoring of mercury which has been discussed intensively during the last revision of the cement and lime BREF document in 2009. There are still unsolved issues concerning the proper and safe practical application of these devices. A further issue of growing concern for the European cement industry are multi-component gas analysers. In principle they are able to monitor many different components simultaneously, but the installation and proper application of these devices can also be a real challenge for plant operators. Depending on the number of components which have to be monitored, the maintenance expenses can be of growing importance.

Mercury (Hg) is a ubiquitous trace element with important toxicological aspects. Like all trace elements it is introduced in small quantities into the clinker burning process via the raw materials and the fuels. Due to its high volatility, mercury is retained in the kiln system only to a lesser extent. Although the European cement industry was able to reduce its mercury emissions significantly over the last years, the proper monitoring of mercury emissions is still important. While periodic measurements are well established, the continuous monitoring of mercury in the stack gases of a cement kiln is still challenging. This is the reason why in the revised Reference Document on Best Available Techniques (BREF document) of the European Commission, the continuous monitoring is not yet fixed as a best available technique (BAT).

The specific role of mercury

Mercury forms gaseous components which are not retained in the rotary kiln and the preheater area. Moreover, it should be noted that mercury can react with other elements in the kiln/preheater zone to different components. **Figure 1** gives a non-exhaustive overview of the possible reaction partners and the respective products.

Based upon the European Directive on the Incineration of Waste (Directive 2000/76/EC), the mercury emissions of cement kilns burning alternative fuels have to be monitored periodically. The procedure has to be carried out according to the European standard EN 13211.

In Germany, the continuous monitoring of mercury emissions has been mandatory by law since the year 2000 for cement kilns using alternative fuels. From the very beginning, however, there have been technical problems regarding the application of the commercially available mercury CEMs. Basically, all these monitoring devices apply the same analytical technique, which is based upon cold vapour photometry. The complete reduction of all mercury compounds before the actual analysis is one of the crucial points in the application of the CEMs. The operational principle of the CEMs is depicted in **Figure 2**.

Practical experience showed that a lot of additional maintenance steps had to be carried out. Additionally, it was necessary in many cases to modify the commercially available devices to make them suitable for the individual application. These measures were able to improve the performance of the CEMs in general, but even now there are still cases where the devices cannot be used properly.

Regardless of the experiences which have been gained so far, there are still open questions concerning the application of mercury CEMs at a cement kiln. In particular the long-term stability as such is still questionable. Furthermore, it transpired that in many cases the periodic maintenance intervals had to be shortened tremendously in order to obtain sufficient results.

Based upon these efforts, some progress could be made during the last years. Nevertheless, continuous monitoring of mercury emissions cannot yet be considered as an available technology for the cement industry in Europe like for example the continuous monitoring of dust or NO_X. The technical working group

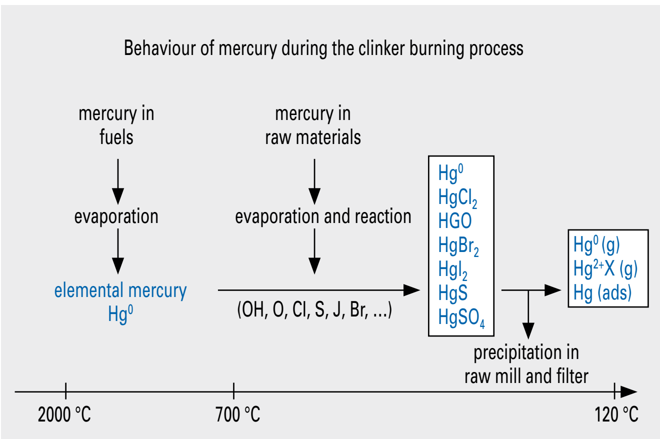

Fig.1: The different sources of mercury and its behaviour in the kiln/preheater system.

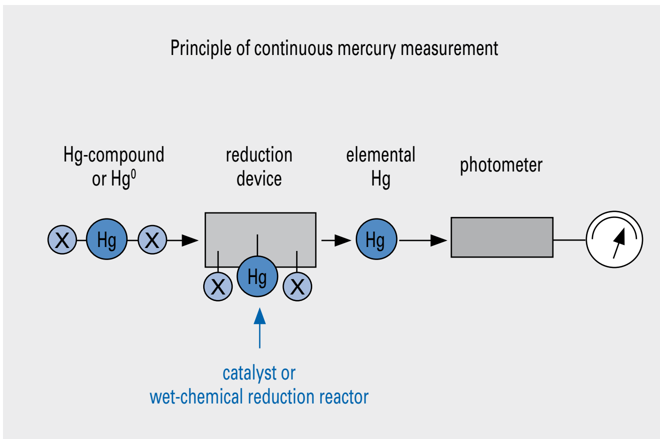

Fig. 2: Basic principle of a mercury CEM.

which was responsible for the revision of the European BAT reference document for the cement and lime industry took these experiences into account. It was concluded to further observe the developments and experiences in Germany and Austria.

Multi-component gas analysers

There is, as a matter of fact, currently a certain tendency within the European cement industry to install multi-component gas analysers. This development is mainly driven by the fact that European and national authorities keep asking for more components to be monitored continuously. While a few years ago it was sufficient to monitor dust, NO_x and SO_x, nowadays additional components such as TOC have to be measured as well.

Additionally, the growing development of flue gas abatement techniques also leads to further measurement requirements. In this context the successful reduction of NO_x emissions in the European cement industry can be taken as an example. By increasingly applying SNCR technology, European cement manufacturers were able to reduce the NO_x emissions of their kilns significantly. On the other hand it is well known that under certain circumstances the injection of the reducing agent may lead to an increase of the ammonia emissions of the kiln. This leads to an increasing requirement for a continuous monitoring of ammonia in the cement industry. Despite the fact that multi-component gas analysers seem to offer smart solutions for plant operators, it should be kept in mind that these devices are far from always being a “Swiss army knife” for all purposes. Acquisition costs as well as not insignificant maintenance efforts and possible cross-sensitivities have to be taken into account before a final decision for a certain option is made.

Power consumption – an essential KPI for cement plants

Challenges in the reduction of the electrical energy consumption of cement plants

In recent times there have been important milestones with regard to reducing the consumption of thermal energy in the clinker production process. With continuously increasing prices for electrical energy and to some extent shortages in power supplies, electrical energy consumption is now starting to become equally important. Some cement plants have access to their own power generation for various reasons and are therefore not dependent on common power supplies. The question of how electrical energy consumption can be influenced, however, remains when most of the boundary conditions such as installed capacity are fixed and changes are difficult to implement.

Specific electrical energy consumption in a cement plant increased continually from below 90 kWh per tonne of cement to over 110 kWh per tonne of cement in the late 80s of the last century. Later, mainly due to the introduction of cement types with lower clinker content, it fell to an average of 100 kWh per tonne of cement in efficient cement plants. In cement plants where inefficient technologies are still being used, the specific power consumption ranges up to between 130 and 150 kWh per tonne of cement.

It is often a fairly obvious step to replace some high energy consumers in a cement plant with more effective ones, but the best solution is an overall, systematic approach to evaluate the potentials for the reduction of the specific electrical energy consumption in question.

Power Management

Power management is partly a commercial domain, involving searching for power suppliers and looking for the most suitable pricing for individual cement plants. However, the cost reduction potential is limited for various reasons.

On the other hand, it is also possible to align the operation of a cement plant to the power supply to some degree: in the case of cement grinding plants it is possible to run the mills with only a low-tariff (night) power supply. This solution of course requires flexibility of production, and the sufficient sizing of equipment and storage. In many plants these parameters are fixed and their adjustment would require a substantial investment.

Auxiliaries

In a cement plant there are many small electrical energy consumers which can be operated more efficiently: lighting, computers, air conditioning or belt conveyor systems. These items are easy to manage through using better settings or shutting them down when they are not in use. However, the input of these consumers is only a marginal part of the total electrical energy consumption. The main focus therefore falls on the biggest consumers, such as compressed air, which accounts for a higher proportion of the total consumption. The utilisation and efficiency of compressed air can be improved by lowering the system’s pressure drop, the elimination of leakages and by using it for proper purposes (not for example for cooling the kiln shell). A further point could be the optimisation of operating times which in turn reduces the consumption of compressed air.

Replacing outdated machinery

The electrical equipment of a cement plant will become outdated sooner or later, independently of whether the equipment in question is a mere switch, a transformer device or an electric motor or drive. The continuous development of such equipment results in more efficient units. With the application of new equipment, the electrical energy consumption of the production process can be reduced – however, in some cases it may be a costly exchange. The comparison of old and new drives, the calculation of benefits, utilisation and finally the total cost of ownership are therefore always necessary.

Optimisation of process and products

Looking at the main electrical energy consumers in a cement plant, it is evident that there are only a few high power consumers which are worth focussing on. High energy consumers such as mills, kilns and compressed air generation are responsible for around 90% of the total electrical energy consumption of a cement plant.

In the case of grinding processes, feed size reduction or coarser product fineness will decrease the specific power consumption. Feed size reduction can be achieved with an additional crusher or pre-grinder, while a decrease in fineness will immediately affect the product quality. The optimisation of a mill system can in many cases contribute to a saving of as much as 5-15% of the specific electrical energy consumption. With reasonable effort, such an optimisation is sometimes feasible with only small changes at the plant, for example by a modification of the grinding media composition.

At the kiln system, air fans are the high power consumers. The fan operation can also be optimised and aligned to allow smooth production.

Pneumatic transport systems can be replaced by mechanical transport or can be upgraded to modern, more efficient ones.

In addition to these examples there are many other possible ways of reducing specific electrical energy consumption. For a more detailed consideration of energy efficiency the consultation of a expert is recommended.

There is one more key factor concerning electrical efficiency which must however be taken into account, and that is ensuring that all employees are informed about electrical energy consumption and the plant's targets regarding the saving of electrical energy. Ultimately, only awareness about the use of electrical energy can create high energy efficiency.

Finally, there is no universal optimisation solution which fits all cement plants, and individual measures cannot be generalised. An electrical energy audit can identify bottlenecks in the production process, and an expert in energy efficiency can evaluate solutions and calculate the benefits for the plant in question.

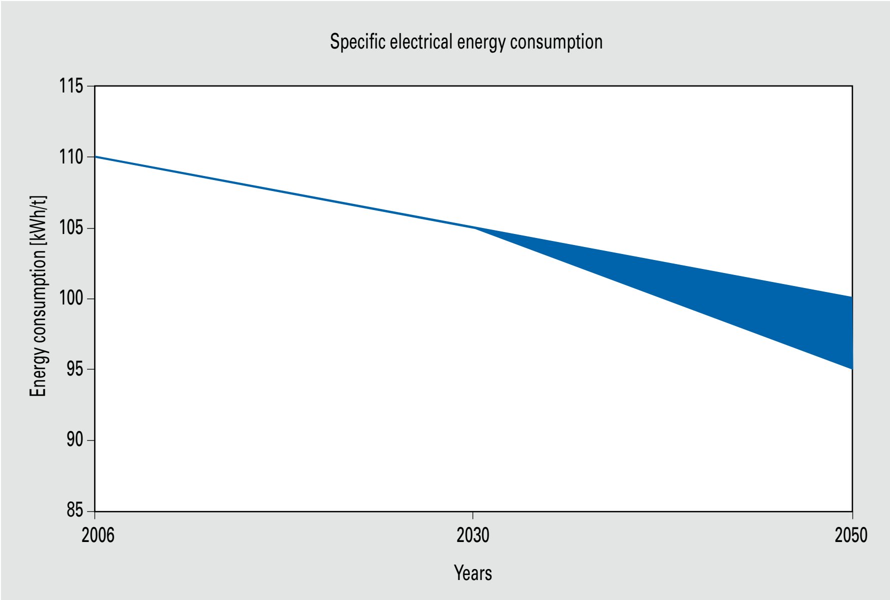

Fig. 1: Estimated specific electrical energy consumption of cement works worldwide projected to 2050 by ECRA.

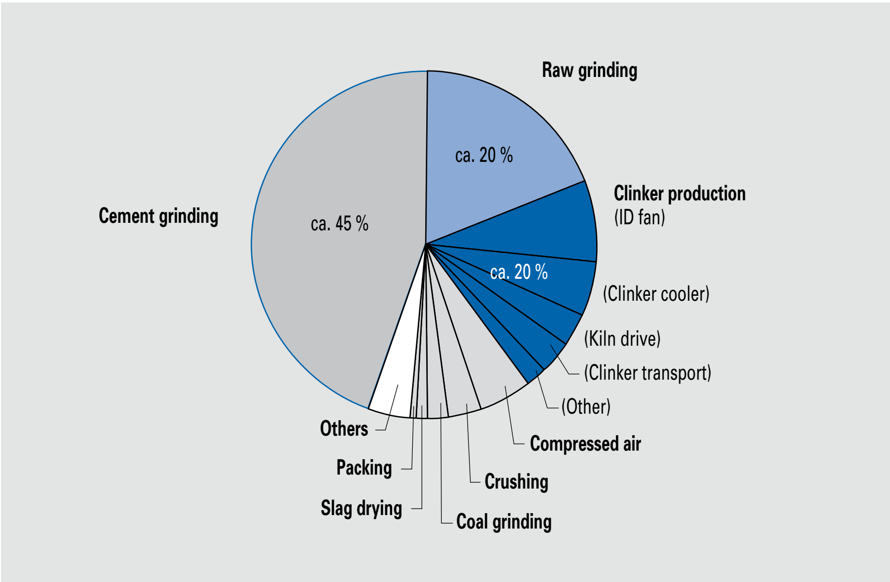

Fig. 2: Distribution of electrical energy consumers in a cement plant.

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