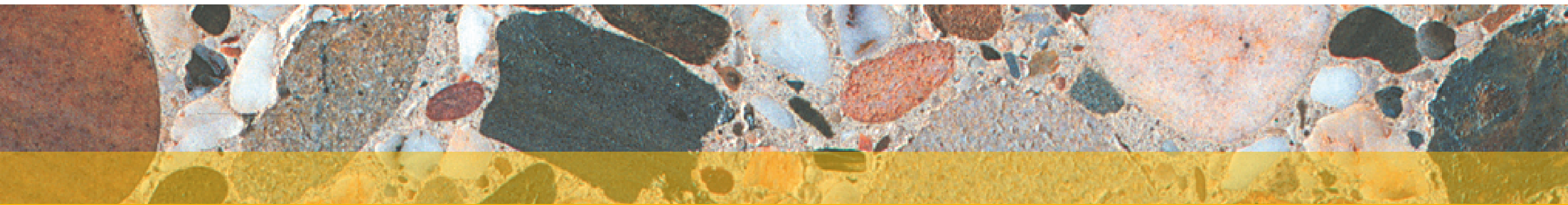
ecra
european cement research academy



1 / 2020

NEWSLETTER

A message from ECRA

Dear members and friends of ECRA,

First of all, and most importantly, we hope this newsletter finds you and your families well.

Over the past months the Covid-19 pandemic has altered all of our daily lives in many different ways. At ECRA, the effects of the current situation have been particularly felt with regard to our seminars, which as those of you who have taken part in them in the past will know, are international events, held in different countries and attended by participants from all over Europe and even further afield. The present situation unfortunately makes it impossible for us to hold our seminars in the usual manner, which we are sure you will understand.

In order to work around this however, we are delighted to be offering the following three seminars online:

- The Future Composition of Cement and Concrete: Resources in a Material-Constrained World (30 September 2020)
- Plant Performance and Process Optimisation (13 October 2020)
- State-of-the-art Calciner Technology (26 November 2020)

All seminars are now open for registration at www.ecra-online.org.

Our online seminars will offer you the same expert speakers and state of-the-art knowledge on cement and concrete for which ECRA is renowned.

We remain more committed than ever to continuing our success in creating and disseminating knowledge from research, and to facilitating and accelerating innovation in the cement industry.

As soon as we are able to do safely, we will hold our seminars in the usual format again, including plant visits and ample opportunity to meet and network with colleagues. Until then, we look forward to welcoming you online!

Martin Schneider
Managing Director

What will be the future resources for cement and concrete production?

Industry has to contribute to society's goals of sustainability and the circular economy

A modern and viable production of cement and concrete has to take into account the central aspects of environmental and climate protection and the conservation of natural resources. Besides diverse technical measures to optimise the production processes, the development and market launch of new, environmental-friendly cements and the recycling of demolished concrete are also indispensable.

More than 200 years ago Louis Vicat, with his work on hydraulic binders, laid the foundation for the development of today's cements. Since then, industry has been producing cement based on Portland cement clinker. In the course of the 20th century, the use of granulated blast furnace slag (ggbfs), fly ash, pozzolana, burnt shale, silica fume and limestone as cement constituents was established and standardised in the European EN 197-1.

Cement has proven to be a success story. Concrete produced with common cement made the construction of durable, solid and comfortable buildings and a modern infrastructure possible. The cement and concrete industry can rightly be proud of this contribution to global progress and development.

Environmental aspects

However, the production of cement and concrete is associated with a considerable consumption of natural resources, high energy usage and significant CO_2 emissions. Cement has the biggest influence on the global warming potential of concrete (Figure 1). Viewed worldwide, the cement industry is the third largest industrial consumer of energy and is responsible for 5 % of anthropogenic greenhouse gas emissions in CO_2 equivalent.

The vast majority of these CO_2 emissions arise in the clinker production process. Burning fossil fuels to generate the required process heat and the decomposition of calcium carbonate $CaCO_3$ in the clinkering reaction are both connected with the release of high volumes of CO_2.

The cement industry has implemented and is still implementing numerous measures to reduce specific CO_2 emissions. These include the technical optimisation of the production facilities, the replacement of fossil fuels with biogenic fuels and also the development of carbon capture technologies.

Efforts to reduce the clinker factor

In addition, the amount of clinker in cements has been reduced through the increasing use of other cement constituents. The clinker factor averaged 0.65 worldwide in 2014 and lower clinker factors are technically possible. Work is underway around the world to develop new cements that contain less Portland cement clinker while maintaining the advantageous technical properties. However, Portland cement clinker will continue to be indispensable to meet the global demand for durable concrete.

A first possibility is the further increased use of traditional cement constituents besides clinker. However, the availability of industrial by-products like ggbfs and fly ash is limited and will besignificantly reduced in some regions in the future.

Natural materials are less critical with regard to their availability. For example, natural pozzolana are silicon dioxide-containing minerals with pozzolanic properties due to strong heating through volcanism or meteorite impact. The worldwide availability of such materials is high, so that there is still further potential for the cement industry.

Another possibility is the use of calcined clay as a cement constituent, which has been the subject of intensive research over the past years. Clay minerals must undergo a heat treatment (calcination) in order to convert them into pozzolanic material. This process requires much less energy than the production of Portland cement clinker and furthermore there are no raw material-related CO_2 emissions. Clays of interest to the cement industry are those whose quality is insufficient for the production of ceramics, but which are suitable for calcination. The worldwide availability of such material is high. In combination with limestone, cements containing calcined clay show very good workability and performance in concrete.

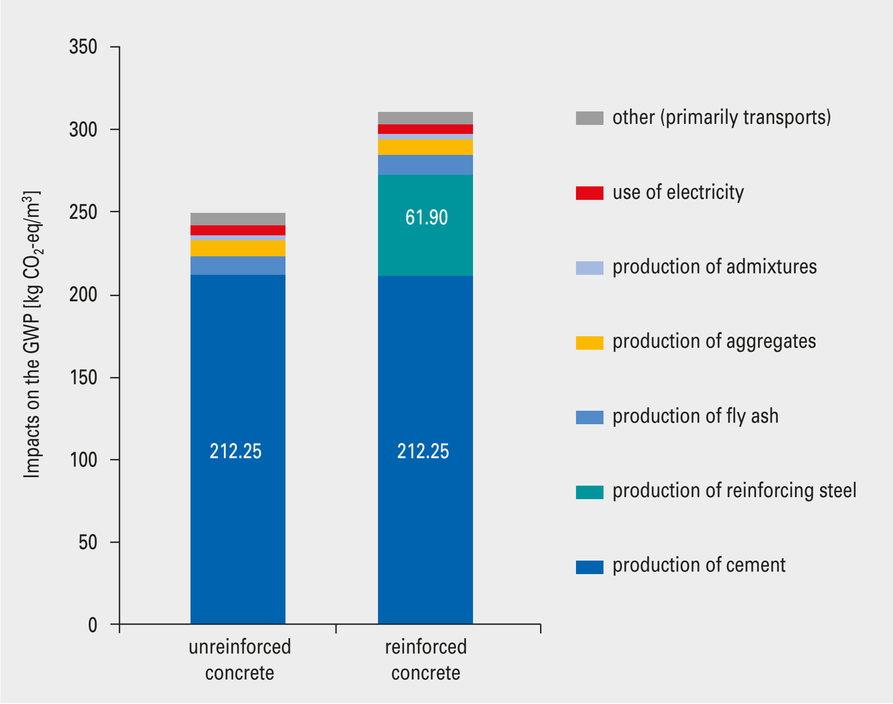


Figure 1: The global warming potential of concrete

Circular economy and recycling

In recent years, the issues of the circular economy and the recycling of construction products have become main topics in political discussions. Many research projects investigated the extent to which crushed building material can be re-used in construction. For example, in the "R-Concrete" project it was demonstrated that cements with 30% by mass fines from recycling of different building materials can achieve the strength classes 32,5 R to 52,5 R. Concrete produced with cements with 10 % by mass of these fines have successfully passed the durability tests (carbonation, chloride penetration, freeze-thaw and freeze-thaw with de-icing salts).

Another important recycling path is the use of crushed construction products as aggregates for concrete. Depending on the regions different recycling rates exist. But in all cases a further increase in the amount of recycled material seems possible.

As part of the "Green Deal" and the "Circular Economy" action plan, the European Commission is willing to promote sustainability aspects of construction products. This will also influence the content of future standardisation requests. As a consequence, sustainability will be addressed in European standards and the products covered thereby.

CSC certification creates new incentives

In 2017 the Concrete Sustainability Council (CSC) introduced a worldwide certification system for responsibly produced concrete. The system promotes transparency regarding the concrete manufacturing process and the effects on the social and ecological environment. It includes the entire value chain, also aggregates and cement. The certification shall illustrate the high level of sustainability that the industry has already achieved and promote continuous further improvement.

Improving energy efficiency: The main daily objective

High alternative fuel rates and finer cements can go hand in hand with an increase in energy efficiency

By increasing the use of alternative fuels (AF) and improving energy efficiency, the cement industry has proven in the past decades that sustainability and the simultaneous reduction of operational costs can go hand in hand. Nevertheless, the reduction of energy consumption and therefore the lowering of CO_2 emissions is the daily work of every cement plant operator. Potential energy savings are plant specific and some trade-offs must be negotiated. In order to reach the highest technical level, the correct operation and maintenance of state-of-the-art equipment, tight control of the whole process and the careful selection of fuels and raw materials are fundamental.

The production of cement is one of the most energy-intensive production processes in the manufacturing industry, in which energy typically accounts for around 40 % of operational costs. For this reason, energy demand has always been a subject of major interest to cement companies in order to limit or reduce production costs. Energy efficiency is often mentioned as one important lever to reduce CO_2 emissions. In general, energy efficiency in cement plants is high compared to other industrial processes because waste heat is used twice – for heating the combustion air and for drying raw materials.

Thermal energy demand

The replacement of outdated major equipment (e.g. clinker cooler, cement mills, etc.) with other equipment with higher efficiency, or even the construction of new BAT kiln lines requires considerably high investment. The economic viability of both is usually difficult to justify when based exclusively on potential energy gains. Such projects are often carried out if the market situation is favourable, especially in growing markets, or if the equipment is outdated. Electric energy demand is closely connected to technological and market needs, in particular, cement properties, and to environmental regulations and emission level constraints. The type of production process and the moisture content of the raw materials remain the two key factors for the fuel energy demand of a plant.

Based on the GCCA GNR data from 2017, the global specific thermal energy demand for cement clinker manufacturing was 3,490 MJ/$t_{clinker}$. However, the thermal energy demand ranges from below 3,000 MJ/$t_{clinker}$ to over 5,000 MJ/$t_{clinker}$ (wet production process). An overview of influencing parameters and technologies was published in 2017 by the European Cement Research Academy (ECRA) in its Technology Papers.

Influencing parameters

The most outstanding performance levels can only be achieved by well-maintained large precalciner kilns and if these are linked to raw materials with low moisture content and good burnability. The higher the production capacity, the lower the production-specific energy losses. Short-term figures (e.g. in a 24h performance test) are usually 160 to 320 MJ/$t_{clinker}$ lower than the yearly averages, as they are not affected by unplanned kiln stops, heating up and shutting down the kiln or the market situation, etc. Therefore, the "mean time between failures" (MTBF) should be as high as possible for good energy performance. The use of alternative fuels instead of fossil fuels has proven that these can not only provide considerable economic gains but also relevant environmental benefits. In the EU-28 the thermal substitution rate was around 45 % in 2017 (as a yearly average) and is rising steadily.

However, experience shows that firing AF – depending on the AF type and properties – often leads to a certain increase in the thermal energy demand of cement kilns, mainly due to the higher moisture content of AF, higher ash content and therefore lower calorific value than fossil fuels. But this does not necessarily imply a less efficient energy utilisation. Since an increase in fuel substitution often leads to a higher preheater exhaust gas temperature, its increased energy content yields the potential of further waste gas usage apart from raw material drying within the raw mill and kiln system. In order to take this into account, the energy demand of cement kilns can be assessed depending on the AF ratio and kiln capacity (see Fig. 1).On the other hand, due to the lower C/H ratio and biogenic content in some AF, CO_2 emission is reduced compared to the use of coal.

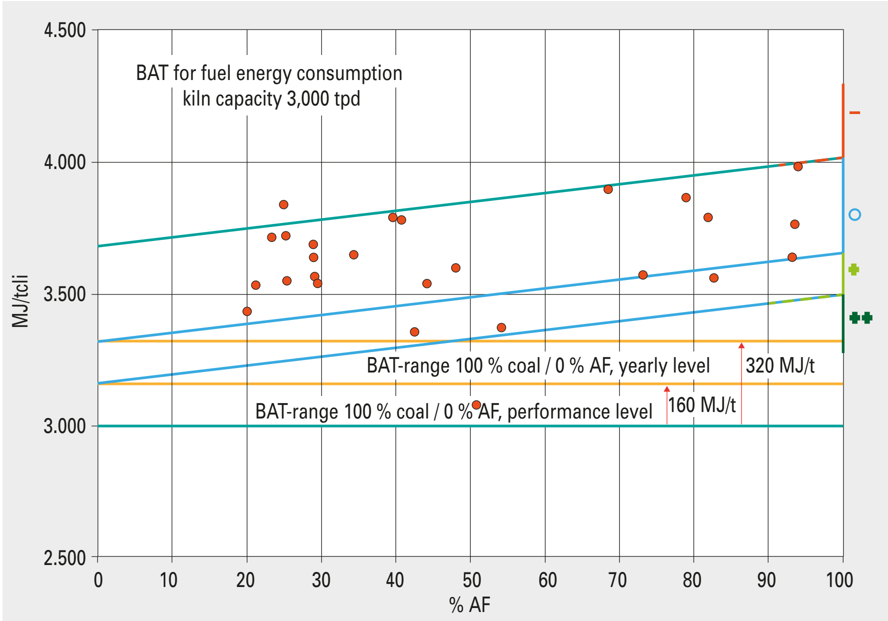


Figure 1: Assessment of fuel energy performance depending on the AF substitution rate.

Electrical energy demand

The global average electric energy demand for cement manufacturing was 102 kWh/tcement in 2017 (weighted yearly average; all types of cement; covering 19 % of the global cement production and all technologies) and has been stable since 2012. The 10 % best in class in 2017 reported figures below 80 kWh/t_{cement}. In Germany, it rose by around 12 kWh/t_{cement} in the period from 2008 to 2018, reaching 111 kWh/t_{cement}. The same trend was observed in the EU-28.

The most relevant influencing factors are the cement properties required by the respective markets. The higher the cements' strength development, the finer they typically have to be ground, requiring significantly more energy in the cement mills. Worldwide, there has been a clear trend towards efficient mill types for many years, mainly vertical roller mills and high pressure grinding rollers for cement production. On the other hand, in markets demanding a high variety of cement types, partly with very high fineness, the plants have to ensure high flexibility with a limited number of mills. Therefore, ball mills are still the predominant mill type in many regions of the word, although they are less energy efficient.

The abatement of pollutants such as dust, NO_x or SO_2 requires additional installations which also require electricity. Cement plants which have for example installed SCR equipment for NO_x abatement, require an additional 4 to 7 $kWh/t_{clinker}$.

The implementation of certain measures to improve thermal efficiency often demands more power (e.g. WHR systems, dryers of AF or alternative raw materials). As a consequence, the increase of the electric energy demand combined with higher AF rates tends to counterbalance the cement-specific energy gains achieved in the past decade with lower clinker/cement ratios and higher energy efficiency. This implies that it requires dedicated and more complex measures to further reduce energy consumption for cement production.

Upcoming ECRA online seminars:

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  30 September 2020
- Plant Performance and Process Optimisation
  13 October 2020
- State-of-the-art Calciner Technology
  26 November 2020

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