Mixed to resist.
Additives and active agents for the concrete admixture industry

<table>
<thead>
<tr>
<th>SITREN®</th>
<th>SITREN AirVoid®</th>
<th>TEGOSIVIN®</th>
<th>TEGO® Antifoam</th>
</tr>
</thead>
</table>

Evonik
POWER TO CREATE
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Evonik
Your first choice for specialty chemicals
Polymer & Construction Specialties
On the right track for future trends

What will tomorrow’s world look like? What technologies can we expect and what possibilities will they offer? What challenges will the construction industry face in 10 and 20 years? Only those who raise these questions will be able to identify emerging trends and needs in good time, and develop future-proof solutions for their customers.

The Polymer & Construction Specialties (PCS) product line is part of Evonik’s Interface & Performance business line, which strives to innovate, shape trends, and continuously improve and develop its product portfolio.

Interface & Performance, part of Evonik’s Nutrition & Care segment, invests significantly in research and development to maintain and extend its advantage in key technologies.

In order to strengthen our position, our efforts are supported by five competence centers for manufacturing, applied technology, research and development and sales and marketing. These are located in Germany (Essen/Geesthacht), North America (Richmond, Virginia), China (Shanghai) and India (Mumbai). Investment in our manufacturing sites ensures global security of supply.

Face-to-Face Performance
Consulting, development and cooperation on an equal footing

We develop tailor-made solutions, and use our proven skills to support our customers with their specific tasks.

Our willingness to meet unique customer requirements is shaped by:

- An in-depth knowledge of each market’s technical requirements
- An understanding of customer challenges and the corresponding tasks
- The ability to develop customer-specific products

Experienced technical specialists and sales managers are available to assist and advise our customers throughout the world. In addition, we have regional laboratories and competence centers that enable us to deliver effective support at all times and in all locations. This gives us the ability to develop and deliver solutions specifically designed for the needs of each market.
Our management systems for the concrete admixtures industry
At a glance.

Process and Performance Additives for the concrete admixture industry

- **AirVoid Management**
  - Air-entraining agents
  - Defoamers

- **Protection Management**
  - Hydrophobing agents

- **Curing Management**
  - Shrinkage reducing admixtures

- **Release Management**
  - Mold release agents

- **Formulation Management**
  - Wetting agents
  - Dispersants
  - Defoamers

**SITREN®, SITREN AirVoid®, TEGOSIVIN® and TEGO® Antifoam Admixtures**, additives for concrete industrial building materials, additives for e.g. insulating materials and fillers

All five management systems and their associated activities and products address the two following areas of application:

- **Admixtures**, additives for concrete
- **Industrial building materials**, additives for e.g. insulating materials and fillers

We understand our customers’ challenges, including their manufacturing processes and the requirements their products have to meet. In addition, we offer a broad product portfolio, extensive experience and specialized technical expertise, plus our in-depth knowledge of applications and markets.

At the same time, we are dedicated to protecting the environment, and to sustainable socioeconomic development. With more than thirty years’ experience in product design, we continuously improve and evolve our products. As a result, our solutions set new standards in terms of efficiency and performance.
A solid base for construction

Our product portfolio for concrete admixtures

New and highly sophisticated design options make ever-increasing demands on the properties of concrete. Many of these challenges can be overcome with the help of chemical admixtures for the construction industry.
In the future, the construction industry will be increasingly affected by **megatrends** such as a **scarcity of resources** and **climate change**.

The latest chemical methods are accordingly being applied to develop and test chemical compounds for the construction industry to achieve an optimal interaction between diverse mineral substrates. **These new active ingredients and additives are constantly improving the ways in which materials can be used to adapt to the changing conditions by mega trends.**

The focus is shifting to new objectives:

- sustainable socio-economic development (e.g. energy efficiency)
- architectural structures with extended lifespans
- cost controls and faster construction
- addressing changing climatic and environmental conditions

This development is increasing the demand for new high-performance additives and process aids. **Our goal is to support our customers in the development of high-performance materials.**

Construction chemistry has developed numerous admixtures through which the properties of concrete can be individually influenced. No other building material in the world is processed in such huge quantities as concrete.

**With our Admix product portfolio, we not only offer solutions for market requirements, we also understand the entire process of development, production and processing of concrete, as well as its different levels of quality** – from simple concrete mixed on building sites to the ultra-high-performance varieties.

**Our five unique management systems** offer our customers a targeted and effective product solution to meet their individual challenges.
Air has a significant impact on the performance of concrete – in both positive and negative terms. The manufacturing process of concrete generally requires mixing with water. The application of shear force combined with surfactant components in the concrete mix leads to the distribution and stabilization of air in the fresh concrete.

Air in the right quantity and in the right form is essential for the end properties of cement based materials and has a direct impact on the

- workability
- mechanical properties
- durability
- aesthetics
- slump properties
- insulation properties
- and density

Our air entrainers and defoamers can actively control the quantity, the distribution and the size of the air voids in the concrete – we call this AirVoid Management.

THE FIVE MANAGEMENT SYSTEMS:

AirVoid Management
Air entrainers
Defoamers
AIR ENTRAINERS AND DEFOAMERS IN USE – AIRVOID MANAGEMENT

Concrete without additives:
- Total porosity:
  - gel pores
  - capillary pores
  - air voids

Concrete with special properties:
- Total air volume
- Air void size
- Air void distribution
- Air stability over time

- freeze-thaw resistance
- processability
- density

- impermeability
- durability
- strength
AIRVOID MANAGEMENT

Air entrainers
Our air entrainers create stable and homogeneously distributed air voids. Their main purpose is to stabilize the air entrained with the water during mixing.

Depending on the requirements, our portfolio of air-stabilizing additives can optimize the size, content and distribution of the air voids.

Influencing factors

Contrary to what the current name indicates, the function of air entrainers is not to generate air voids but to stabilize the mechanically entrained air during mixing. Therefore, air void content is dependent on the mixing process and can vary depending on mixing device, mixing duration, time of mixing, temperature and the additives used.

While the air void content is controlled under more or less defined conditions during the mixing process in a prefab concrete plant, the situation is different if the concrete is transported from the concrete plant to a construction site by truck.

The transport of the concrete to the construction site is a factor which is difficult to control, as transport time and ambient temperature can vary. If the concrete is not mixed long enough during the production process or if the air entrainer concentration is too high, the concrete can contain unreacted air-entraining agents. As these are activated by the mixing energy during transportation, the air void content (post-activation) can increase.

Conversely, the air void content may decrease due to extended and intensive mixing, or increasing temperatures.

Application areas

- Onsite and ready-mixed concrete  
  (incl. lightweight and special concrete)
- Road paving concrete
- Concrete products  
  (such as paving stones and concrete blocks)
- Screed concrete
- Air-entrained concrete
- Reinforced concrete
- Self-compacting concrete
Building on fresh air

Air voids for more efficient construction

Advantages of synthetically produced air entrainers

There are a variety of different air-entraining agents on the market, consisting of natural active ingredients, synthetic surfactants and mixtures. Our synthetically produced air entrainers do not suffer from quality fluctuations associated with natural active ingredients. They offer consistent quality, are more stable and therefore more reliable. Synthetic air entrainers are characterized by the fact that dosage and entrained air correlate. On the other hand, air entrainers based on natural active ingredients, increase the air content at high dosages disproportionally. The increase in efficiency of synthetic air entrainers ensure optimized construction costs and resource efficiency.
Increased durability

Ideally buildings are built to last. However, many buildings frequently require maintenance after only a few years.

Frost and de-icing salts have a decisive effect on the durability of concrete. Water and salt penetrate the structure of the building and destroy the microstructure of the building material. The crystallization of de-icing salts and the increase in volume of the frozen water lead to an internal explosive effect – and often result in severe spalling of the concrete’s surface.

Air voids play a major role in situations like this. On the one hand, the additional air voids change the pore structure and reduce the capillary suction effect, so that less water and reduced amounts of harmful salts penetrate the structure. On the other hand, the air voids act as expansion space, ensuring that the internal pressure of the freezing water and crystallizing salts is absorbed.

Maintenance can quite often become a significant cost factor during the life of many buildings. If conscious planning is carried out for the total usage period of a building, the priorities often shift from a budget-bound solution to a durable, long-term and consequently cost-optimized solution.

Air entrainers from the SITREN AirVoid® range provide increased durability and the option of efficient lightweight construction and improved processing, thus optimizing construction costs and the entire life cycle management of a building. Ideal for the manufacture and processing of air-entrained concrete, in accordance with EN 1992 EC2.

Efficient lightweight construction and improved mechanical processability.

www.evonik.com/admixtures-air-entrainers
SITREN AirVoid® Air entrainers

Standards play a crucial role in ensuring the stability of performance characteristics during the planning, production and processing of concrete. DIN 1045-2 is one of the standards which applies to freeze-thaw resistance.

SITREN AirVoid® 601 is a highly effective air entrainer particularly suitable for concrete formulations, targeting high freeze-thaw and de-icing salt resistance. Even under difficult conditions, the capillary suction and the water absorption is reduced.

Stabilized air void

![Image of a stabilized air void as seen through a scanning electron microscope](image)

Determination of the air void parameters in hardened concrete in accordance with DIN EN 480-11

<table>
<thead>
<tr>
<th></th>
<th>AIR CONTENT [%]</th>
<th>MICROPORE CONTENT [%]</th>
<th>SPACING FACTOR [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Setpoints</td>
<td>≥ 4.00</td>
<td>≥ 1.8</td>
<td>≥ 0.2</td>
</tr>
<tr>
<td>Concrete with SITREN AirVoid® 601</td>
<td>6.46</td>
<td>3.99</td>
<td>0.12</td>
</tr>
</tbody>
</table>

SITREN AirVoid® 601 fulfills the requirements in accordance with DIN EN 480-11.

**Air content [%]:**
Percentage of the air voids’ volume (chord length up to 4 mm) compared to the total volume of the concrete.

**Micro air void content A300:**
Content of micro air voids with a diameter of up to 0.3 mm (300 microns).

**Spacing factor [mm]:**
Calculated characteristic value of the greatest distance of any point in the hardened cement paste from the periphery of an air void (measured through the cement paste).

**Formulation**
- Cement (CEM I 52.5 R): 350 kg/m³
- Water (w/c: 0.55): 192 kg/m³
- Aggregates
  - Stone dust: 5 kg/m³
  - 0–2 mm: 407 kg/m³
  - 2–8 mm: 531 kg/m³
  - 8–16 mm: 423 kg/m³
  - 16–32 mm: 317 kg/m³
- SITREN AirVoid® 601: 0.035 kg/m³
Verifiable freeze-thaw/de-icing salt resistance

DURABILITY OF CONCRETE WITH SITREN AIRVOID® 601 SUBJECTED TO FREEZE-THAW/DE-ICING SALT

Concretes modified with SITREN AirVoid® 601 belong to the highest resistance class (exposure class XF4) after being subjected to frost/de-icing salt. Weathering amounts to less than 1,000 g/m² after 28 freeze-thaw cycles.

Our modern air entrainers from the SITREN AirVoid® series for the construction industry chemicals sector consist of a combination of highly effective specialty surfactants.

**Product overview**

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>CHEMICAL CHARACTERIZATION</th>
<th>ACTIVE INGREDIENT CONTENT [%]</th>
<th>RECOMMENDED DOSAGE* [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>SITREN AirVoid® 601</td>
<td>Mixture of anionic surfactants</td>
<td>35</td>
<td>0.01–0.5</td>
</tr>
</tbody>
</table>

SITREN AirVoid® 601 enables targeted and stable air entrainment into concrete mixes. SITREN AirVoid® 601 generates an air void system in the concrete that meets micro air void volume and spacing factor requirements. Very small distributed air voids are formed that allow freezing water to expand, making SITREN AirVoid® 601 ideal for formulations that are in accordance with exposure classes XF3 and XF4 (frost attack with and without de-icing agents).

More information about air entrainers and additional products is available in our product overview or on request.
Defoamers
The entrainment of uncontrolled air into cement based building materials is unavoidable and leads inevitably to a loss of quality in high performance concrete. Undesired air voids weaken the system resulting in lower mechanical strength and abrasion resistance. Air voids on the surface allow the penetration of harmful substances and can lead to surface defects.

Defoamers are preferably used for the prevention and removal of large air inclusions at the concrete’s surface and for rapid foam collapse in aqueous formulations. If, on the other hand, it is necessary to remove finely distributed air from a system, deaerators are the preferred alternative. However, practice has shown that a clear differentiation between defoamers and deaerators is usually not possible. Most defoamers also have a deaerating effect to some extent and vice versa.

Alternatively, defoamers can be used as a stand-alone concrete additive.

By direct addition into the concrete, surfaces can be optimized with regard to cavity clearance and other properties relevant for the exposed concrete, especially architectural concrete.

Application areas:
Defoamers are added to plasticizers and hybrid systems (on a chemical basis of lignosulphonates, naphthalenes, melamines or PCE’s) for the production of:

- Onsite and ready-mix concrete (incl. lightweight and special concrete)
- Precast concrete elements
- Concrete products (e.g. paving stones and concrete blocks)
- Screed concrete
- Special concrete (e.g. HPC/UHPC)
- Architectural concrete
- Reinforced concrete
- Self-compacting concrete
Not just hot air

Stay strong with our defoamers

How defoamers work can be best explained in the images below. Defoamers and deaerators are active at the air/water interface; they cause the stabilized structure of air voids to rupture in a liquid medium, thus allowing air to escape.

**Defoamers are characterized by:**

- a low surface tension
- insolubility in the formulation to be defoamed
- a positive spreading coefficient
- a positive penetration coefficient

The working mechanism of a defoamer is a three-step process. First, a defoamer droplet enters the foam lamellae. Second, it spreads and destabilizes the surfactant. Third, the foam lamellae becomes less elastic and finally ruptures.

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### DEFOAMERS – AT A GLANCE

<table>
<thead>
<tr>
<th>TECHNICAL PARAMETERS</th>
<th>EFFECTS</th>
<th>ADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced air content</td>
<td>Smooth and defect-free surfaces</td>
<td>Optimized external appearance</td>
</tr>
<tr>
<td>Low porosity</td>
<td>Reduced abrasion</td>
<td>Better durability/resistance</td>
</tr>
<tr>
<td>Choice of suitable molecular structures</td>
<td>Better compressive and tensile strength</td>
<td></td>
</tr>
<tr>
<td>Dispersing effect</td>
<td>Higher density (wet density)</td>
<td>Optimized construction costs</td>
</tr>
<tr>
<td></td>
<td>No negative effect on curing</td>
<td>Improved workability</td>
</tr>
<tr>
<td></td>
<td>Better flow properties</td>
<td></td>
</tr>
</tbody>
</table>

The addition of defoamers leads to:

- Optimized external appearance
- Better durability/resistance
- Optimized construction costs
- Improved workability
Higher mechanical strength

Mechanical strength and resilience play a crucial role nowadays, with architecture being more sophisticated and creative than ever and the trend towards more streamlined building components constantly growing.

Our AirVoid Management defoamers give fresh concrete a higher bulk density. The reduction in air content results in higher flexural, tensile and compressive strengths and improved abrasion resistance of hardened concrete. The selection of the correct molecular chemistry ensures that neither cement hydration nor the concrete’s early strength are adversely affected.

Thanks to our in-depth knowledge in the field of interfacial technology, we can influence the interplay between air entrainers and defoamers in a targeted way and are able to manage the strength of concrete.

With the SITREN AirVoid® brand, we offer high-quality defoamers that allow air voids to be selectively removed from the system. This not only results in higher mechanical strengths, an optimization of the surface and easier workability, but also in meeting the highest demands of aesthetics and durability. Our defoamers can be dosed easily. They can either be added to the plasticizers or directly to the concrete.

Optimization of the surface appearance and improved workability. www.evonik.com/admixtures-defoamers
SITREN AirVoid® defoamers

Plasticizers and superplasticizers offer numerous advantages, but also increase the air content in the concrete and thus lead to a certain loss of strength. Our SITREN AirVoid® defoamers are based on a broad range of modified anionic surfactants and organo-modified siloxanes, which make the air content in the concrete controllable. In addition, they provide excellent compatibility in aqueous polymer solutions. Our defoamers can also be used in combination with our air entrainer SITREN AirVoid® 601 to achieve a more targeted control of the air void size and the air void size distribution.

**Significant reduction of air content with SITREN AirVoid® defoamers**

**Formulation**
- Standard mortar according to DIN EN 196 Cement (CEM I 42.5 R): 450 g
- Standard sand: 1350 g
- Water (w/c: 0.5): 225 g
- Superplasticizer: 4.5 g
- SITREN AirVoid® 301/305: 0.2 % (based on superplasticizer)

**Dispersion effect**

Our defoamers are characterized by an additional dispersing effect which ensures the optimal distribution of solid substances within a liquid matrix, guaranteeing excellent workability.

Defoamers from the SITREN AirVoid® series reduce the air content in the concrete to an absolute minimum.
**AIRVOID MANAGEMENT – Defoamers**

SITREN AirVoid® 301 and 305 – Excellent compatibility in aqueous polymer solutions

The excellent compatibility of SITREN AirVoid® defoamers in aqueous polymer solutions ensures reliable and consistent protection against increased air entrainment that results from the use of plasticizers and superplasticizers in concrete.

Image left: Superplasticizer with SITREN AirVoid® 305 - no sign of turbidity or separation
Image right: Superplasticizer with commercial defoamer - heavy creaming and turbidity.

**IMPROVED FLEXURAL AND COMPRESSIVE STRENGTH WITH SITREN AIRVOID® DEFOAMERS**

**Formulation**
Standard mortar according to DIN EN 196
Cement (CEM I 42.5 R): 450 g
Standard sand: 1350 g
Water (w/c: 0.5): 225 g
Superplasticizer: 4.5 g
SITREN AirVoid® 301/305: 0.2 %
(based on superplasticizer)

**Flexural and compressive strength after 28 days**

![Flexural and compressive strength graph](image)

**Product overview**

<table>
<thead>
<tr>
<th>CHEMICAL CHARACTERIZATION</th>
<th>SITREN AirVoid® 301</th>
<th>SITREN AirVoid® 305</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACTIVE INGREDIENT CONTENT [%]</td>
<td>Nonionic surfactant</td>
<td>Nonionic surfactant</td>
</tr>
<tr>
<td>RECOMMENDED DOSAGE* [%]</td>
<td>0.1–1.0</td>
<td>0.1–1.0</td>
</tr>
<tr>
<td>COMPARABILITY</td>
<td>*****</td>
<td>*****</td>
</tr>
<tr>
<td>DEFOMING</td>
<td>*****</td>
<td>*****</td>
</tr>
<tr>
<td>APPLICATION IN</td>
<td>Polycarboxylate ethers</td>
<td>Lignosulphonates, Melamine sulphonates</td>
</tr>
</tbody>
</table>

*based on plasticizer/superplasticizer

***** = good    ***** = superior

Information about additional defoamers and products is available in our product overview or on request.
Water and moisture that infiltrate facades, buildings, roads, tunnels and bridges every year causing massive maintenance costs.

Water infiltrates building structures in different ways and can trigger a variety of different processes that have a considerable influence on the functionality, the appearance and the durability of structures.

In nature even hard rocks can turn into sand. One prominent example is the formation of the Grand Canyon through erosion/surface abrasion in combination with the force of the water.

Therefore, it is crucial to understand the different mechanisms of water absorption and to control moisture effectively, thus preventing water induced damage.
Potential damage – cracking, spalling, efflorescence, biological fouling by algae, lichens and fungi, corrosion of concrete reinforcements, deteriorated insulation of exterior walls, surface soiling and flaking paint.
Water is a valuable natural resource – but water infiltration can cause major issues for concrete. Freezing and the pollutants and dirt associated with this water can cause considerable damage. Our water repellents provide effective protection against these adverse effects.

Typical reasons for the penetration of water and moisture into buildings are:

- technical and manual application errors, which can cause cracks to appear
- hygroscopic water absorption, i.e. moisture absorption through salts and minerals
- driving rain (with wind speeds of up to 150 km/h)
- leaking or missing horizontal barriers, facilitating the absorption of groundwater.

Wetting angle of a water droplet on a hydrophobic surface:

One unit of measurement for the hydrophobic effect on a surface is the contact or wetting angle, a method of measuring the wettability of a surface. This is determined by means of water droplets applied to the surface. Surfaces with a wetting angle of > 90° are referred to as being hydrophobic. If the contact angle is < 90°, the surface is described as being hydrophilic.

Application areas:

- Onsite and ready-mixed concrete
- Precast concrete elements
- Concrete products (e.g. paving stones and concrete blocks)
- Screed concrete
- Special concrete (e.g. HPC/UHPC)
- Air-entrained concrete
- Reinforced concrete
- Self-compacting concrete
Water repellents are used to provide buildings and roads with durable protection against water and moisture. Our silicone-based water repellents minimize the infiltration of water and dissolved pollutants, while maintaining the water vapor permeability at the same time.

Important requirements for water repellents:

- High degree of alkaline stability
- Permeability to gas and water vapor
- Low surface tension
- No sticky surfaces
- Deep penetration depth

WATER REPELLENTS – AT A GLANCE

<table>
<thead>
<tr>
<th>TECHNICAL PARAMETERS</th>
<th>EFFECTS</th>
<th>ADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Addition of water repellents</td>
<td>Very good beading effect</td>
<td>Less dirt pick-up</td>
</tr>
<tr>
<td></td>
<td>Complete hardening reaction</td>
<td>No sticky surfaces</td>
</tr>
<tr>
<td></td>
<td>Reduced water and salt transport</td>
<td>Reduced primary efflorescence</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduced secondary efflorescence</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Freeze-thaw and de-icing salt resistance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>pH value retention</td>
</tr>
</tbody>
</table>
Hydrophobing agents reduce water and salt transport in building materials and minimize primary and secondary efflorescence. Reduced water transport also has a positive effect on limiting water uptake and minimizing frost damage. During the phase transition from liquid to ice, the volume of water increases by up to 10%. This volume is inevitably absorbed by the concrete structure or transported to the surface. If there is not enough expansion space, pressure and tension are created, which can cause the material structure to fail.

Water repellents prevent the penetration of water and increase resistance to freeze-thaw damage, significantly reducing maintenance costs.

Other water induced damage mechanisms include:

- Steel corrosion
- Carbonation
- Alkali-silica reaction

Our TEGOSIVIN® brand consists of powerful water repellents, which significantly reduce water absorption and provide outstanding beading properties. This optimizes a building’s external appearance and offers more design freedom; it also guarantees a significant improvement in durability, which in turn leads to lower maintenance costs.

Further Information about other water induced damage mechanisms

www.evonik.com/admixtures-water-repellents
TEGOSIVIN® water repellents

TEGOSIVIN® water repellents for the concrete admixture sector are based on alkoxy silanes and siloxanes, a technology that has been used for many years with great success to improve the sustainability and durability of concrete.

Efflorescence

**Primary efflorescence**
Doses lower than 0.1 % of TEGOSIVIN® referred to cement can significantly reduce primary efflorescence.

**Secondary efflorescence**
A dosage of 0.5 % TEGOSIVIN® referred to cement ensures long-term protection. In contrast, unprotected objects, depending on the climatic conditions can exhibit efflorescence after just a few weeks.

Besides avoiding efflorescence, TEGOSIVIN® water repellents also contribute to the reduction of water absorption.
ENVIRONMENTAL INFLUENCES SUCH AS FINE DUST AND GENERAL AIR POLLUTION HAVE A SIGNIFICANT IMPACT ON THE APPEARANCE OF STRUCTURAL SURFACES AND CAN CAUSE HIGH CLEANING COSTS.

TEGOSIVIN® PRODUCTS COUNTERACT THESE INFLUENCES – AND THANKS TO THEIR EXCELLENT BEADING PROPERTIES, THEY ARE NOT ONLY STAIN-RESISTANT, THEY ALSO FACILITATE THE CLEANING OF SOILED SURFACES.

More information about water repellents and other products is available in our product overview or on request.
The final properties of concrete structures are strongly determined by controlling the water content. **Errors made at the beginning cannot be controlled later.** A lack of water prevents the cement from fully hydrating which may result in loss of compressive strength, reduced frost resistance and increased susceptibility to chemical attack which can all have adverse effects on the concrete durability. Concrete shrinkage properties during curing and drying are one area of major concern to the industry.
SHRINKAGE REDUCING AGENTS IN USE

- reduced wettability
- water evaporates
- coarse pore structure
- crack formation
  - poor durability

without shrinkage reducing agents

fresh concrete

with SITREN® SRA L 210

- reduction of the surface tension with SITREN® SRA L 210
- good wettability of the cement with the pore solution
- water is available for cement hydration
- fine pore structure
  - high amount of gel pores
  - better entanglement of mineral crystal needles
- smooth surface
  - excellent durability
Shrinkage reducing agents
Shrinkage is the term used to describe a reduction in volume of cement-based products due to a change in the water balance.

In addition to ambient weather conditions and internal dehydration, chemical/mineral reactions also play an important role. This volume reduction can affect both the shape of the concrete element as well as its bearing points. Restriction of the free shrinkage results in the build-up of internal forces and tensions, which can lead to deformation and crack formation.

Factors influencing shrinkage

The most important factors that affect shrinkage include not only low humidity, wind, solar radiation and unfavorable temperatures, but also the individual concrete composition and component dimensions.

Application areas:

- In-situ und ready-mixed concrete
- Prefabricated concrete
- Concrete products
  (e. g. paving stones and concrete blocks)
- Concrete screeds
- Special concrete (e. g. HPC and UHPC)
- Architectural concrete
- Reinforced concrete
- Self-compacting concrete
Evonik recognizes that sustainability is of utmost importance for all our futures. As a result, our product development focuses on high-performance products that are friendly to the environment.

With this in mind, Evonik has developed a new generation of SITREN® shrinkage reducing agents. Thanks to their extremely low VOC content, SITREN® shrinkage reducing agents are able to meet the most stringent eco label requirements such as EMICODE EC1PLUS – without any dosage restrictions.

**SHRINKAGE REDUCING AGENTS – AT A GLANCE**

<table>
<thead>
<tr>
<th>TECHNICAL PARAMETERS</th>
<th>EFFECTS</th>
<th>ADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction of the surface tension of</td>
<td>Reduced capillary pressure</td>
<td>Reduced shrinkage, less cracking</td>
</tr>
<tr>
<td>the pore water</td>
<td>Reduced tension in the pore structure</td>
<td></td>
</tr>
<tr>
<td>Better dispersibility</td>
<td>Optimized water content</td>
<td></td>
</tr>
<tr>
<td>Increased amount of gel pores, less</td>
<td>Better wetting</td>
<td></td>
</tr>
<tr>
<td>capillary pores</td>
<td>Dense microstructure</td>
<td></td>
</tr>
<tr>
<td>New raw material technology (low VOC)</td>
<td>Ecologically and technologically state-of-the-art</td>
<td></td>
</tr>
<tr>
<td>No retardation of cement setting</td>
<td>No impact on early strength development (“concreting at low temperatures”)</td>
<td></td>
</tr>
<tr>
<td>Addition of Shrinkage reducing agents</td>
<td></td>
<td>Better durability, Lower porosity,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sustainability, Resource efficiency, Reduced costs</td>
</tr>
</tbody>
</table>
Minimize shrinkage – increase durability

Both technical and aesthetic demands for building materials are higher than ever before. Lack of shrinkage control has a strong impact on the use and durability of concrete materials.

The setting characteristics of cement based building materials have a considerable influence on the final concrete properties. The hardening of mineral building materials results from a large number of complex processes. It is especially important to minimize shrinkage and to avoid cracking.

Our new generation of shrinkage reducing agents frequently out-perform other commercially available products. They can reduce drying shrinkage as well as plastic shrinkage. They also enhance the workability of the cementitious system whilst having no effect on the setting process. A significantly reduced number of capillary pores with simultaneously increased micro pore content leads to lower porosity and thus, to a more dense microstructure.

Further information on chemical or autogenous shrinkage, plastic shrinkage and long-term shrinkage or drying shrinkage.

www.evonik.de/admixtures-shrinkage-reducing
CURING MANAGEMENT – Shrinkage reducing agents

SITREN® shrinkage reducing agents

Shrinkage refers to the volume reduction of cementitious products over time. The water balance in these systems plays a central role, since the shrinkage processes or the subsequent drying of these materials are promoted by the chemical reaction of the binders with water.

There are basically three types of shrinkage:

1. **Chemical or autogenous shrinkage** – through water removal in the chemical reaction between water and cement.
2. **Plastic shrinkage** – resulting from the evaporation of the excess water as long as the cement-based building material can still be processed.
3. **Long-term shrinkage or drying shrinkage** – as a result of the drying out of cement based building material over time.

Our novel shrinkage reducing admixtures are based on the latest raw material technologies and significantly influence the process of plastic and drying shrinkage. SITREN® SRA L 210 is a liquid shrinkage reducing agent based on modified polyethers to prevent cracking of cement based building materials.

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**SITREN® SRA L 210 HAS ALMOST NO IMPACT ON THE SETTING BEHAVIOUR**

![Graphs showing flexural/compressive strength after 1 day and Vicat setting test](attachment:image.png)

The use of SITREN® has almost no impact on early strength or set times compared to neopentyl glycol.

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![Cracking of concrete surface without shrinkage reducing agent](attachment:image1.png) ![Crack prevention in concrete by using SITREN® SRA L 210](attachment:image2.png)
SITREN® SRA L 210 not only significantly reduces drying shrinkage, also known as capillary shrinkage, but also plastic shrinkage within the first 24 hours.

**Product overview**

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>CHEMICAL CHARACTERIZATION</th>
<th>ACTIVE INGREDIENT CONTENT [%]</th>
<th>RECOMMENDED DOSAGE* [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>SITREN® SRA L 210</td>
<td>Modified polyether</td>
<td>100</td>
<td>0.5 – 3.0</td>
</tr>
</tbody>
</table>

* based on cement

Additional shrinkage reducing agents and further information are available in our product overview or on request.
The demolding process and the associated use of mold release agents is becoming increasingly important due to the aesthetic demands on concrete structures. Smooth, defect-free and thus visually attractive concrete surfaces are seen today as hallmarks of quality in manufactured building components.

The mold and mold release agents

After the concrete has cured the demolding process has to be undertaken with care to avoid damaging the concrete surfaces, especially for visible surfaces, but also in sensitive areas, such as corners, edges and recesses.

To ensure a smooth and efficient process, the release procedure between the mold and the concrete must be safe and reliable. Our mold release agents form a protective film at the interface between the mold surface and the fresh concrete to avoid unwanted bonding and build-up.
Influencing factors

Selecting the right mold release agent depends not only on the temperature, the type of concrete, the load and the on the type of mold but also on the condition of the mold. Here a distinction is made between absorbent molds (timber) and non-absorbent molds (coated timber, steel and plastic). The correct interaction of all the components not only affects the quality of the concrete surface, but also protects metal molds against corrosion. A mold protected with SITREN® MR products can therefore be used more frequently.
Mold release agents
Our mold release agents are used in almost all molding processes. Depending on the application, very different demands are made on the release agents to be used. Appropriate systems that match the general and working conditions should be selected; this will achieve a dependable and safe mold release procedure.

**Protect the environment – protect health**

In today’s society, the issue of environmental protection is becoming increasingly significant. Our environmentally friendly mold release agents exceed all requirements in terms of environmental aspects of modern release agents.

Our products are readily biodegradable in accordance with OECD 301 F/28d and offer an environmentally friendly alternative to mineral-oil-based systems. Our solvent-free products set the highest standards in the areas of health protection and work safety.

**Application areas:**

- Onsite and ready-mix concrete (incl. lightweight and special concrete)
- Precast concrete elements
- Concrete products (e.g. paving stones and concrete blocks)
- Special concrete (e.g. HPC/UHPC)
- Architectural concrete
- Air-entrained concrete
- Reinforced concrete
- Prestressed concrete
- Self-compacting concrete
Whether on the construction site, the precast plant or in the building materials industry: shaping and molding manufacturing processes are everywhere – and choosing the right mold release agent plays a decisive role.

High aesthetic standards for concrete surfaces often play a part in pre-planning procedures designed to avoid visible defects. Therefore mold release agents must not impair the curing process of the fresh concrete. After mold stripping takes place, smooth and visually perfect concrete surfaces must be there for all to see.

Mold release agents from our SITREN® MR product range not only deliver outstanding release performance. In addition they prevent concrete discoloration, surface residues and corrosion of metal molds that can also impact on further processing (paints, plasters and other coatings).

## MOLD RELEASE AGENTS – AT A GLANCE

<table>
<thead>
<tr>
<th>TECHNICAL PARAMETERS</th>
<th>EFFECTS</th>
<th>ADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emulsion technology</td>
<td>No impact on hardening process</td>
<td>Excellent appearance of the concrete</td>
</tr>
<tr>
<td></td>
<td>No discoloration or residue</td>
<td>Cost-effective construction</td>
</tr>
<tr>
<td></td>
<td>No effect on further processing</td>
<td></td>
</tr>
<tr>
<td>Corrosion protection</td>
<td>Reduced formwork and cleaning efforts</td>
<td>Environmental protection</td>
</tr>
<tr>
<td>Thin release film</td>
<td>Simple, clean molding</td>
<td></td>
</tr>
<tr>
<td>Concentrate</td>
<td>Good processability for any application</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Biodegradable in accordance to OECD 301 F/28d</td>
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</tr>
</tbody>
</table>

A marriage doesn’t have to be permanent

Letting go is easy with our mold release.
Processing and economy in the spotlight

In molding processes, the processing timeframe always goes hand-in-hand with economic efficiency. The concrete and the mold must separate easily and cleanly, without damaging either the concrete surface or the mold itself. At the same time, the mold surface must be protected from both the elements and any buildup of contaminants to minimize mold and cleaning costs.

Our emulsions not only meet these requirements, they also possess excellent corrosion protection properties for metal molds. The high active content of our emulsion concentrates enables simple dilutions and a thin-layered and efficient coating. Our mold release agents are produced using cutting-edge technology and have excellent storage stability.

SITREN® mold release agents guarantee visually excellent concrete surfaces, they also generate enormous cost efficiency thanks to optimized working and usage times. Our products ensure easy demolding process and are readily biodegradable.
SITREN® mold release agents

Our SITREN® MR range of concentrated mold release agents are based on renewable raw materials. These concentrated mold-releasing agents make preparation of handling concrete molds a simple task – just add water and employ easy stirring techniques. Depending on the degree of dilution, mold release agents can be formulated with different performance properties and for different types of molds.

Application areas

<table>
<thead>
<tr>
<th>FORMWORK TYPE</th>
<th>SITREN® MR 870</th>
<th>SITREN® MR 871</th>
</tr>
</thead>
<tbody>
<tr>
<td>METAL</td>
<td>⭐⭐⭐⭐⭐</td>
<td>⭐⭐⭐⭐⭐</td>
</tr>
<tr>
<td>PLASTIC</td>
<td>⭐⭐⭐⭐⭐</td>
<td>⭐⭐⭐⭐⭐</td>
</tr>
<tr>
<td>WOOD</td>
<td>⭐⭐⭐⭐⭐</td>
<td>⭐⭐⭐⭐⭐</td>
</tr>
<tr>
<td>RUBBER</td>
<td>⭐⭐⭐⭐⭐</td>
<td>⭐⭐⭐⭐⭐</td>
</tr>
</tbody>
</table>

⭐⭐⭐⭐⭐ = improper ⭐⭐⭐⭐⭐ = extremely suitable
Very effective separation effect with SITREN® MR-based concrete release agents even in the most demanding applications.

More information about mold release agents and other products is available in our product overview or on request.
Today’s formulations for the construction industry often consist of a complex combination of a wide range of different raw materials, admixtures and additives. To meet technical and economic demands placed on modern building products, all components have to be optimally matched, enabling all the "wheels", no matter how small, to engage with one another accurately and reliably. Process or performance additives – perform a wide range of critical functions during manufacture, processing or final product finishing.
The fundamentals of formulation management is the foundation for our extensive product portfolio and our expertise in surface-active substances.

Our additives influence the interaction of the different components within chemical formulations used in the construction industry and as a result improve the efficiency and performance of these systems. Evonik’s product range offers a wide range of additives that enable our customers to achieve numerous objectives including:

- increased efficiency and compatibility of compounding ingredients
- optimized mixing and processing procedures
- improved adhesion properties
- increased storage stability

Properties can be adapted within a formulation through the direct addition of additives such as wetting or dispersing agents; alternatively, individual formulation ingredients such as fillers or pigments can be pre-modified by means of surface treatment, providing them with an optimized property profile within the formulation.
Interaction of surface-active substances

In addition to the results reported here, our broad chemical portfolio of organically modified siloxanes, oleochemicals, polyethers, polyacrylates, nonionic amphoteric and cationic surfactants enables us to offer our customers innovative, tailor-made and solution-oriented products and concepts created through our targeted molecular design.

Our solution-oriented process and performance additives increase both the efficiency of industrial production processes significantly as well as enhancing the performance characteristics of the materials used within the construction industry.
Modified surface properties

Additives can also specifically change surface properties, modifying the performance profile to match the desired application. Surface tension, for example, can be modified to match the application.

The wettability of the surface is one of the typical property profiles that are changed in this way. Here, the interfaces can be modified from heavily hydrophobic or lipophilic to particularly hydrophilic and lipophobic. Our additives thus enable wettability, essentially affecting the bonding properties of surfaces.

Regardless of the specific objective, our product portfolio aims to achieve solutions of the highest quality and optimal efficiency.
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