CEMENT ADDITIVES
CREATIVE GRINDING SOLUTIONS
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In the mid-1930s, cement plants started to use cement additives to increase the production volume of cement. It became evident, that the use of cement additives enabled producers to achieve cement fineness and qualities which would hardly be possible without them.

The basic raw materials used then were amines, amino-acetates, glycols and gluconates. In the last decades, the main focus was to find new and more efficient amines concerning grindability and hydration-enhancement.

New technology
Sika has now developed a new raw material with excellent properties in terms of improved grindability. The latest generation of SikaGrind® cement additives is based on polycarboxylate (PCE) polymers. These products allow for a consistent production at the highest production rates. The special ViscoCrete polymers have been developed in Sika's central R&D laboratory in Zürich, Switzerland and are produced worldwide by all Sika's polymer-production plants.

The PCE polymers, which look similar at the molecular level to amines and glycols, and contain similar ionic groups are quickly distributed to their field of action due to the excellent mixing behaviour of the mill.

Figure 1: total feed of cement mill consisting of fresh material, the return from the separator and SikaGrind

Figure 2: adjustable mill output related to the dosage of SikaGrind®-800

Creative grinding solutions
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The use of chemical processing agents in the manufacture of cement is well known and state-of-the-art today. The latest developments in the chemical industry have opened new possibilities to further improve the cost structure. Sika has introduced a new approach to the grinding aid business. The brand SikaGrind stands for new creative solutions for grinding aids and performance enhancers.
The easy dispersable PCE polymers support cracking behaviour of the cement particles by direct contact of the millions of smallest molecules which can be found in each drop of SikaGrind. This critical property of grinding aids is achieved in the case of these new polymers mainly through two mechanisms: (1) they avoid re-agglomeration of particles, and (2) they improve the performance of the separator significantly, decreasing the return feed, allowing for an increase of the fresh feed and thereby increasing the overall production rate.

**Synergies**

During the laboratory grinding trials in Sika’s research and development centre for cement additives in Leimen, Germany, it became evident, that the best grinding behaviour could be achieved with products based on formulations of special PCE polymers and existing, proven raw materials. This synergy effect was confirmed in multiple international plant trials with different cement types and grinding conditions (see Figure 1).

Since the usually achieved final strengths for this particular cement where always at the upper limit according to EN 197-1, an additional test series was performed targeting a 200cm²/g lower Blaine value of the finished cement, which ultimately resulted in another production increase. In total, product performance of these new PCE polymer based products allowed for a production increase of 18 per cent.

**Strength increase**

Another of the plant trials was set the target to increase the slag content at a constant production rate, in this case of a CEM II/B-S 32.5 R (Blaine 3100cm²/g). Sika’s new grinding aid technology allowed for the production of a cement with finer granulometry, all at the same low dosage rate of the grinding aid and the same production parameters, compared to the amine based product currently in use.

This lead to an increased early strength as well as an increased final strength (see Table 1) which then can be used to reduce the clinker content and hence reduce the CO₂ emissions of this cement plant.

**Process optimisation**

Figures 4 and 5 show the results of one of the many executed plant trials, in this case a CEM II/B-S 32.5 R (Blaine 4100cm²/g). Sika’s new grinding aid technology achieved at a significant lower dosage an additional six per cent production throughput compared to a traditional Glycol based product while maintaining the performance of the finished cement.
Tailor made solutions and on-site support

Since every type of cement has its own characteristic and the challenges of cement manufacturing vary according to the local conditions, every single cement plant needs to be handled individually.

Therefore, Sika offers different basic technologies and tailor made solutions, always with the target to assist producers in creating new markets and improve their profitability.

In one of the applications, the target set by the cement manufacturer was to supply a special amine free grinding aid, which would at least meet the same productivity and achieve the same cement performance as the up to this date used amine based grinding aid. Grinding trials as well as all standard cement powder and mortar analyses in Sika’s central cement laboratory (Figure 6) demonstrated the capability of SikaGrind and enabled Sika’s team to prove the company’s quality in plant trials. Finally, the production rates with this tailor made product could additionally be increased by five per cent compared to the conventional grinding aid.

In addition to these new generation of grinding aids and existing technologies for cement additives, Sika offers also the necessary support in the preparation, execution and analysis of the plant trials (see Figure 7). Usually, during a first screening plant production, different types and dosages of SikaGrind are tested to see the reaction of the mill on this new technology.

The positive performance of the ball mill in combination with Sika’s product at the chosen dosage is then analysed in a longer plant trial with constant production conditions.

Figure 8 displays the fresh feed and the return from the separator from a CEM I 52.5R production (Blaine 5000cm²/g) after the balanced system had been reached and before next variations where tested.

It demonstrated how Sika’s products lead to very constant production parameters at an increased level compared to the traditional and commonly used grinding aid (amine based).

Summary

Besides offering a range of traditional cement additives, Sika has developed and introduced a new generation of grinding aids based on polycarboxylate polymer technology.

These new products offer all the positive effects, why grinding aids have been used over the last decades, mainly which improve the production rates of ball mills and increase the separator efficiency, resulting in improved throughput over existing products.

The increased productivity of this new grinding aid technology enables producers to react flexible to the demands for cement volume in the market.

In addition, these products improve the granulometry as well as powder flowability of the finished cement.

These advantages can be used to obtain cost savings due to lower relative power consumption per tonne of cement or to gain quality enhancement. As a joint effect of the multiple reduction of CO₂ emission, from energy saving and clinker replacement, costs are saved and the environment is better protected.

Table 1: Optimised fineness and strength results with SikaGrind®-800 series

<table>
<thead>
<tr>
<th>Product</th>
<th>amine based competitor</th>
<th>SikaGrind®-800 technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dosage ml/min</td>
<td>220</td>
<td>220</td>
</tr>
<tr>
<td>Product (tph)</td>
<td>70</td>
<td>71</td>
</tr>
<tr>
<td>Dosage %</td>
<td>0.20</td>
<td>0.20</td>
</tr>
<tr>
<td>Blain cm²/g</td>
<td>3090</td>
<td>3125</td>
</tr>
<tr>
<td>Sieve residue 32µm in %</td>
<td>31.5</td>
<td>24.9</td>
</tr>
<tr>
<td>Inclination ‘n’ in RRSB net</td>
<td>0.80</td>
<td>0.83</td>
</tr>
<tr>
<td>‘x’ in RRSB net</td>
<td>21.5</td>
<td>19.8</td>
</tr>
<tr>
<td>Compressive strength N/mm²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 day</td>
<td>7.2</td>
<td>9.1</td>
</tr>
<tr>
<td>2 days</td>
<td>17.6</td>
<td>19.4</td>
</tr>
<tr>
<td>7 days</td>
<td>32.9</td>
<td>36.2</td>
</tr>
<tr>
<td>28 days</td>
<td>50.9</td>
<td>54.9</td>
</tr>
</tbody>
</table>

Figure 8: Constant and increased cement production with SikaGrind technology

Figure 7: Sika supports plant trials with a consulting service and active participation, like the taking of samples.

Figure 6: In addition to the ball mill, Sika’s central cement laboratory is equipped with all the necessary tools to provide support.