CEMENT
SIKA SOLUTIONS FOR CEMENT PRODUCTION

BUILDING TRUST

CREATIVE SOLUTIONS FOR CEMENT PRODUCTION

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 additives which positively affect the production process and the quality of cement. The use of this SikaGrind® technology results in more commercial benefits with less environmental impact while improving cement application. In addition, Sika's know how in cement production allows extending the capacity of cement plants at constant clinker production using the whole range of available clinker replacements while in parallel meet the desired performance criteria. The resulting reduced utilization of energy and resources combined with minimized carbon footprint contributes to the profitability of your business. Sika adds value to your cement.

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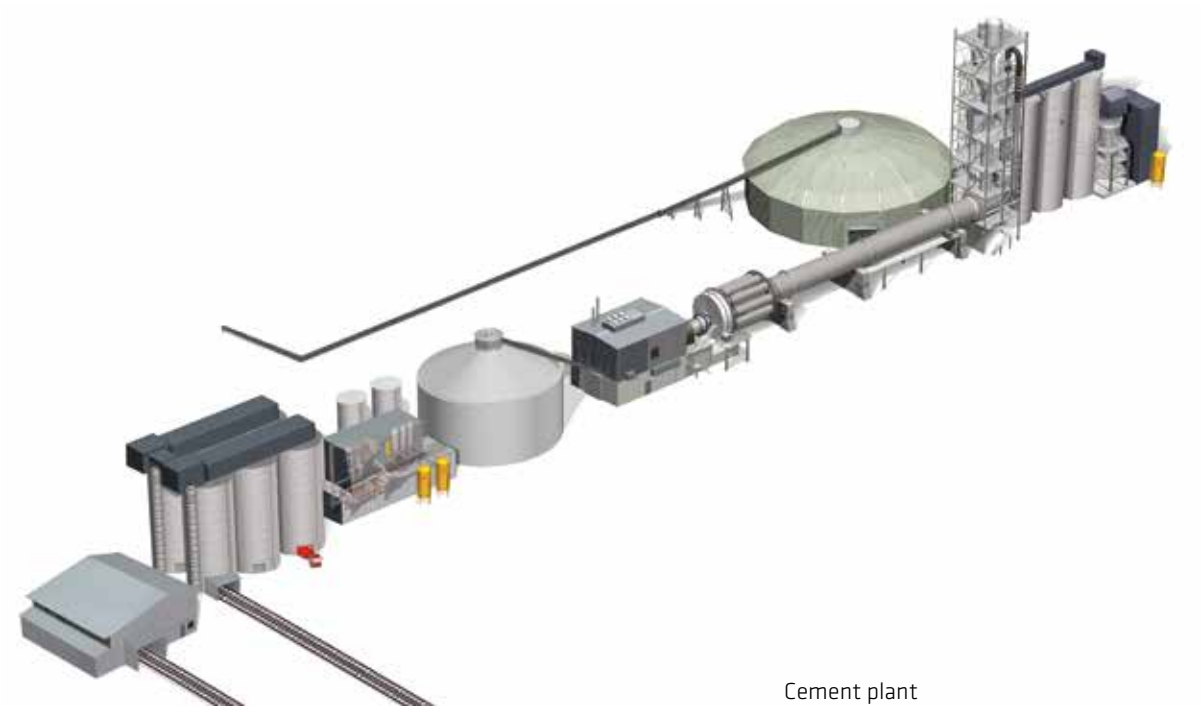
IMPORTANCE OF THE CEMENT GRINDING PROCESS



Cement plant

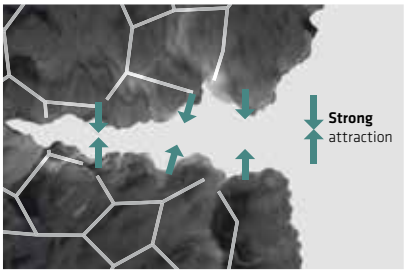
Cement manufacture is a highly technical process in which every part has a decisive impact on the product quality as well as on economical and ecological production parameters. Starting with the origin of the necessary raw materials via the clinker burning and cooling, to the careful adjustment of the cement formulation, cement manufacturers constantly strive for homogeneous quality of their products.

The cement grinding process is the final chance to adjust the cement quality to meet the demands set by relevant standards and cement customers. It combines influences from different areas like the mechanical grinding process, the chemical and physical raw material properties and the cement formulation itself. Interactions between these effects result in a very challenging process which needs skilled and experienced people on all sides.

Optimization of the cement formulation and the cement grinding process creates value. Application of the SikaGrind® technology can help you to further improve your process and profitability.

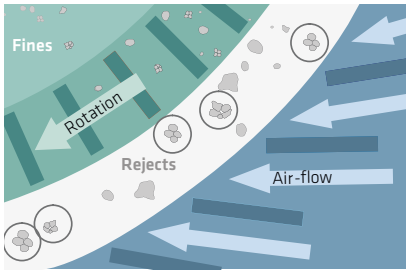
SikaGrind®- TECHNOLOGY: SMALL DROPS WITH A HUGE IMPACT

Within homogeneous solids, the internal forces of opposite direction cancel each other out. At the interface of a particle, the resultant force is directed inwards due to the missing counterpart. This force is called surface energy (similar to surface tension of liquids) or polarity. The higher the targeted fineness of a powder (specific surface), the more surface energy is generated. However, everything tends towards a state with the lowest possible energy level.



- Consequently, finely ground particles attract each other in order to form agglomerates and release energy (agglomeration energy).

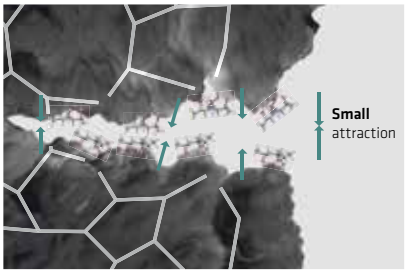
- These attraction forces are the reason why ground particles stick on mill internals (coating effect) and soften the impact of the grinding media.



- Agglomerates of sufficiently ground particles are detected by the separator as coarse particles and consequently return as reject to the mill.

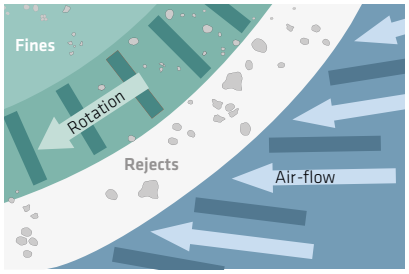
Production values as well as cement quality itself are adversely affected by the resulting lower grinding and separating efficiency. At constant specific surface, increasing amounts of overground particles cause lower production rates in parallel with weaker strength development and higher water demand in the final product.

Grinding aids are added at low dosages, typically in a range of 0.02% - 0.05%, either onto the mill feed or directly into the mill itself. They reduce or even neutralise the surface energy by shielding the polarity to different degrees. As a consequence, the particles do not attract each other any more. Different effects can be observed:



- SikaGrind® ensures that the particles stay separated, thus enabling sufficiently fine particles to leave the mill and creating space for coarse particles to be refined.

- Using grinding aids reduces the coating effect and leads to blank mill internals. The resulting intensified crushing impact of and the friction between the steel balls enhances the grinding efficiency.



- Particles treated with SikaGrind® are better dispersed when entering the separator. The higher the powder dispersion, the greater is the probability that the particles are detected with their actual dimension.

Grinding aids enhance the grinding and separating efficiency which leads to an increased production rate. Additionally, the resulting lower content of over ground particles meets the characteristics of a more favourable particle size distribution with better cement quality. SikaGrind® allows producers to economically achieve the desired fineness and quality of cement!

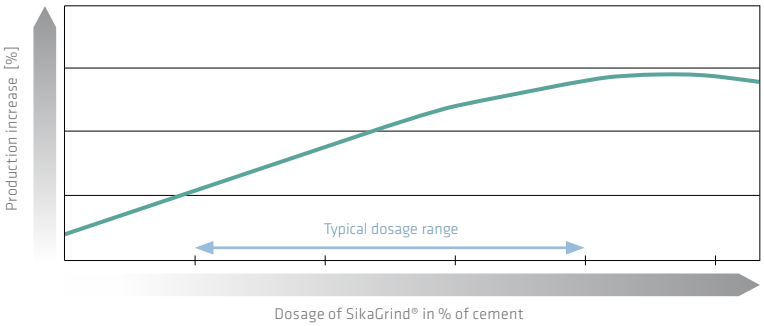
SikaGrind®- TECHNOLOGY FOR OPTIMIZED GRINDING PROCESSES

Cement grinding consumes a major part of the total energy used for the cement manufacturing. The constant absolute energy demand of the grinding system in relation to the adjustable production rate of the mill is expressed as specific energy consumption. Higher cement production rate leads to lower specific energy consumption per ton of cement. SikaGrind® has a positive effect on the production rate and thereby helps to reduce the specific energy consumption.

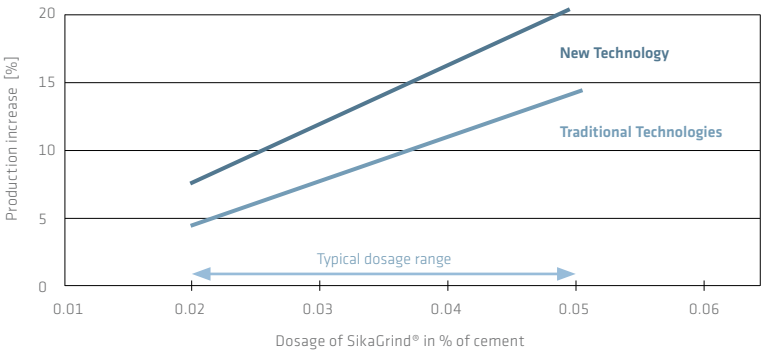
Ball mill

Vertical roller mill

The magnitude of the production increase is related among others to the grinding aid dosage. Up to the maximum reasonable dosage of a specific grinding aid, the production rate increases and the separator rejects decrease. Beyond this maximum, further increased dosage results in shorter time for the cement to pass through the mill. If the mill retention time is reduced too much, the cement is insufficiently ground which leads to increased separator rejects and hence a reduced production rate.



Traditional grinding aids are based on amino alcohols and glycols which can be used in formulated products, but also as pure raw materials. Sika has developed a polycarboxylate polymer powered grinding aid technology which is able to improve the performance of traditional technologies. The major benefit of this new technology can be measured in a distinct production increase which arises from an intensified particle dispersion.

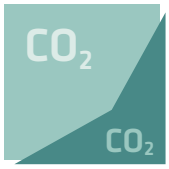


The improved efficiency of the cement grinding and separating process resulting from the use of the SikaGrind® technology contributes to economically optimized cement production.
It can be used to:

Optimize the production-costs:
- Further increase production volume of the mill
- Additional reduction of specific energy consumption

$$\frac{\text{Absorbed power [kW]}}{\text{Production [tons/hour]}}$$

Reduce environmental impact:
- Improved cement quality with increased cement fineness and a more favourable particle size distribution while maintaining production rates
- Increase amount of clinker replacement



Carbon footprint [tons CO_2/tons clinker] x clinker amount

Provide a competitive edge:
- Generate additional sales and contribution
- Greater flexibility to market demands

Additional cement production [tons] x Contribution [money/ton]

SikaGrind®- QUALITY IMPROVER FOR SUSTAINABLE AND COST OPTIMIZED CEMENT DESIGN

Cement manufacturers are continuously striving to achieve more efficient production methods with the target to increase profitability while in parallel reduce the adverse effect on our environment.

The fact remains that cement production leaves a footprint on the environment. The CO_2 emission resulting from the calcination process during clinker production is unavoidable. Therefore, the focus is on the substitution of clinker by supplementary cementitious materials (SCM) like granulated blast furnace slag, fly ash, natural puzzolanes and lime stone.

SCM's typically cause slower strength development but also issues regarding powder flowability, concrete workability and optical appearance. The higher the amount of these clinker replacements the more pronounced are the adverse effects.

SikaGrind® can compensate these weaknesses and hence contribute achieving a sustainable and economic cement design.

Energy efficiency

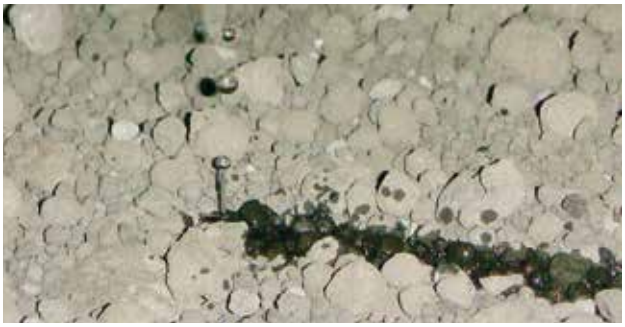
Resources efficiency

Clima protection

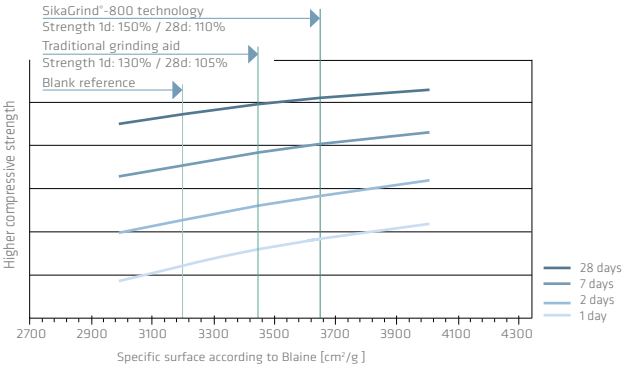
SikaGrind®- QUALITY IMPROVER TO ACHIEVE THE DESIRED STRENGTH DEVELOPMENT

The most significant options to improve strength development and strength potential of cement under existing conditions are improved cement fineness and chemical activation of the hydration process with cement additives. Grinding aids and performance enhancer of the SikaGrind® range as well as tailor made products allow using these technological principals while achieving highest production values.

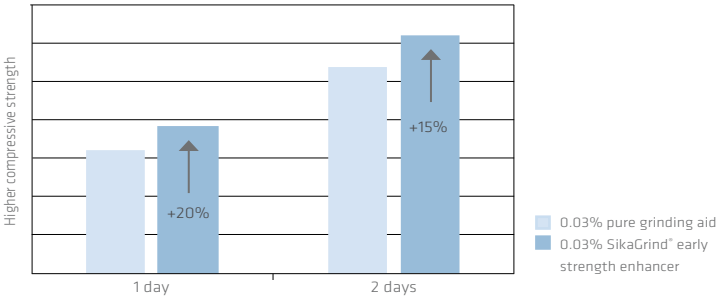
Improved cement fineness, measured as:
- Higher specific surface according to Blaine
- Optimized particle size distribution (PSD) of the cement, especially targeting the particle fraction 3-30 µm



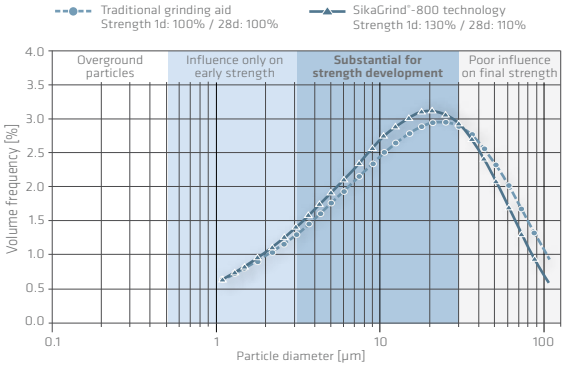
Chemical activation of the hydration process with SikaGrind® which results in enhanced:
- Early strength
- Final strength
- Combination of both early and final strength



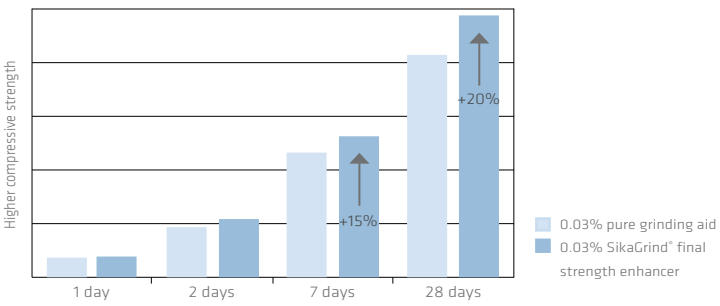
Strength enhancement with SikaGrind® due to increased fineness at constant production



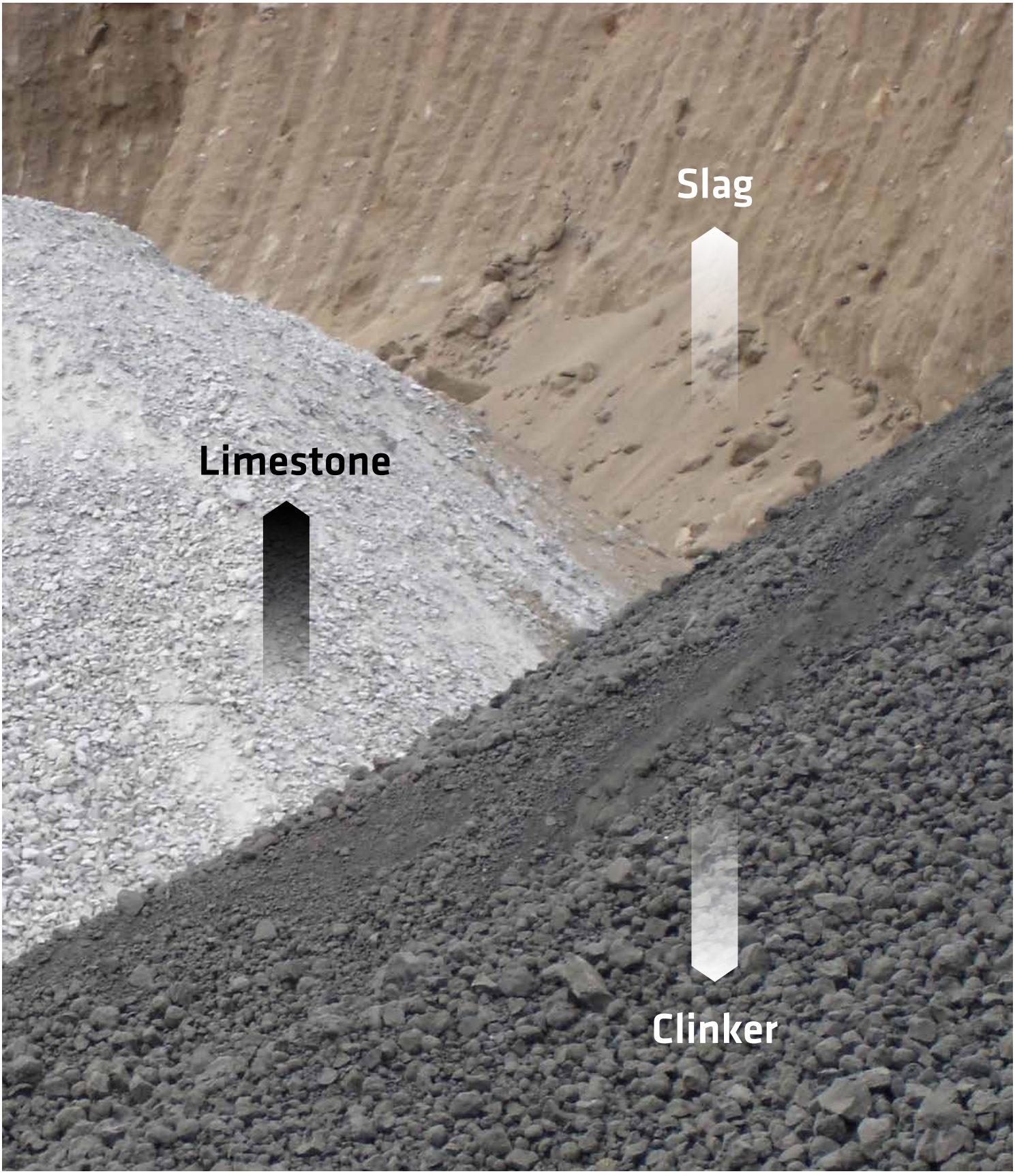
Strength enhancement with SikaGrind® due to optimized particle size distribution at constant production



Early strength enhancement with SikaGrind® at increased production



Final strength enhancement with SikaGrind® at increased production


Slag
Limestone
Clinker

SikaGrind®- PRODUCT RANGE FOR YOUR LOCAL CHALLENGES

The characteristics of the local raw materials, the availability of possible clinker replacements and the conditions during the cement grinding process are different in every individual cement plant. In addition the demands of standards and customers regarding the cement performance vary due to different climate and construction methods. Therefore, the solution for highest possible production rates or maximized use of supplementary cementitious materials needs to be adjusted individually.

1

2

3

1 Individual characteristics of local materials
2 Conditions during the cement grinding process
3 Demands of standards and construction industry

Sika offers all types of products:

- Basic grinding aids
  - achieve a constant cement production at a higher level [tons/hour]
  - reduce the specific energy consumption [kWh/ton of cement]

- Grinding aids with quality enhancing properties
  - enhance early and/or final strength, which allows for higher clinker replacements and hence less CO_2 emission
  - accurately entrain air in masonry cements

- Special products
  - adjusting cement powder flowability
  - suppress carbon bleeding
  - improve concrete workability

Cement additives are classified into different product groups which can be adjusted to tailor made solutions using the latest SikaGrind® technology to meet your local demands!

- SikaGrind®-100 Series
  Chloride containing grinding aids with improved early strength

- SikaGrind®-200 Series
  Efficient grinding aids with improved early strength

- SikaGrind®-300 Series
  Cement additives for specialty cements

- SikaGrind®-400 Series
  Efficient grinding aids with low to zero amine content for brown discolouration sensitive cements

- SikaGrind®-700 Series
  Very efficient grinding aids with improved early and final strengths

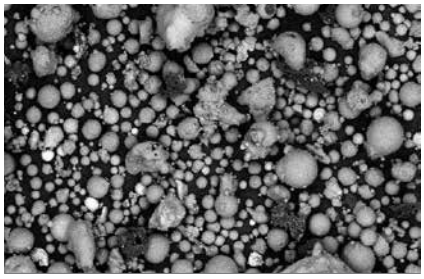
- SikaGrind®-800 Series
  Polycarboxylate polymer powered grinding aid technology which allows for maximized mill production, adjustable cement powder flowability and improved strength development

SikaGrind®- PRODUCT RANGE FOR CHALLENGING CEMENT TYPES

Portland Cements are mainly defined by the achieved strengths. The production and supply of blended cements can trigger additional problems regarding unloading of cement, low concrete workability and adverse effects on the appearance of concrete.
Additives which positively influence cement handling as well as properties during concrete production can become the decisive factor to choose one particular cement and help to differentiate your self versus the competition. The SikaGrind® range offers products and tailor made solutions for individual challenges, providing additional opportunities to optimize cement production, quality and profitability.

Performance	Comment
Clinker Grindability	Achieving fineness is of high importance for all blended cements in order to compensate strength loss coming from the clinker replacement. SikaGrind® grinding aids can improve grinding efficiency.
SCM Grindability	Hardness and reactivity of Supplementary Clinker Replacements (SCM) is the decicive factor. Harder, coarser and more reactive materials need to be ground finely. Mill control has to be adjusted according to the various SCM's, their share of cement formulation and the applied cement additive.
Early Strength	All clinker replacements react slower compared to clinker, which drives the usual demand for higher early strength. SikaGrind® quality improver can compensate this loss of early strength.
Final Strength	Strength after 28d is affected stronger if the reactivity of the supplementary cementitious material is weaker. SikaGrind® quality improver can compensate this strength loss.
Powder Flowability	Powder flowability can be measured with the Pack set method. The higher the targeted fineness, the more sticky the cement becomes (high pack-set) due to larger surface energy leading to stronger agglomeration. Especially soft materials tend to agglomerate easily, causing a low powder flowability and the related problems during unloading of storage and transportation vessels. Selecting the right SikaGrind® product and dosage allows achieving the desired Powder Flowability.
Workability enhancement	Higher fineness of blended cements leads to increased water demand and consequently to reduced workability of concrete compared to the use of pure portland cement. Highest SCM contents can be achieved if the same workability like that of portland cement is ensured.
Balancing Rheology	Varying composition of raw materials causes significant changes in the rheology of the cementitious system which leads to frequently needed adjustment of concrete formulation, especially in regard to the applied concrete admixtures (superplasticizers). SikaGrind® products can balance such varyiing rheology and simplify concrete production.
Carbon Bleeding	The phenomenon that fine visible particles in mortar and concrete float up to the surface and adversely affect concrete applearance is well known. In most cases it results from incomplete burned organic substances deriving from the used raw materials. Specialized SikaGrind® products are able to suppress the creation of carbon bleeding and with this support higher quality of fair faced concrete.

Product	
Grinding Aid	Low contents of the described SCM's can be incorporated with the use of grinding aids which ensure good grindability and particle size distribution of the clinker as well as an improved powder flowability.
Quality Improver	Larger amounts of SCM's need strength enhancement in addition to the described basic needs of a grinding aid.
High Performance Quality Improver	Highest levels of SCM's need the before mentioned process and quality enhancement of a quality improver. In addition, the adverse effects on concrete workability/rheology and concrete appearance need to be compensated with high performance cement additives.

			
	Slag Cement	**Fly Ash Cement**	**Limestone Cement**
	important	important	very important
	very important due to strength gain with fineness	lower importance due to large share of sufficiently fine particles without grinding	not important due to material softness
	most important characteristic*	very important	very important
	small need	strong need	very strong need
	no need due to material hardness	helpful	very strong need due to soft and sticky material characteristic
	n.a.	helpful	very important
	n.a.	very important	helpful
	n.a.	very important	n.a.
	SikaGrind®-200 Series	**SikaGrind®-200 Series**	**SikaGrind®-200 Series**
	SikaGrind®-100 Series *strong enhancement	**SikaGrind®-870**	**SikaGrind®-870**
	SikaGrind®-184 *very strong enhancement	**SikaGrind® FA-58**	**SikaGrind® LS-43**

SikaGrind®- SERVICE FOR YOUR MAXIMIZED BENEFIT

Our target to improve your profitability starts before we first meet, research work is constantly in progress to further enhance the product performance and enable Sika to offer you the latest technology.

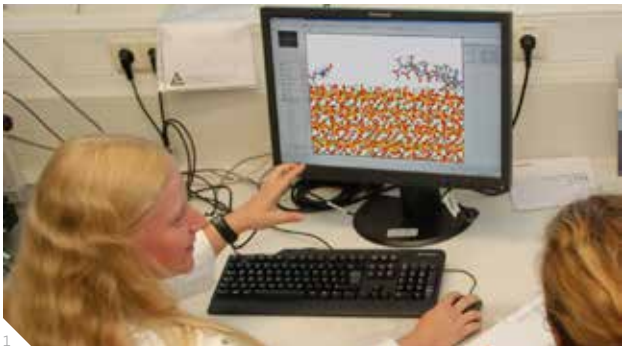
We understand and support your business. Therefore, in whatever situation, being confronted with a special problem or in the daily challenge to improve your profitability, Sika will assist you in reaching your targets.

Local conditions and demands vary strongly which makes it necessary to handle every plant individually. Sika can offer tailor made solutions, designed to meet individual challenges. This implies the necessity to work together as partners with one joint target.

As a starting point of a product and process optimization, well-defined and technically feasible targets related to the present production and quality parameters are agreed upon. Based on our experience in cement production process and product know-how, one or two SikaGrind® products are recommended for plant trials. If necessary, laboratory pre-trials can be arranged in one of our regional cement laboratories.

Preparation and execution of plant trials are handled by Sika staff in cooperation with plant personal. The production data as well as the results of the cement analysis which are determined in our specialized laboratories are than discussed between you and Sika's cement specialists to agree upon the target fulfilment and to define the next steps.

In case of inconclusive results or the need for further optimization work, another plant trial cycle with potential product modification and laboratory pre-trials might be necessary. After reaching the desired targets, Sika proactively supports the implementation of the optimized production and/or quality concept including all necessary logistic topics. Finally, Sika's follow-up strategy will ensure that we continue to work together to support your business.



1 Constant research to further enhance performance

2 Understand local situation and define targets

3 Laboratory pre-trials to evaluate trends

4 Execution of plant trials by Sika experts

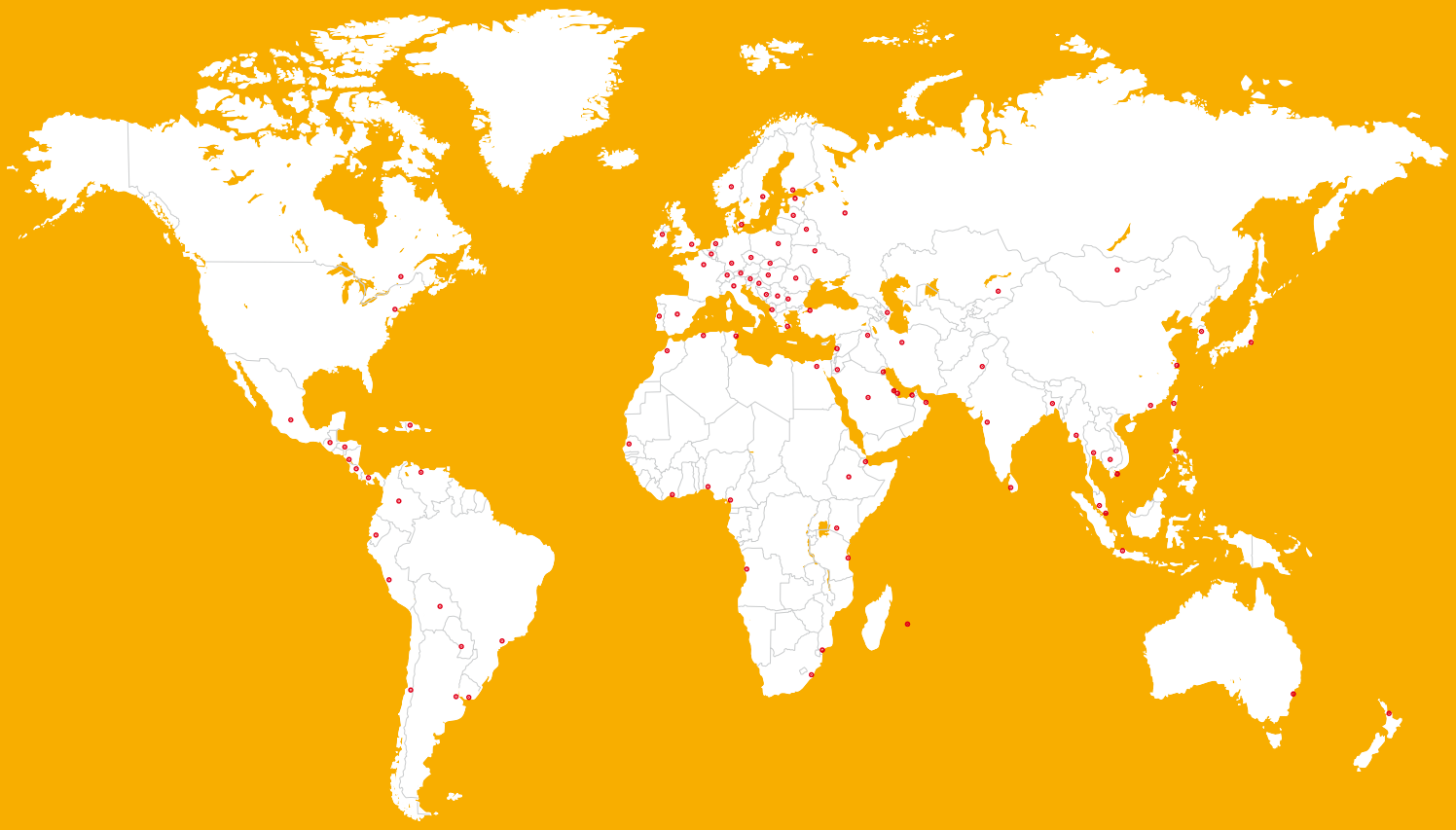
5 Evaluation of cement quality in laboratory analysis

6 Discussion of results with customers

7 Implementation process including logistics

8 Continuous follow-up to further support your business

GLOBAL BUT LOCAL PARTNERSHIP



FOR MORE CEMENT PRODUCTION INFORMATION:

WE ARE SIKA
Sika is a specialty chemicals company with a leading position in the development and production of systems and products for bonding, sealing, damping, reinforcing and protecting in the building sector and the motor vehicle industry. Sika's product lines feature concrete admixtures, mortars, sealants and adhesives, structural strengthening systems, industrial flooring as well as roofing and waterproofing systems.

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