ecra
european cement research academy

1 / 2008

NEWSLETTER

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Next ecra events to come:

- Clinker Reactivity
  in Düsseldorf, 17 April 2008
- Second International Conference
  in Prague, 16 May 2008

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The Cement Industry on its Way into the 21st Century

The second ecra Conference will take place in Prague on 16 May 2008

For the second time the European Cement Research Academy invites ecra members and other interested parties to its conference which, this time, will take place in Prague. Eight presentations will be given on topics which are of high importance for the cement industry. For the first time two reports will be given on research projects which ecra has initiated recently.

The presentations in detail:

Daniel Gauthier (HeidelbergCement), the Chairman of the ecra Technical Advisory Board, will give an overview of ecra's work in recent times and its focus in the future. He will also reflect on the two research projects on CO_2 capture and storage and CO_2 determination from biomass using the ^{14}C method. The presentation will also highlight the technical challenges for the cement industry. Most of them can be deducted from the global spirit of climate change and CO_2 reduction. This leads to challenges in reducing cement clinker factors, increasing the substitution rate of alternative fuels and raw materials and highlighting the advantages of concrete as a sustainable building material.

Concrete: a sustainable construction material in the 21st century

Jacques Lukasik (Lafarge) will highlight the aspects of concrete as a sustainable construction material. It is clear that from an economic, ecological and social point of view concrete is still the building material of the century, contributing to sustainability in every sense. The presentation will give an overview of the recent and future development in this field, underlining the sustainability of cement and concrete and will also give some visionary views into the future.

Research and development in emerging markets

S. K. Maheshwari (Grasim) will focus on research and development in the Indian cement industry which is an excellent example of a quickly developing society and consequently quickly developing cement industry. While being subject to the global spirit of climate change these markets have to satisfy a growing demand for cement and robust concretes capable of supporting the strong growth in housing and infrastructure. The presentation will give an impression of the situation in the Indian cement industry and how it faces the challenges especially through its research and development activities.

Geopolymeres – new binders for the future?

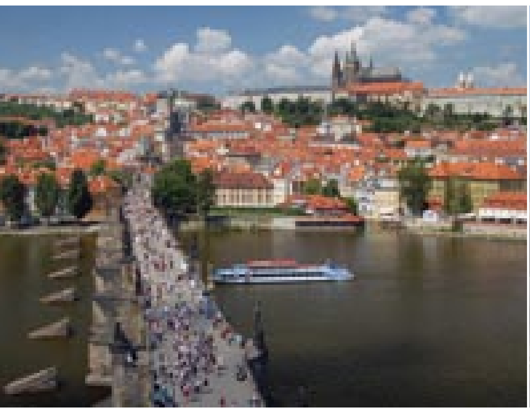
Donald McPhee (University of Aberdeen) will give an overview of the latest research on alumosilicate reactions in cementitious materials. It is known that in a laboratory scale certain materials often called geopolymeres can take advantage of alumosilicate reaction. However, the availability of those materials is very limited. Also requirements for the production process and in addition durability aspects have to be carefully examined. Even if alumosilicates will not provide the basis for a dramatic change in cement technology, the understanding of the chemical reaction in the mineralogical transformation can open possibilities for the improvement of the performance of blended cement that contains constituents like fly ash, ground granulated blast-furnace slag or natural pozzolanas, materials which are regionally available in appropriate quantities and have been well-known for a long time.

Photocatalytic surfaces in construction materials

Luigi Cassar (Italcementi) will point out the development that has taken place in recent years in concrete or mortar surfaces that provide photocatalytic properties. Photocatalysis has been well-known for a long time but it is quite a new field in the context of construction materials. Based on titanium dioxide (TiO_2) concrete surfaces are able to catalytically clean the air in contact with the concrete surface by means of decomposition of certain trace compounds such as NO_x. The presentation will focus on the major steps of this innovation. It will also underline the potential for cementitious construction materials as cleaning surfaces in the future.

Current state of carbon capture technology – potential application in the cement industry

Volker Hoenig (VDZ) will report on the ecra project on CO_2 capture and storage. First results within the ecra study have shown that the costs of such technology will be extremely high. In addition, the cement kilns could only be adapted to this technology by a tremendous modification



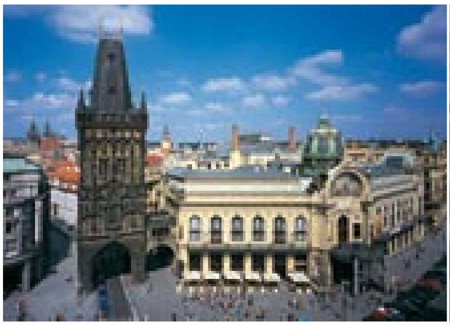
of the clinker burning process. Nevertheless, ecra has decided to look at CCS in more detail in order to be able to express itself in the future. The results of the ecra CCS study phase I will be reported and also the next steps ecra will now undertake will be highlighted.

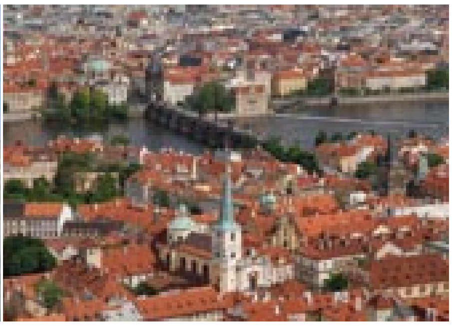
CO_2 savings from alternative fuels in the cement industry

Bruno Vanderborght (Holcim) and Johannes Ruppert (VDZ) will report on CO_2 emissions from the cement industry and what kind of indirect savings can be attributed to cement production. It is well-known that the use of alternative fuels in the cement industry reduces CO_2 first of all by the biomass content in these fuels. Nevertheless the use of waste as alternative fuels in cement kilns also eliminates CO_2 being emitted from other sources. These sources can be landfills or dedicated waste incinerators. As a consequence, the total balance of CO_2 shows dramatic indirect saving potentials even if the CO_2 emissions at the stack of the cement kilns remain almost unchanged.

CO_2 determination from biomass using ^{14}C detection

Rob van der Meer (HeidelbergCement) will focus on the second project which ecra has addressed. The project is based on the emission factor "zero" assigned to CO_2 from biomass. However, the CO_2 determination from biomass is very costly at present. So far the biomass determination has to take place in the individual fuels. This is cumbersome and the owners of the industrial installations pay a high price for this. Another possibility is to extract CO_2 from the stack and to do the analysis of biomass CO_2 from these gases. Taking advantage of the ^{14}C method it should be possible to determine biomass CO_2 immediately.





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Clinker Reactivity – Bridge between Process and Product

In keeping the high standard of cement performance the clinker quality is a key issue

Cement performance is determined to a high degree by the reactivity of clinker. The basic properties of all cement types, such as setting time and strength development, are fulfilling international standard frameworks. This is essential, as the requirements of most cement applications in structural engineering are defined by regulations based on standardized cements. Beyond this, additional demands such as a sufficient constancy of the cement properties or stability of interactions with other concrete constituents like chemical admixtures may be claimed. Being the basic carrier of hydraulic properties, the clinker quality always needs to be addressed with particular emphasis in cement production.

Besides the raw meal constitution and the kiln design, the burning conditions affect the clinker microstructure and by this its properties in cement. This means that the influence of fuel mix, burning zone temperature, flame shape, potential ash entrainment, kiln atmosphere and cooling rate need to be controlled to maintain a constant and satisfactory clinker reactivity (**Fig. 1**).

Interactions in composite cements

In cements with more than one main constituent, the impact of clinker reactivity is superposed by interactions between clinker and the supplementary cementitious materials during hydration. Pozzolanic materials for instance dissipate the calcium hydroxide deliberated by the hydrating calcium silicates from the clinker. The hydration of latent hydraulic constituents, however, is initiated by the clinker hydration, mainly through the pH increase of the pore solution. In these more complex systems, the formation of hydration products different from the dominating phases ettringite, calcium silicate hydrate and portlandite, as known from Portland cement, may occur on an accessory level. With the development of composite cements containing three and more main constituents, the situation has gained in complexity.

Analytical key methods

Yet, the hydration of Portland cement itself is subject to a number of parameters involving the clinker reactivity. Basic parameters such as the lime saturation factor, silica and alumina ratio as well as other numbers describing the clinker's chemical composition provide a cursory basis for clinker assessment and quality control and can be measured automatically e. g. by means of X-ray fluorescence. Since the clinker properties are a result of more complex influences, additional analytical techniques are approved to contribute essential information about the reactivity. An appropriate quantitative phase

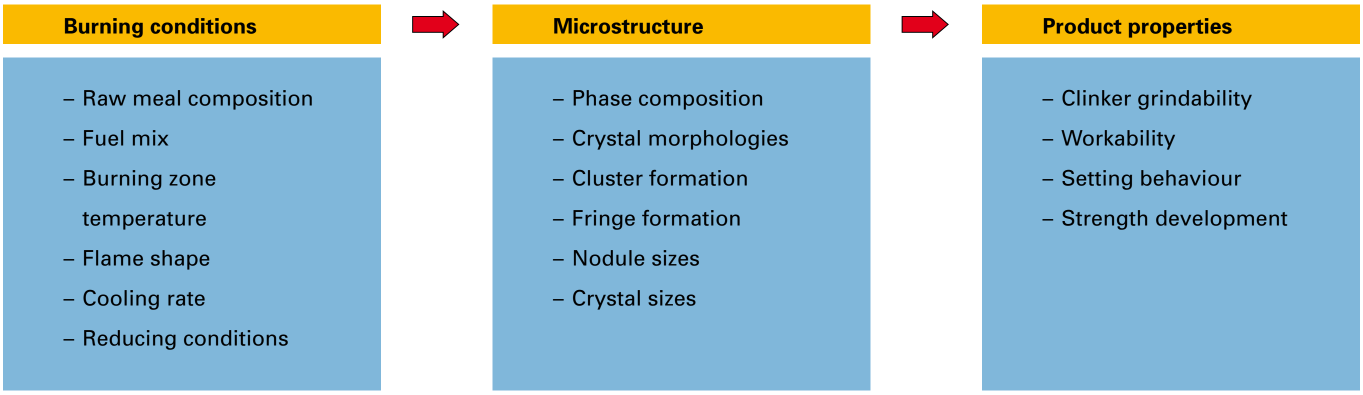

Fig. 1: Chemical and physical clinker properties building the link between process parameters and cement performance

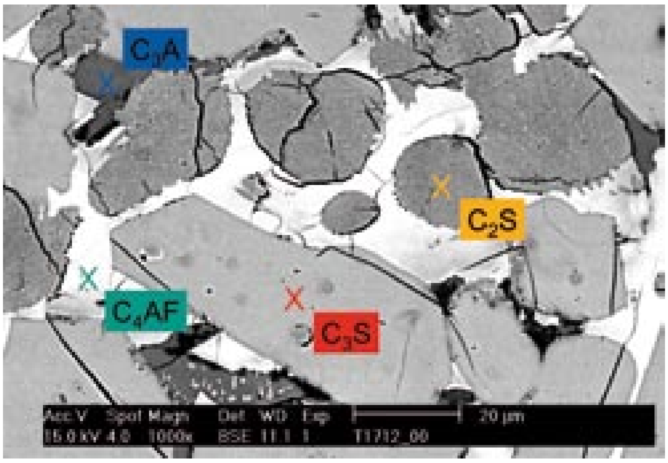

Fig. 2: Scanning electron micrograph of a cement clinker grain (polished surface)

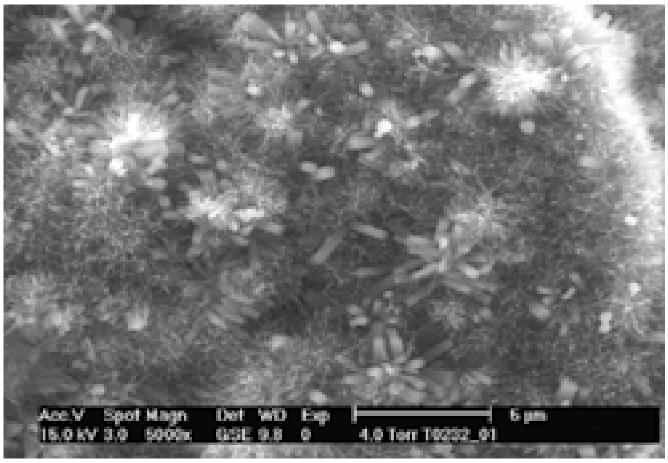

Fig. 3: Microstructure of a hydrated cement with optimum setting regulation, showing few ettringite crystals in a matrix of calcium silicate hydrate

analysis can preferably be obtained by X-ray diffraction with Rietveld refinement, because other methods suffer strongly from error sources like inhomogeneities and impurities of the plain clinker phases. Microscopical techniques provide for an examination of morphological features of clinker and cement structures (**Fig. 2**). Setting and hardening reactions of cement can be tested not only mechanically but also by analytical methods such as scanning electron microscopy or thermal analysis. The obtained results allow for product improvements on the levels of raw material processing, kiln operation, grinding and sulphate optimisation.

One example is an achievement of optimum setting retardation, which is usually obtained by adding suitable amounts of calcium sulphate to the cement. By this, the C_3A hydration is regulated in such a way that an initial formation of ettringite improves the cement workability as long as possible. The dense microstructure of a hydrated cement with virtually ideal setting regulation is shown in **Fig. 3**.

However, the interactions between sulphate agent and C_3A are subject to a number of parameters such as the amount of soluble alkali sulphates in the clinker as well as the C_3A reactivity, being a matter of alkali incorporation and also clinker cooling rates. Changes in C_3A hydration rates can be met by adjusting the amount and the composition of calcium sulphates. The use of gypsum coupled with an optimised grinding temperature to control its dehydration is one opportunity to meet this issue.

Numerous and complex influences on clinker properties are currently being observed in cement production practice. Another point of growing importance is the modification of clinker properties due to new chemical concrete admixtures. These issues can be sufficiently controlled by the mentioned techniques available today.

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