CEMENT ADDITIVES

ADDITIVES FOR A CHALLENGING CEMENT MARKET

REPRINT OF PAPER PUBLISHED IN WORLD CEMENT OCTOBER 2009
Cement is vital for today’s construction industry. The cost optimized production of quality cement which meets customer demands and standards as well as sustainability issues challenges every cement plant individually. Sika offers innovative cement additive concepts combined with a specialized technical support, targeting improved production rates, enhanced strength development and adjusted workability. The reduced utilization of energy and clinker contributes to the profitability of your business.
Additives for a Challenging Cement Market

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Introduction
In today’s market of increasing competition and decreasing volumes, cement manufacturers as well as cement users are aiming for cost reduction with the aim to increase profitability and stabilise or extend their own position in the global market. Additives that offer additional benefits during cement production and cement application in concrete can help to differentiate oneself from the competition.

While the major quality parameters are regulated in the different standards, additional unregulated properties can become the decisive factor when choosing a particular cement.

Cement quality
Cement producers need to supply the cement quality as it is defined by the standards, such as the European standard EN 197-1, while also meeting customers’ demands. Strength development is the most important property since it is the reason why cement is used in the construction industry.

Concrete producers look for a cement that supports their daily work as much as possible. Key words from this perspective are homogeneity and good concrete workability, but also easy handling of the cement itself.
New developments in grinding aids and quality improvers offer solutions for individual challenges, providing additional opportunities to optimise cement production and improve business competitiveness.

**Grinding aids and quality improvers**

State-of-the-art cement production uses cement additives to achieve the desired production values, as well as the designed strength parameters.

Chemical process aids for the grinding process with ball mills and vertical mills (so-called “grinding aids”) are used to assist the comminution and reduce the specific energy consumption per tonne of cement. The latest developments in grinding aid technology achieve the highest grinding and separating efficiency, using combinations of commonly used raw materials like amino-acetates or glycols with special polycarboxylate polymers.

Strength enhancing cement additives – “quality improvers” – have become increasingly common since the 1980s. In this product group, different chloride-free and chloride-containing technologies mainly target a higher early strength, which increases the use of clinker replacements like slag, pozzolans and limestone.

**Additional benefits**

While the strength development usually stays within the designed limits, other side effects of the constantly increasing use of clinker replacements are often out of the main focus. These can range from increased water demand and the connected low concrete workability to bleeding of the produced concrete. Since the amount of water in concrete and its in-homogeneities affects its appearance, highly consistent cement quality is demanded, especially for the increasingly used fair faced concrete in architectural applications.

Based on a tailor-made approach, additional benefits can be achieved with the use of the polycarboxylate polymer powered grinding aid technology:

- Adjustable powder flowability (cement handling).
- Reduced carbon bleeding (concrete homogeneity).
- Improved consistency (concrete workability).

**Adjusted cement flowability**

The comminution of clinker during the cement grinding process results in unsatisfied charges on the newly created surfaces, which cause an electrostatic attraction of the cement particles. With increasing fineness, more surface charges are generated, which increasingly reduce cement powder flowability. These inter-particle forces can adversely affect the flow characteristics in airslides and result in a no-flow condition during discharge of silos and transportation vessels.

Investigations into how to reduce this frequently encountered problem with and without aeration equipment have been discussed in literature. Grinding aids reduce the inter-particle adhesion and hence have a positive influence on the powder flowability. With the new polycarboxylate polymer containing grinding aid technology, the flow characteristics can be adjusted from a relatively small to a pronounced powder flowability increase.

Sika usually uses two different test methods to determine the powder flowability:

- The bulk density represents approximately the powder flow behaviour during the filling of silos.
- The Imse method represents approximately the unloading of silos and transportation vessels, which makes sense to test over the potential cement storage time.
Figure 1 shows the flow enhancing effect of the SikaGrind-800 Series according to the Imse method, while Figure 2 shows the resulting improved discharging in a real production application. Cement with a traditional grinding aid needs continuous mechanical activation to leave the outlet pipe (Figure 2, left). Cement using the new grinding aid technology based on polycarboxylate polymers easily flows when opening the valve.

Reduced carbon bleeding
Carbon bleeding is understood as the circumstance that fine visible particles in mortar and concrete float up to the surface and give it a significant change of aspect. This phenomenon is well-known in concrete technology, where flyash is frequently used as a cement substitute. In most cases, these particles are carbon black, which results from incomplete burning of organic substances in raw materials used during the cement grinding process or as cement replacement in concrete. Today, the constantly increasing content of major and minor clinker replacements like flyash or kiln dusts, which might be subject to certain amounts of carbon black, intensifies this critical topic.

This effect gets more pronounced with:
- Increased creation of bleeding water.
- Prolonged compaction times of mortar and concrete.

The target in the following example was to suppress the creation of carbon bleeding on the concrete surface and maintain the production values with a combined product. Naturally, the maximum allowed loss of ignition in cement had to be considered. In a first step, mortar trials have been executed to demonstrate the stabilising effect for the cement. After the fulfilment of these demands, plant trials were executed that confirmed the laboratory findings. As can be seen in Figure 3, flyash cement CEM II/A-V 32.5 R carbon bleeding could be successfully reduced.

Improved workability of cement paste and concrete
Another subject related to today’s situation of maximised secondary cementitious materials is the consistency development of the concrete manufactured with blended cement. It is a matter of common knowledge that at constant fineness the strength of cements with interground limestone decreases by an amount corresponding approximately to the extent that the Portland cement is “diluted” with limestone. To keep the strength unchanged, the cement or at least the clinker component thereof must be ground to a greater fineness. This leads to an increased water demand of the cement and hence to a reduced concrete workability. The same applies to the use of puzzolanes as clinker replacement.

In the following example, concrete producers complained about the unacceptable short slump life with this particular cement compared to another possible cement supplier. Naturally, production rates and strength development had to remain unchanged.

Via a tailor-made approach, laboratory trials have been executed with the target to extend slump life. 10 kg of a pure Portland cement CEM I 42.5 R was ground in a horizontal laboratory mill TTS 50 from Siebtechnik to a fineness of 3300 cm²/g with the help of different experimental products. Even though the constant grinding time resulted in a slightly finer particle size distribution, the initial consistency of the resulting cement remained unchanged. The convincing results (Figure 4) allowed plant trials to be executed immediately with the targeted limestone cement.
Samples of the CEM II/A-LL 32.5 R produced during the plant trial with 0.02% of the traditional competitor’s product and 0.02% of the tailor-made product out of the SikaGrind-800 Series, respectively, were then additionally analysed in extensive concrete trials. The results show the consistency development measured with the flow table spread of different types of concrete and temperatures (Figure 5). In this case, the tailor-made polycarboxylate polymer based grinding aid technology offered the additional benefit of a more favourable concrete workability (extended slump life) compared to the traditional grinding aid technology.

**Conclusion**

Today, cement additives are used for more than only reduced specific energy consumption and improved strength development.

Based on a tailor-made approach, additional benefits like adjustable powder flowability, reduced carbon bleeding and improved consistency can be achieved. These additional benefits can become the decisive factor to ensure the application of specific cement types.

Products from the SikaGrind range offer a solution for individual challenges, providing additional opportunities to optimise cement production and improve your business.

**References**


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WHO WE ARE
Sika AG, Switzerland, is a globally active specialty chemicals company. Sika supplies the building and construction industry as well as manufacturing industries (automotive, bus, truck, rail, solar and wind power plants, façades). Sika is a leader in processing materials used in sealing, bonding, damping, reinforcing and protecting loadbearing structures. Sika’s product lines feature high quality concrete admixtures, specialty mortars, sealants and adhesives, damping and reinforcing materials, structural strengthening systems, industrial flooring as well as roofing and waterproofing systems.

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