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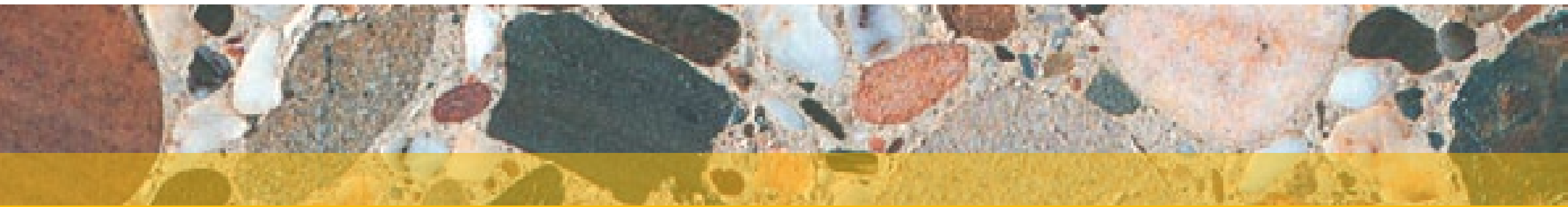

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NEWSLETTER

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Secondary fuel combustion in precalciner kilns

The ecra seminar in Rüderdorf about the newest precalciner technology was a great success

The second ecra seminar in 2007 about the combustion of secondary fuels in precalciner kilns and the newest developments in precalciner technology was a great success. 55 delegates from 17 countries all over the world participated in the seminar organized by ecra from May 15th to 16th, 2007 to inform about the newest developments of precalciner technology, secondary fuel combustion and refractory solutions. During the two days the participants had also the opportunity to visit the modern Rüdersdorf cement plant and the Museumpark with lime factories from the last two centuries.

Today, the design of virtually all new kiln installations in the cement industry worldwide as well as major upgrades are equipped with precalcining technology. Precalciners provide particular flexibility, as secondary fuels can be fed at several firing places at different temperature levels. In addition to economic criteria, physical (e.g. particle size) and chemical (e.g. chlorine, sulphur, alkali and phosphate content) criteria play a decisive role in the selection of secondary fuels as they may have an impact on kiln operation and emissions, respectively. The seminar gave an overview of the use of secondary fuels in precalcining systems and their impact on the burning process. Also the current state of the art of calciner designs and thermal pretreatment systems for the combustion or gasification of secondary fuels were presented. Furthermore the impact of secondary fuel combustion on the refractory and possible solutions for preheater cement kilns were shown and discussed (**Fig. 1**).

On the first day of the seminar the participants had the opportunity to visit the cement plant and the Museumpark (lime factories of the last two centuries) in Rüdersdorf (**Fig. 2**).

Utilisation of secondary fuels

Secondary fuels are usually fed directly into the calciner. In principle, all firing units at which standard fuels are fed are suitable for their input as well. Depending on the type of fuel to be utilised, fuel metering is fairly complicated. It may therefore be reasonable in individual cases to subject secondary fuels to thermal pre-treatment in a separate device first. Basically, two types of plants must be distinguished: in gasifiers the fuel is pyrolysed under extremely low-oxygen conditions, and the lean gas thus produced is subsequently fed to the calciner as fuel. The energy required in this process is either supplied externally or released in a partial combustion process. In precombustion chambers, by contrast, a considerably higher proportion of fuel is converted at over-stoichiometric or slightly under-stoichiometric conditions, respectively. Energy is used – similar to the gasifier – to decarbonate the kiln feed. The unburnt part of the fuel (residual coke) can also subsequently be fed to the calciner.

Thermal pretreatment

The devices for thermal pretreatment existing in Europe up to date are the circulating fluidised bed from Lurgi, precombustion chambers from Polysius and Technip Cle and the so called Hot Disc of FLS. The operating experience gained shows that all methods work reliably, although process engineering expenditure should not be underestimated. The circulating fluidised bed is suited for intake of fairly fine-grained fuels only, while the precombustion chambers and the Hot Disc are rather designed for coarse fuels. But also fine-grained fuels can be treated with these designs. In the precombustion devices usually waste tires, sticky materials, tire chips or fuels with a low volatile content (e.g. petcoke) are burned. In the Hot Disc for example the waste materials (whole tires or fluffy materials) are dropped to the bottom part which consists of a turntable. The fuel will, when exposed to the hot tertiary air, slowly gasify and burn out while the disc is rotating (10 to 45 minutes). The Hot Disc is connected to the kiln via the riser duct from the inlet chamber to the precalciner. In the pre combustion chamber of Polysisus the coarse materials

Fig. 1: Impression from the seminar

Fig. 2: Participants during the plant visit in the Museumpark in Rüdersdorf

(usually whole tires, up to 5 t/h) are burnt and converted into a fuel gas, coke and residues separately. The fuel gas as well as the coke and the residues can then be fed separately to the calciner or the kiln inlet. Positive experiences with the pre combustion chamber of Technip Cle were also presented at the seminar. In this device several fuels like coal, petcoke or plastics are burned. At high temperatures (1100 to 1600 °C) also fuels with a low ignition behaviour (e.g. petcoke) can be burned. The experiences show that the chamber works reliably and the calciner system can be controlled very easily. With the gasifier at the Rüdersdorf cement plant a wide variety of waste materials, regardless of their calorifc value, can be handled. The product gas, generated under reducing conditions in the circulating fluidized bed reactor is fed directly to both calciner strings, while the combustion residues are conveyed to the proportioning station, from where they are fed into the raw mill as a raw material component. The circulating fluidised bed reactor supplies the kiln with up to 40 % of its fuel consumption in this way. Any variation in the gas quality (calorific value, CO concentration) can be balanced by the burners in the calciner.

The before mentioned devices (with exception of the Hot Disc) can be uncoupled from the kiln system by means of slides, thus allowing the kiln still to be run on primary fuels only.

The choice of the most suitable system is influenced mostly by investment and operating costs, but also by fuel processing costs, availability of the waste fuels, the removal of contaminants and substances forming recirculating systems and safety concepts that might be required. Plant designers are currently making increasing efforts to further optimise existing plants, and to develop and test new concepts. As gasifiers and combustion chambers, respectively, permit a high degree of flexibility in terms of type, composition and nature of the fuels utilised, the number of these plants in the cement industry can be expected to grow in the long run.

Controlling chlorine and sulphur cycles with bypass systems

Effective bypass systems can stabilize kiln operation and allow an increase in the use of secondary fuels

Many cement plants are operating their cement kilns with bypass systems in order to control chlorine, sulphur and alkali circulation. This is due to the fact that the raw materials from their local quarries contain certain levels of these compounds which can cause coating formation in the kiln and as a consequence a less stable kiln operation. Also the increased use of certain secondary fuels or raw materials may lead to an increase of the sulphur, alkali or chlorine input into the plant. Therefore within the last years a number of cement plants have increased the bypass ratio or have installed new bypass systems.

The volatility of alkali compounds is mainly determined by their melting and boiling points as well as the temperature dependance of their vapour pressures. At a temperature of 1450 °C the vapour pressure of alkali chloride reaches a value of 1 bar, for they can fully vaporize. On the other hand, the vapour pressure of alkali sulphate is lower, and a greater retention in the clinker leads to increased removal from the recirculating system through the clinker.

Efficiency of bypass systems

For high efficiency a bypass system will be designed as gas bypass in the area of the kiln inlet. As such removal is most efficient in the point of highest concentration the alkali source can be removed through a partial gas offtake at the kiln inlet. Depending on the question where the main focus is on the removal of chloride or suplhate from the system, the gas offtake itself can be designed in different ways. As sulphates are in a solid phase at a temperature between 1000 and 1150 °C more dust has to be taken off. As on the other hand, alkali chlorides are gaseous at these temperatures the removal of dust is only necessary as seed material for condensation.

Fig. 1 and **2** show the effectiveness of bypass systems in various kiln plants for the removal of sulphate and chloride. According to these investigations the efficiencies of bypass plants for the removal of chlorides lie between 20 and 75 % relative to the total input of chlorine into the kiln system. On the other hand, the removal rates for sulphur lie only between 2 and 12 % relative to the total input of sulphur. The systems investigated have been originally designed and built for an effective chloride removal. Great differences in some cases in the removal rates for chlorides can be attributed, on the one hand, to different bypass sizes and, on the other hand, to different designs or plant configurations. For example, the removal of chloride at the kiln inlet is very effective in pre-calciner plants as the specific quantity of kiln exhaust gas in the kiln inlet is significantly smaller, and the chloride concentration is therefore larger, than in conventional kiln plants.

Use of bypass gas

In principal the thermal energy of the bypass gas can be utilized for raw material drying in the raw mill, for drying of other materials such as blast furnace slag, or for the grinding and drying of coal. If there is no need for utilizing the excess heat from the bypass gas, it can be discharged separately after the purification or mixed with waste air from the clinker cooler and discharged together with it. Usually the mixing of the bypass gas with the preheater exit gas and the use of the mixed gas in the raw mill has advantages. If certain levels of acid gases like SO_2 are present in the bypass gas they will be bound in the raw mill by the raw material. Furthermore, the NO_x mass flow with the bypass gas has to be taken into account. Depending on the kiln operation the NO concentration in the kiln inlet can be significant. As the bypass gas is not treated e.g. by an

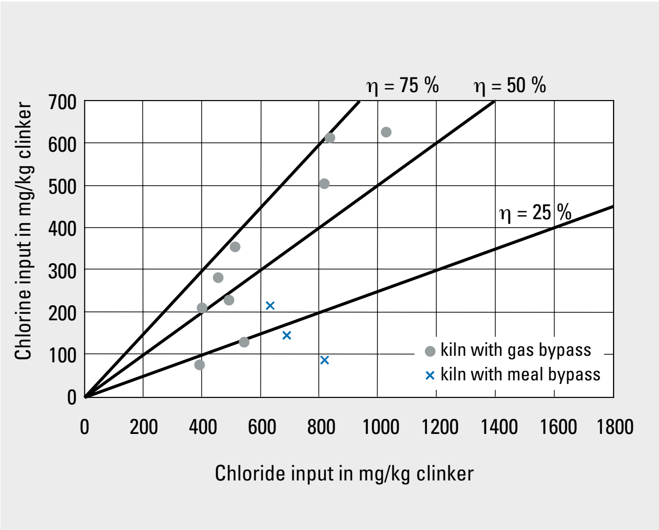

Fig. 1: Chloride-removing efficiency of bypass systems in different plants

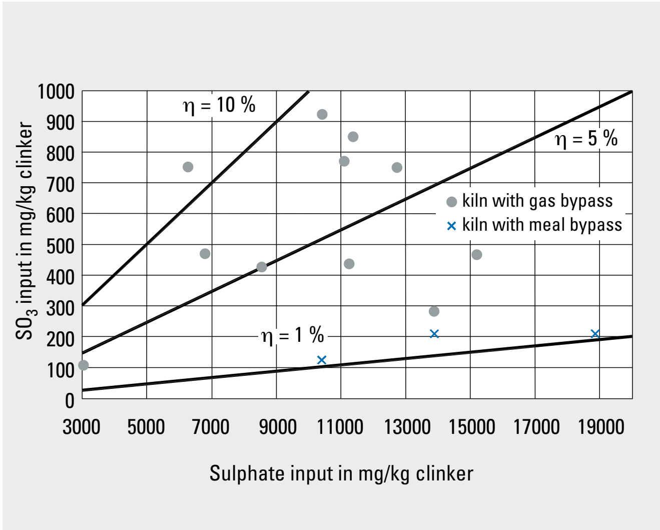

Fig. 2: Sulphate-removing efficiency of bypass systems in different plants

SNCR facility – if implemented – this mass flow will contribute to the total NO_x emission of the kiln.

With regard to economic aspects the filter to be installed is of particular importance. If the bypass flow is used for drying blast furnace slag with a downstream filter, a device for intermediate dedusting may possibly be dispensed with entirely. With the other variant, an electrostatic precipitator or a cyclone must be provided for dedusting. If a high-performance cyclone is used for bypass dust precipitation, it must be taken into account that only the coarse fractions of the dust at fairly low concentrations are precipitated, while the finer fractions pass the cyclone. For that reason, a cyclone can be utilized only if the exhaust gases are made further use of or if another filter for the removal of residual dust has been installed. Using the cyclone for dust precipitation presents the advantage that heat losses are lower than with comparable filter systems owing to the high operating temperatures of up to 500 to 600 °C that are possible.

Use of bypass dust

Usually the precipitated bypass dust is used in the cement mill to control certain cement properties depending on the cement type. Depending on the composition of the raw materials and fuels it can happen that the bypass dust quantities cannot completely be used in the cement mill e. g. for quality reasons. In these cases, other possibilities of the valorization of the bypass dust has to be looked for in order to avoid cost-intensive disposal.

An option for the utilization of the bypass dust outside the cement production process is mixing with other construction materials such as other binders or mixed binders for the solidification of soils. Of course this option is limited due to quality standards for these materials and from an ecologic point of view.

Another technical option is the washing of the bypass dusts. Worldwide there are two applications in operation in cement plants. The bypass dust with its salt content of up to 50 % is mixed with water to a sludge and then de-watered in a filter press. Most of the soluble salts are washed out and the washed filter cake can be recirculated to the kiln feed of the cement kiln. The salt containing water must be neutralized and possibly other polluting substances must be filtered. Up to now this process is from an economic point of view only applicable where salt containing waters can be disposed of into the environment.

Bypass dust contains higher contents of alkalis which can also can be of interest for the production of glass. Investigations of the Research Institute of the Cement Industry in Düsseldorf show that it is in principle possible to produce special glass types or products respectively (**Fig. 3**). Limiting factors can be sulphates and chlorides which are present in the bypass dust which can have a negative impact on the viscosity of the melt. On the other hand, an important condition for the use of bypass dust in glass production is a relatively high homogeneity concerning composition and material properties.

Fig. 3: Pilot trial for manufacturing compact glass pellets

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