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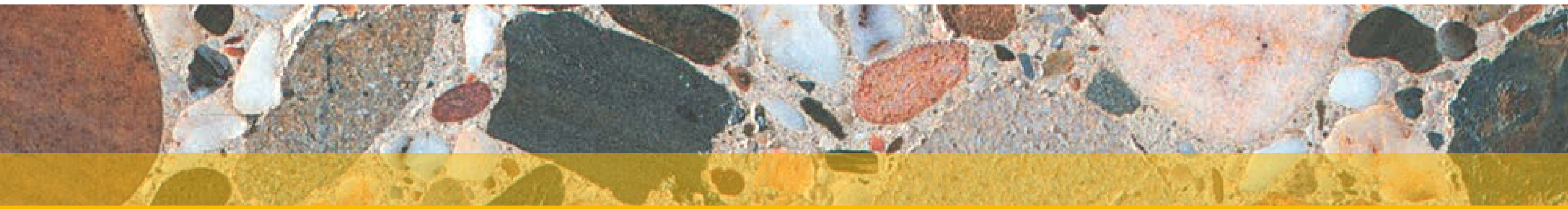
european cement research academy



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NEWSLETTER

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Upcoming ECRA seminars/workshops:

- Use of Alternative Fuels and Raw Materials
  in the European Cement Industry
  12–13 June 2018

- Modern Clinker Cooler Technology
  27–28 June 2018

The use of alternative materials in the cement industry

On a challenging path towards cement production sustainability

Cement is a key material needed to build society's infrastructures and thus a driving force for present and future economic growth. Cement production is responsible for 6-7 % of the world's CO_2 emissions. Reducing the demand for cement and/or replacing it by other materials are not realistic options. With this in mind, the European cement industry has been working intensely over the past decades to reduce its environmental footprint and increase cement production sustainability.

The use of alternative fuels has been identified as a key CO_2 emission reduction lever for the cement industry. Moderate substitution rates may be reached by the use of widely available bulky materials combusted in the kiln inlet. High substitution rates require high-quality or even tailor-made alternative fuels guaranteeing constant moisture contents, particle sizes and heating values to avoid possible issues regarding process conditions and clinker quality. In parallel, the replacement of traditional by alternative raw materials has contributed to the reintroduction of waste materials into the value creation chain and thus to the conservation of natural resources.

Waste materials regarded as sustainability levers

The ecological and economic value of using alternative fuels and raw materials (waste materials) has been proved in Europe, and in recent years their use in cement manufacturing has increased significantly worldwide. Enabling trouble-free and environmentally- friendly operation without negatively influencing product quality and the plant's economic competitiveness is the golden rule for cement producers. The employment of alternative materials entails some operational adaptations to the production process and also additional costs. These allow good kiln line stability and availability. Also, negative impacts on product quality and the environment are excluded, while at the same time local regulations are complied with. As the chemical composition of fuel ashes and alternative raw materials must be taken into account, adjustment of the raw meal chemical composition is usually required. Additional health and safety measures also have to be implemented on-site. Furthermore, the purchase of suitable equipment for the proper handling of such materials inside the plant is necessary (e.g. unloading, conveying and storage systems, weighing/dosing systems, burners, etc.). In summary, to take full advantage of using alternative fuels and/or raw materials, extensive knowledge and tight process control are mandatory. Know-how can be gained through "learning by doing" and training. The sharing of operational experiences and best practices among cement producers is fundamental. On the other hand, process control and continuous optimisation requires the gathering and assessment of a large amount of

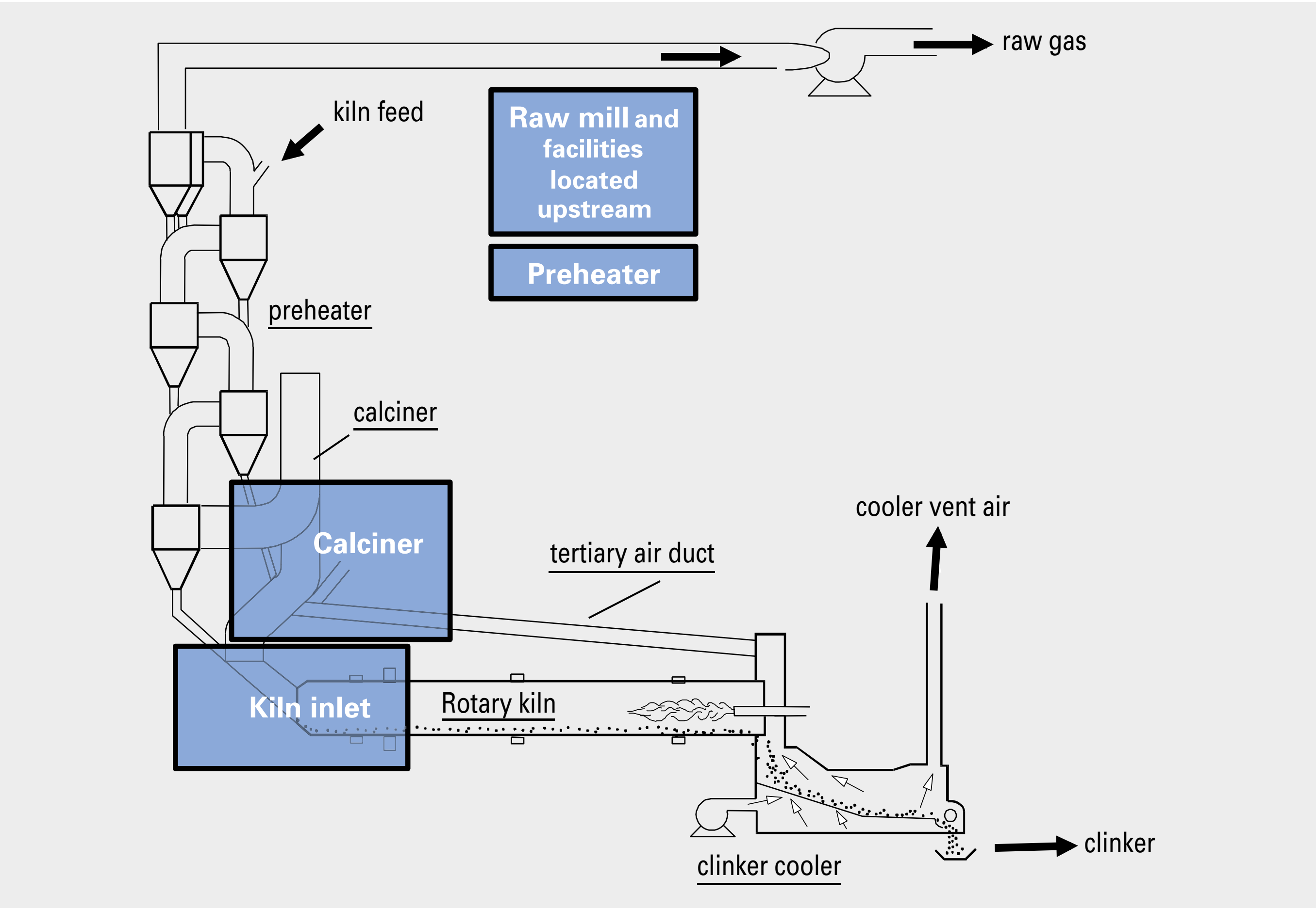

Figure 1: Suitable feeding points for alternative raw materials

information. This can only be performed in a time-effective way with the help of well-trained technical personnel, suitable and reliable equipment and a well-implemented quality control management system. Quality control is generally seen as the foundation for securing the processing of suitable waste materials.

Alternative raw materials

The decision-making process regarding the correct feeding point for a certain alternative raw material is based on the material properties, the technology available in the plant, and local environmental regulations. Permits for using such materials include emission limits for dust, SO_x, NO_x, trace elements and organic compounds. In terms of process technology therefore, the aspects of material homogenisation, the temperatures, and residence times of the exhaust gases and of the alternative material in the process are of particular importance. In addition, feeding waste materials continuously and consistently is crucial in order to guarantee a stable clinker burning process. Stable kiln operation not only benefits product quality but also minimises energy consumption and the environmental impact.

Depending on process and waste material specifications, different feeding points, dosing and conveying systems may be selected.

Fig. 1 shows an overview of possible locations for feeding alternative raw materials. As long as organic compounds in alternative raw materials are assessed as uncritical with regard to their volatility and toxicity, they can be fed directly into the raw mill or an installation located upstream from it. Therefore, alternative raw materials can be added as a substitute or corrective material in the crusher of the quarry or even in the blending bed. This not only enables a blending effect with the main raw material stream, but also a kind of pre-processing, if necessary (pre-shredding, grinding). Alternative raw materials with volatile organic compounds should be fed exclusively into the clinker burning process. However, the feeding of alternative raw materials into the calciner or kiln inlet involves some additional technical issues that should be taken into account for operational and clinker quality reasons. The following aspects should be safeguarded:

- Adequate grinding fineness of the raw material (pre-shredding, grinding)
- Sufficient homogenization with the main material stream
- Adequate heating rate and residence time
- For calcium carriers: heating rate and residence time in the precalcination zone
- Oxidising firing conditions.

Conclusion

The clinker burning process offers a unique opportunity for the simultaneous recovery of energy and recycling of resources. However, the cement industry's path towards sustainability is not free of challenges. Only by assessing, case by case, all the technical, economic, strategic and environmental requirements involved in the use of alternative materials it is possible to achieve a technical solution that provides the best balance of costs, quality and environmental security.

Clinker coolers guarantee high energy efficiency

Efficient clinker cooling for good heat recovery and product quality

Over the past years the grate cooler has become state-of-the-art technology for clinker cooling. All modern grate coolers are now equipped with static inlet sections, which help to distribute the clinker on the movable grate. The static grate was developed in its present form in the late 1980's.

Today, three types of grate coolers can be found, all with static inlet sections:

- Movable grate (Fuller Cooler)
- Walking floor (with dead-layer)
- Walking floor (without dead-layer)

Presently, the most commonly installed cooler is the grate cooler. The designs of grate coolers can differ in several details such as the grate design, transport mechanism, and number of cooler exhaust air take-offs for different purposes.

The cooling principle

Each manufacturer who builds and sells grate coolers has his own individual designs, especially with regard to the specific details for the transport mechanism and grate-plate design. Nevertheless, all grate cooler work on the same principle. The material falls from the rotating kiln into the static part of the cooler. The static part of the cooler distributes the clinker onto the movable "grate". The clinker gets moved with the transport mechanisms to a crusher and is then discharged from the kiln system. A major improvement, which some early designs already exhibited 20 years ago, was the reduction of clinker falling through the grate. At the present time most grate coolers have little to no fall-through. In the past 15 years the development of how to move the clinker more efficiently has brought further improvements, especially the reduction of operational costs.

In the static section of the cooler a major part of the combustion air is introduced and heated up to approximately 950-1 000 °C. The rest of the combustion air comes through the movable part of the cooler. The good heat recuperation is mainly driven by the high bed depth of 800 -1 200 mm, which can be achieved with modern grate coolers.

Heat recovery

The amount of air which is introduced to the grate cooler exceeds the amount of air needed for the combustion. The cooling air, which is not used for combustion, but needed for cooling, can be used for drying purposes or waste-heat powered-generation.

Grate coolers need approximately 1.7-1.8 Nm^3 cooling air per kg clinker, but the latest designs can already reach an air-to-clinker ratio of 1.4-1.5 Nm^3 cooling air per kg clinker. With this cooler technology, the clinker leaving the cooler can be

Figure 1: Smart Glider cooler at the Schretter & Cie cement plant in Austria

cooled down to a temperature range of 50-70 °C above ambient air temperature.

With a well-adjusted fixed inlet, very high secondary air temperatures can be achieved. The temperatures can even reach temperatures which can reduce the lifespan of the burner refractory and cause damage to the burner tip. The cooler efficiency of new modern grate coolers is very high, but more importantly, the new technology helps to drive fuel consumption down and delivers well-cooled clinker for the process following. The cooler clinker helps to save maintenance costs on conveyors and dust collection in the process after the cooler.

Clinker quality and power consumption

A major quality benefit is that the clinker gets quenched early on. The clinker minerals get frozen right at the discharge of the kiln where the clinker falls on the static part of the grate. This has a very positive effect on the clinker quality and can be adjusted to some degree to the required clinker quality.

Grate coolers require 3 to 6 kWh/t of clinker electrical energy for the cooling air fans, the filter ID fan and the heat exchanger. The use of fans requires a higher specific power consumption compared to other cooler types, but the effects on quality and the more effective cooling outweigh the higher electrical power consumption.

Walking floor coolers which convey the clinker above a clinker dead bed require additionally around 1.5 kWh/t of clinker.

A drawback of the original grate cooler in the past has been that the maintenance costs and maintenance efforts have been high. The development of the latest generation of grate coolers has led to drastically decreased maintenance costs. Also, in the past years understanding has grown with regard to the effect of the hood velocity, and the decrease of the velocities in the hood below < 4.5 m/sec has reduced the refractory wear tremendously. In some cases the maintenance costs (refractory included) could be reduced drastically – even by a factor of 20 (!).

Summary

The cement industry is facing great challenges worldwide with the steadily increasing cement demand and the need to reduce emissions. Nevertheless, the size of single kiln lines is increasing steadily and the largest kilns now produce up to 14,500 t of clinker per day. These huge material flows are already a manageable challenge for grate coolers.

Many years of positive experience gathered during daily operation, today's high availability and the high recuperating efficiency have led to the fact that the grate cooler is favoured above all other cooler types. The cooler manufacturers have been able to meet the expectations of the cement industry and its demand not only by adjusting the cooler size but also through several optimisations of crucial details and components of the cooler. The total number of grate cooler installations worldwide has therefore grown steadily over the past years whereas the use of other types has decreased.

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