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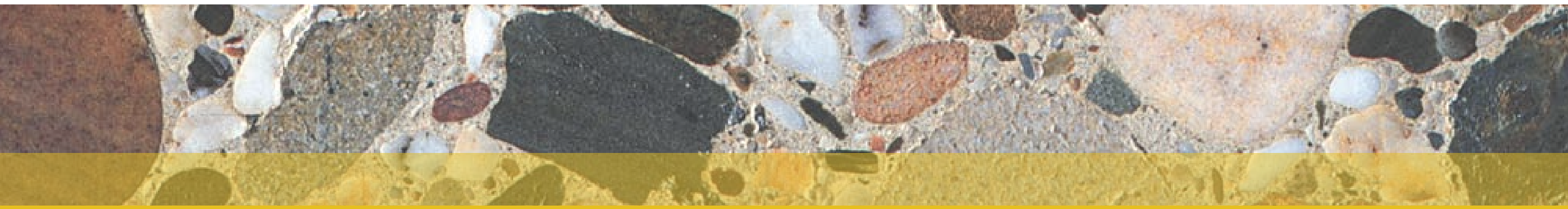
european cement research academy



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NEWSLETTER

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The use of waste fuels continues to be a major issue

Pretreatment, storage and handling play a decisive role for high substitution rates

The European cement industry is committed to ensuring an environmentally safe and sound production process. In this context, the increased use of alternative fuels (waste fuels) has become a more and more crucial point over the past years. The clinker burning process as such offers excellent boundary conditions for an environmentally beneficial waste to energy and material recovery application. Nevertheless, the appropriate pretreatment (Fig. 1 and Fig. 2) as well as the safe feeding, handling and dosing of these waste fuels also play a decisive role in the success of the recovery process.

The share of suitable alternative fuels used in the European cement industry has been increased continually in recent years. Whereas the present average substitution rate of the overall thermal energy demand for European cement kilns is about 20 %, some countries such as Austria and Germany were able to reach average substitution rates of above 60 % in 2010. Regardless of the actual substitution rate, the use of alternative fuels in the clinker burning process delivers a significant contribution towards the reduction of fossil fuel-related greenhouse gas emissions. Moreover, the specific characteristics of the clinker burning process not only allow the use of the energy content of the specific waste fuels, but also the material recovery of the ashes. The expression "co-processing" has therefore been used in the cement industry over the past years in order to describe the simultaneous energy and material recovery (recycling) of the substances. These positive characteristics were also the main reason why the use of waste fuels in the cement industry is considered as a Best Available Technique (BAT) in Europe.

Selection and feeding of waste fuels

One decisive prerequisite for the above mentioned positive aspects is the proper selection and a suitable pretreatment of the respective waste materials. Untreated mixed fractions, such as mixed municipal wastes are not suitable material for the clinker burning process.

As the energy recovery in the clinker burning process is mainly targeted at the substitution of thermal energy, the calorific value of the waste fuels is a key parameter. Therefore, the pretreatment processes are directed towards getting high calorific fractions out of the waste materials. Depending on the quality and the source of the alternative fuels, typical values for solid materials are between 17 and 23 MJ/kg.

With regard to an undisturbed kiln operation, the chlorides, sulphur and alkali content of the fuels have to be taken into consideration. These constituents may build up in the kiln system leading to accumulation, clogging and unstable kiln operation. Therefore, a second major task in an appropriate pretreatment process is to remove these "pollutants" from the high calorific fractions. From the environmental point of view, the content of volatile trace elements has to be assessed and controlled.

If it is necessary, the pretreated waste fuels are subject to suitable quality assurance systems. These monitoring and surveillance procedures can be implemented in the pretreatment process.

Weighing, feeding and dosing

In comparison to kilns which are only operated with primary fuels (e. g. coal), the use of alternative fuels requires the implementation of suitable feeding and dosing systems (**Fig. 3**) to guarantee stable and smooth kiln operation. This is especially the case if high substitution rates are to be reached. Apart from this, the feeding point for the waste materials can also vary. Depending on their composition, waste fuels are used either in the main firing system or in the secondary firing system. This variation in the feeding points can also lead to different requirements concerning the feeding and dosing systems.

Since 2004, European cement kilns have been subject to the European greenhouse gas emission trading scheme. This trading scheme sets additional strict requirements concerning the metering and determination of the mass flows. In order to monitor the use of the various waste fuels in the respective kiln, reliable dosing and weighing systems are an inevitable prerequisite.

Fig. 1: Modern plant for the pretreatment of waste fuels (Source: Ecowest)

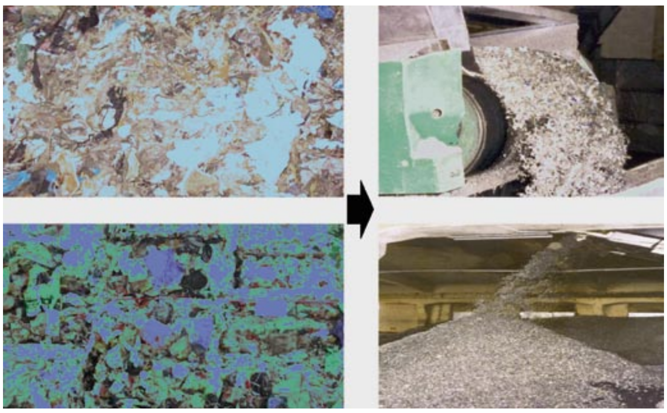

Fig. 2: Fractions from mixed municipal waste have to be pretreated (Source: neovis)

Health and safety aspects

It goes without saying that the co-processing in the cement industry must not have any negative impact on the health and safety of its workers or the surrounding neighbourhoods. Thus, it is important that the respective pretreatment processes are also targeted at reducing occupational health and safety risks which might derive from the waste fuels. Furthermore, the feeding and weighing systems also have to be adapted to the specific characteristics of the alternative fuels in order to avoid any potential risk. Due to the huge variety of the alternative fuels, there is still a lack of standardised parameters to assess these potential risks. It is therefore necessary to already take these material-related aspects into consideration during the pretreatment process.

Co-processing as an efficient solution

Due to its specific characteristics, the clinker burning process provides an excellent option for an efficient use of alternative fuels. Simultaneously, the recovery of the alternative fuels leads to a direct and significant reduction of fossil fuel-related greenhouse gas emissions. However, in most cases cement companies use selected and pretreated alternative fuels only, because these materials must suit the process and the final product from a technical as well as from an environmental point of view. Moreover, the aspects of occupational health and safety are increasingly becoming the focus of attention. The careful selection and if necessary the pretreatment of the waste materials ensure that the co-processing of wastes does not lead to any harmful emissions to the environment. Due to these positive factors, the European cement industry will continue to use suitable waste materials in the production process.

Fig. 3: Example of a feeding system for solid alternative fuels (Source: FLSmidth Pfister)

Bypass systems for kilns with high alternative fuels usage

A high removal efficiency requires careful adaption to the individual cement kiln

Raw materials and fuels for cement production contain certain portions of volatiles such as chloride, sulphur and alkali. These tend to enrich through circulation between the sintering zone of the kiln and the lowermost cyclone stage of the preheater. A detrimental effect is a higher potential for coating formation in the host meal duct to the kiln inlet as well as coating and ring build-ups in the rotary kiln. For smooth operation it is important to limit these cycles and, if necessary, reduce them. Cement kilns are therefore increasingly being equipped with bypass systems. A high removal efficiency requires careful adaption to the individual cement kiln to also ensure low losses in material and thermal energy.

Modern plants for burning cement clinker operate according to the counter-current principle. This means that the prepared raw meal is preheated by the hot kiln exhaust gas. At the same time hot clinker from the kiln is used to preheat the combustion air. Under these conditions, chloride, sulphur, and alkali compounds evaporate in the sintering zone and condensate in the lower part of the preheater. Depending on the specific situation, these compounds can build up cycles between the rotary kiln and the preheater which can affect the kiln operation.

Options to limit cycles

To ensure trouble-free kiln operation, sulphur and chloride cycles can be limited in two ways, either by reducing the input of these compounds or by removing a part of the circulating materials from the kiln preheater system. Such a removal is most efficient at the point of highest concentration when the loss of material, gas and thermal energy is at its lowest. However, for this purpose the circulation profile of the whole kiln system must be known and has to be determined by measurements.

In kilns with cyclone preheaters three options have been proven to reliably limit the inner cycles. Which of these options is preferable for which specific kiln depends on the level of the circulation system and the volatility of the compounds to be discharged. At lower circulation levels, dust can be removed from the exhaust gas dust filter, preferably at times when the raw mill is not being operated. The installation of a meal bypass system can also be used for the purpose of the removal of less volatile materials. In this case, hot meal can be removed from a lower cyclone stage. Finally, the installation of a gas bypass has particularly proved to be effective for the limitation of chloride cycles. In low amounts the discharged material from the process can be bypassed past the clinker burning process and used as an additional component in cement. Large amounts and highly enriched material have to be recovered in other ways or deposited.

Design of gas bypass systems

Gas bypass systems should effectively remove the largely evaporated alkali chlorides at the prevailing temperatures in the kiln inlet and riser duct with low kiln feed losses. The alkali chloride removal is therefore most efficient in those parts of the riser duct where dust concentrations are low and gas temperatures are high. However, because alkali sulphates are already combined with particles to a large extent in this part

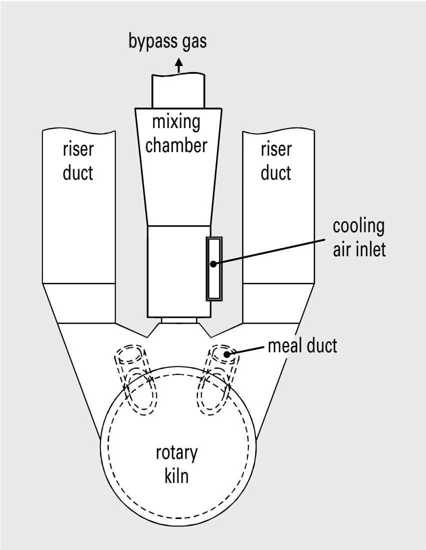

Fig. 1: Two-string cyclone preheater with a gas bypass discharge

of the kiln, they tend to remain in the kiln system because of the low-dust takeout. As a consequence, gas bypass systems have to be dimensioned according to the input of alkali, sulphates and chlorides and their molar ratio as well as to the lime saturation factor of the raw material and the temperature profile in the kiln plant. **Fig. 1** schematically shows the kiln inlet area of a two-string cyclone preheater with a modern gas bypass system.

The most efficient point for removing chloride from the system is the kiln inlet chamber or the lower point of the riser duct, where the chloride concentration in the kiln flue gas is highest. To minimise the loss of kiln feed, the take-off of the bypass gas should be located at a point where the flue gas carries a minimum of kiln dust. Computer-aided modelling helps to describe the flow pattern of the flue gas and its compounds, and to evaluate the point where the bypass gas duct should be attached.

Efficiency of bypass systems

Fig. 2 and 3 show the efficiency of bypass systems at various kiln lines regarding the removal of chloride and sulphate respectively. Investigations have shown that the efficiency of bypasses lies between 20 and 75 % for chlorides with reference to the total input of chlorides into the kiln system. The removal rates for sulphur can be adjusted to be between 2 and 12 % with reference to the input of sulphur.

Gas bypass systems are highly efficient in removing chloride from the system but only moderately so when removing sulphate and alkali. A hot meal bypass is capable of taking off sulphate or alkali according to the position of the discharge point.

Utilisation of bypass dust

The removal of bypass gas is naturally linked to the precipitation of bypass dust. Besides partly carbonated, partly decarbonated hot meal, the dust contains alkali chlorides and sulphur compounds as well as intermediate products such as C_2S and CA. The utilisation of bypass dust depends on the composition of the dust. The biggest portion of the bypass dust is used as a minor additional constituent in cement, according to the European cement standard EN 197-1. Other possibilities of utilisation are usage in agriculture, roadworks or the conditioning of sewage sludge. Moreover, bypass dust can be used as a raw material component for glass production. A relatively recent development is the purification of the precipitated bypass dust. The dust is washed, so adsorbed chloride compounds become trapped in the absorbing eluent. After separating liquid and solid, the chloride-freed dust can be returned to the cement manufacturing process.

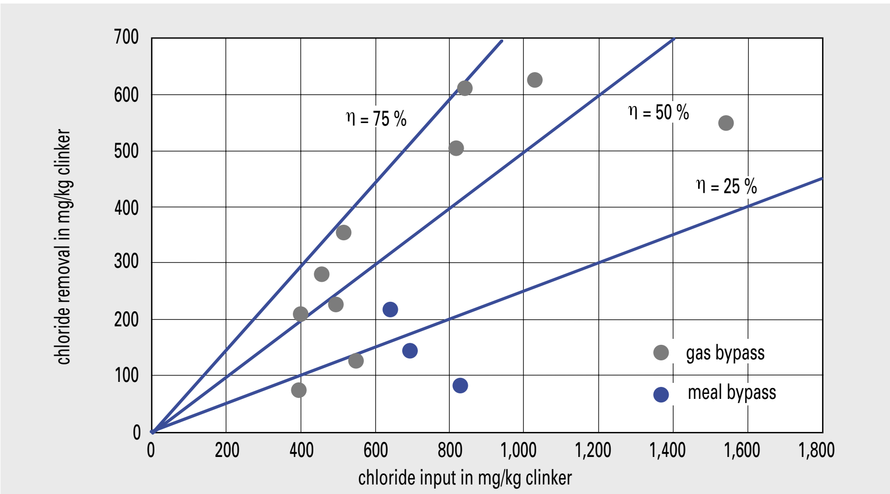

Fig. 2: Chloride removing efficiency of bypass systems

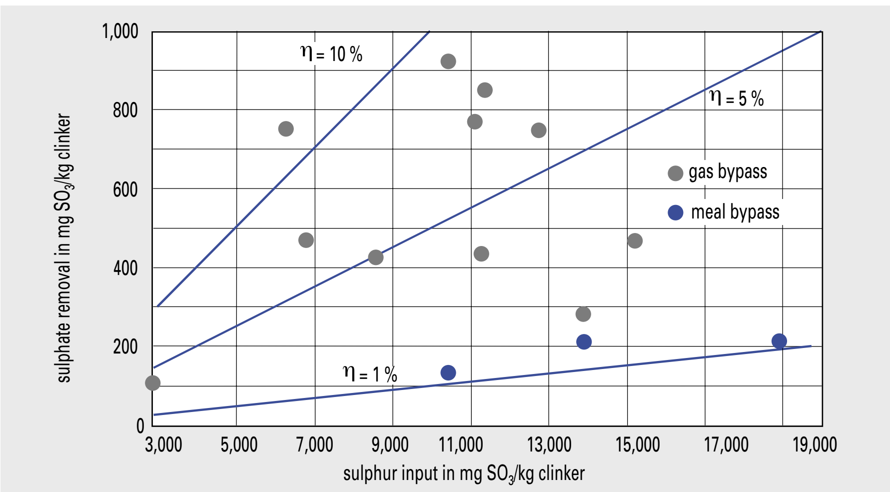

Fig. 3: Sulphate removing efficiency of bypass systems

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