Concrete Admixtures and the Environment

PRELIMINARY REMARKS

This fifth, updated State-of-the-Art Report, „Concrete Admixtures and the Environment“, was prepared by Work Group 2.1 „Concrete and Mortar Admixtures and the Environment“ (AK 2.1) and discussed and adopted by Special Committee 2 „Concrete Technology“ (FA 2). Its intended purpose is to provide information to all members and the specialised public.

All of the documents submitted by the end of April 2011 and the feedback we received on the 4th edition of the State-of-the-Art Report published in June 2005 were integrated into this report.

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Deutsche Bauchemie e.V. invites you to share your experience and make comments on this State-of-the-Art Report which should be directed to the main office in Frankfurt am Main.
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1 IN GENERAL

Because of concrete’s great range of variety, it offers specifiers and architects nearly unlimited possibilities. From simple structures to complex buildings of intricate design, practically all ideas can be realised with concrete. However, modern construction with concrete in all of its aspects would be unthinkable without concrete admixtures. Ever since statistics have been collected on the sale of concrete admixtures in Europe by EFCA, starting in the year 1994, the market has nearly tripled and has doubled in Germany since the beginning of the 1990s.

With the continuously growing ecological awareness that is spreading all over the world due to discussions on climate changes, construction materials have become a focus of general interest as important factors in assessing the sustainability of construction methods and buildings. The most used construction material in the world, concrete, is of particular interest. A number of investigations and a great deal of research work in this field are testimony. As a consequence, cement manufacturers are going to great efforts to optimise their carbon footprint when producing cement by reducing the quantity of clinker used in cement and thus also in concrete. In this connection, it is natural that concrete admixtures and their contribution to the sustainability of construction with concrete must be examined. A basis for this is Environmental Product Declarations. These have been available for a number of concrete admixtures for several years but must now be revised to follow the general development in this area.

REACH, The European regulation, evaluation and authorisation system for chemicals, is another subject that has strongly influenced the discussion in the chemical industry and among concrete admixture manufacturers in recent years and will still require considerable resources in the years to come.

Along with REACH, the CLP Regulation is another significant European regulation on chemicals. With the CLP Regulation, the Globally Harmonized System of Classification and Labelling of Chemicals (GHS) issued by the United Nations was implemented into European law. The resulting new rules for the classification and labelling of substances, which have been in effect since the end of 2010, concern a number of the raw materials used for the admixtures named in this State-of-the-Art Report. A new classification of preparations will follow in the coming years (by June 2015). Until then, the provisions of the Preparation Directive still apply.

Along with activities in the field of the environment as well as health and occupational safety in general, concrete admixtures were also further developed from a technical point of view. New types of admixtures came on the market and the economic significance of others changed. That is why shrinkage reducers are dealt with for the first time in this State-of-the-Art Report and recycling aids were left out. They no longer have any economic significance in Germany and there are no longer any products on the market with a National Technical Approval.

In view of these developments, it was time for the admixture manufacturing members of Deutsche Bauchemie e.V. to update the State-of-the-Art Report, ’Concrete Admixtures and the Environment’, so that all users and the interested public have up to date information.
2 CRITERIA FOR EVALUATING A PRODUCT

A number of different kinds of product specific data and information are used as the basis for evaluating the acceptability of products for humans and the environment.

These can be divided into three groups:

- human toxicological criteria
- ecological criteria
- physical-chemical criteria

2.1 Human Toxicological Criteria

Human toxicological criteria are of central importance for the assessment of products in regard to their health risk for humans.

Whether products present a health risk to humans during their production, use and disposal essentially depends on the type and manner of exposure. The extent and type of effect always depend on the quantity taken up. In the case of local effects such as, e.g. skin or mucous membrane irritation, the concentration of the active substance also plays a role.

When evaluating the effect, acute effects and long-term effects are distinguished, depending on whether the damage is observed after a single or short-term intake or more long-term after repeated uptake.

In these cases, intake can be oral (by swallowing), dermal (through the skin) or by inhalation (through the respiratory system). To evaluate a product, data on acute toxicity, chronic effect, skin/mucous membrane tolerance and potential for sensitising are taken into consideration.

Of special significance are the cancer-inducing (carcinogenic), reproduction-endangering (reproduction toxic) and genetic code changing (mutagenic) effects.

2.2 Ecological Criteria

To evaluate the influence of products on the environment, the following issues are taken into consideration:

2.2.1 Eco-Toxicological Effects

Chemical and physical effects are primarily understood here which can lead to the harm of organisms and eco-systems. To assess these, tests are carried out that rate the aquatic and/or terrestrial toxicity, i.e. the harmful effect on organisms and eco-systems in water or soil such as fish, daphnia, algae or bacteria as well as organisms in the ground.

2.2.2 Bio-Accumulation

This is understood as the accumulation of substances in living organisms. It is the result of the interaction between uptake and excretion of substances by organisms.

Since the consequences of bio-accumulation are not easy to estimate, it is in principle an undesirable property.

Indications of the potential of a substance to accumulate are given by the distribution coefficient n-octanol : water (log P_{ow}).
2.2.3 Biodegradability

The residence time of products in the environment is substantially influenced by its biological degradability.

In principle, biodegradability is desirable and should lead to complete mineralization or decomposition of the substance without forming any hazardous decomposition products.

Biodegradability is determined with the aid of different test methods in relation to specific product groups and the decomposition process.

A distinction is made between screening tests, tests for inherent biological degradability, simulation tests, tests for complete degradability and tests for anaerobic biological degradability.

Most of the tests are executed according to standard regulations such as e.g. DIN, ISO or OECD and are internationally recognised.

- Tests for Substances Readily Biodegradable
  In general, screening tests represent the first stage in evaluating biodegradability. The primary degradation of surfactants, for example, is tested according to the OECD screening test. To evaluate the biodegradability of practically all organic substances, ultimate degradation screening tests such as the modified OECD screening test, the closed bottle test or the CO₂ evolution test are used.

- Tests for Inherent Biodegradability
  Substances that do not fulfil the criteria for „readily biodegradable“ can then be examined with tests for „inherent biodegradability“ to determine whether they are at least „inherently biodegradable“. The test substances are examined under conditions that strongly promote degradation. Conventional test methods in this group are the modified Zahn-Wellens test and the SCAS test.

Simulation tests such as the OECD Confirmatory Test or the Coupled-Unit Test create the anaerobic degradation conditions of the biological stage in sewage disposal works on a laboratory scale.

To prove complete degradation without the formation of difficult to degrade interme- diate products, a so-called metabolite test is used. Empirical conclusions from tests for substances „readily biodegradable“ can be proved experimentally by this means.

To evaluate biological degradation under anaerobic conditions as they are found in, e.g. absorbing wells or digestion towers, the ECETOC test was developed.
2.3 Water Hazard Classes

To evaluate the influence of a substance on the physical, chemical or biological properties of water, substances have been divided into water hazard classes in Germany.

There are three classes:

- **WGK 1**: slightly hazardous to water
- **WGK 2**: hazardous to water
- **WGK 3**: extremely hazardous to water

The substances assigned to the three water hazard classes are listed in annexes of the German General Administrative Regulation for the Classification of Water Hazardous Substances into Water Hazard Classes (VwVwS) and their amendments. Along with the three water hazard classes, VwVwS also has a list of substances that are not hazardous to water (nwg). VwVwS as well as the respective annexes are published by the German Federal Environment Office (UBA).

To determine the water hazard class of a substance, three criteria are mainly relied on:

- acute oral toxicity for mammals
- acute toxicity for bacteria
- acute toxicity for fish

Other data such as biodegradability, toxicity for daphnia and algae as well as bi-accumulation and data on carcinogenic, teratogenic as well as mutagenic effects are also taken into consideration for classification.

The classification of a substance is determined by the „Commission on the Evaluation of Water Hazardous Substances“ (KBwS) upon application. Preparations are classified by the manufacturer on the basis of a mixing rule governed by the „General Administrative Regulation for the Classification of Water Hazardous Substances into Water Hazard Classes“ (VwVwS).

2.4 Physical–Chemical Criteria

A basic requirement for being able to use products safely is to have comprehensive knowledge on their physical-chemical properties. As a rule, only a few parameters are of central importance, the most important being water solubility, vapour pressure, and flash point as well as any explosion or fire-promoting effects. This information is found in the Safety Data Sheets for the respective products.

Safety rules for handling products and notes on measures to be taken for transport and storage, limit values for exposure as well as rules for working and application can be derived from the large number of evaluation criteria listed here. These are determined by national and international laws, regulations and directives.
2.5 Physical-Chemical Criteria

To support member companies, trade associations in the German construction industry have set up an information system for hazardous substances (GISBAU) that provides comprehensive information to business enterprises, making it easier for them to fulfill their obligations to identify and control these substances and to provide instructions for their use in compliance with regulations on hazardous substances. The heart of the system is made up of product information and examples of operating instructions that comply with regulations on hazardous substances.

In cooperation with the manufacturers of concrete admixtures, product group information tailor-made for concrete admixtures was compiled that divides concrete admixtures into three product groups with a specific code:

- **BZM 1** Concrete admixtures, no labelling required  
  Code: BZM 1
- **BZM 2** Concrete admixtures, irritant  
  Code: BZM 2
- **BZM 3** Concrete admixtures, corrosive  
  Code: BZM 3

The code is printed on the information provided by the manufacturer and on container labels which enables the user to immediately assign the product to the respective product group. Thus, on the basis of just a few product groups, information concerning the protective measures to be taken can be given for a number of products. These notes refer to the pure product.

The manufacturers of concrete admixtures provide GISBAU with information on products.

2.6 Hygiene, Health and Environment Protection

In the European Union, the Construction Products Directive is the basis for the general assessment of the suitability of construction products today. It defines a number of „essential requirements“ to which product assessment must be oriented as the basis for placing products on the market. Along with stability, safety for use, safety in case of fire and several other criteria, „hygiene, health and environment protection“ are deemed essential requirements.

In 2005, the European Commission gave the European Committee for Standardisation (CEN) the mandate (M/366) to harmonise the testing standards for hazardous substances. The main result of the standardisation work by the end of 2010 were three drafts for harmonised testing standards that will be up for validation in 2011. Two of the draft standards deal with leaching methods to determine the release of inorganic/organic substances from construction products in monolithic, slab or sheet-like as well as granular form. The third draft standard deals with the release of volatile organic compounds (VOC) in the air of interior rooms. Publication in the form of a Technical Specification (TS) is planned for 2013. The final European Standards (EN) should be completed by 2016.

In Germany, principles for assessing the effects of construction products on soil and ground water as well as the subject of their effects on indoor air and the quality of living were prepared by the German Institute for Construction Technology (DIBt). These assessment schemes are used when DIBt issues National Technical Approvals for construction products and will be described in more detail in the following.
2.6.1 Soil and Ground Water

Under the aegis of the German Institute for Construction Technology (DIBt), in a cross-departmental project group in cooperation with a number of interested parties, including Deutsche Bauchemie, „Grundsätze zur Bewertung der Auswirkungen von Bauprodukten auf Boden und Grundwasser“ [Principles for Assessing the Effects of Construction Products on Soil and Ground Water] were drawn up (May 2009). These principles replace the DIBt Code of Practice on „Bewertung der Auswirkungen von Bauprodukten auf Boden und Grundwasser“ [Assessing the Effects of Construction Products on Soil and Ground Water]. In part I of these principles, an interdisciplinary concept on site-independent evaluation of possible harmful effects on soil and groundwater were drawn up, taking the current laws on ground, water and waste into account.

In part II of these principles, the evaluation concepts for special construction products are described. Section 1 of part II deals with concrete parent substances and concrete. The general principles (part I) and the evaluation concepts for concrete parent substances and concrete were published in May/June 2010 by DIBt.

In Germany, no testing is necessary to evaluate the effects on soil and groundwater if standardised, parent substances are used which are, a priori, deemed safe or environmental acceptability has been proved by a National Technical Approval (e.g. according to DIBt principles). Concrete admixtures according to DIN EN 934 are deemed safe, a priori. This was clarified in an explanation by the German Committee on Reinforced Concrete (DAfStb) which is available as a download on the website of DAfStb.

2.6.2 Indoor Air

Heightened public awareness on issues concerning health and the environment has also increasingly drawn the attention of experts to the emission behaviour of construction products.

To assess the emission behaviour of construction products in regard to volatile organic compounds (VOC), the AgBB evaluation concept was anchored in the „Principles for the Health-Related Evaluation of Construction Products in Indoor Rooms“ (as per October 2008) in which testing and evaluation of emission behaviour are governed in general. Special evaluation concepts have already been stipulated for certain product groups, according to which approval tests must be carried out. Details on the AgBB evaluation concept and other regulations are found in Deutsche Bauchemie’s State-of-the-Art Report, „Gesunde Innenraumluf mit modernen Bauprodukten“ [Healthy Indoor Room Air with Modern Construction Products] which is only available in German at present.

2.7 REACH

REACH is the European legislation on chemicals and has been in force since June 1, 2007. It governs the registration, evaluation, authorisation (approval and restriction) of chemical substances. The regulation has the goal of ensuring a high level of protection for human health and the environment. The core of REACH entails the obligation that all chemical substances which are produced in or imported into the EU in a quantity greater than 1 tonne/year must be registered with the European Chemicals Agency, ECHA.

To register, the manufacturer/importer must present an extensive dossier that contains basic data for evaluating environment and health relevant properties of the substances. What is new is that the substances are not considered in isolation; instead, an evaluation in regard to the use of the substances takes place – and that over their entire life cycle. This takes place in steps within the scope of registering the substances. Since
December 1, 2009, all chemicals that are produced in the EU or are imported into the EU that fall under REACH must be pre-registered with ECHA; otherwise they may no longer be used. Full registration of relevant substances then takes place between 2010 and 2018, depending on hazard potential and the quantities produced or imported. Preparations or mixtures (e.g. concrete admixtures) themselves are not registered, only the chemical substances they contain. The main responsibility and the central tasks lie with the manufacturers and importers of these (basic) chemical substances.

Under REACH the Safety Data Sheet is still the central instrument for information. New is that after final registration the Safety Data Sheet may contain an annex – a so-called exposure scenario. These exposure scenarios contain the basic conditions and, if applicable, protective measures for safe use. During the period until 2018, the Safety Data Sheets will be successively revised, if necessary, and the latest version passed on to customers.

The use of a chemical product (e.g. concrete/mortar admixtures) is then safe if the user observes the conditions (which, if applicable, are stated in an exposure scenario) given in the Safety Data Sheet. If the commercial user observes the protective measures and conditions for use stated in the Safety Data Sheet and, if applicable, in the enclosed exposure scenario, he has no further obligations under REACH.

If a customer in the construction chemical industry (user, downstream user) discovers that the protective measures and conditions for use stipulated in the Safety Data Sheet cannot be implemented in practice, this must be discussed with the manufacturer of the product and together they must find a solution. The same applies if the customer’s use deviates from the stated use. The manufacturer of the product must then examine whether the deviating use can be authorised by observing further conditions, if applicable, or must be refused.

2.8 Environmental Product Declarations (EPD) for Construction Products

Most construction products are used in combination with many other products to construct a building or structure. Environmental Product Declarations (EPD) for the individual construction products can be drawn upon for ecological evaluation as well as for assessment and evaluation of their sustainability.

In the future Construction Product Regulation, a new basic requirement No. 7 “Sustainable Use of Natural Resources” will have been added. An option for implementing these requirements is to use the EPDs according to prEN 15804 as an element in a harmonised procedure for evaluating sustainable construction.

At the moment, environmental declarations exist for a number of concrete admixture types that were prepared by an independent institute on behalf of the European Federation of Concrete Admixtures (EFCA). As soon as a single European standard for the preparation of EPDs goes into effect, these environmental declarations will be correspondingly revised to meet the new standard.
3 CONCRETE PLASTICIZERS AND SUPERPLASTICIZERS

Concrete plasticizers (BV) must correspond to the general requirements in EN 934-1 and the additional requirements of EN 934-2, Table 2.

A concrete plasticizer is defined here as: „An admixture that allows the water content of a specific concrete mixture to be reduced without impairing its consistency or to increase its slump without changing the water content or to achieve both effects at the same time.“

Superplasticizers (FM) must correspond to the general requirements in EN 934-1 and the additional requirements of EN 934-2, Table 3.1/3.2.

A superplasticizer is defined here as:

„An admixture that allows the water content of a specific concrete mixture to be considerably reduced without impairing its consistency or to considerably increases its slump without changing the water content or to achieve both effects at the same time.“

There are also superplasticizers that are tested according to Tables 11.1/11.2 of EN 934-2 which are defined as:

„An admixture that has the combined effects of a superplasticizer (main effect) and a retarder (supplementary effect).“

These are the product groups that may be used in Germany as concrete plasticizers and superplasticizers. However, EN 934–2 also recognises two further multi-functional type admixtures.

One of these is an admixture according to Table 10, „an admixture that has the combined effects of a concrete plasticizer (main effect) and a retarder (supplementary effect)“ and the other is a concrete admixture according to Table 12, „an admixture that has the combined effects of a concrete plasticizer (main effect) and a set accelerator (supplementary effect)“. These multi-functional admixtures are also found on the market in other countries besides Germany.

3.1 Raw Materials Used for Concrete Plasticizers and Superplasticizers

The raw materials essentially used in Germany for concrete plasticizers and superplasticizers are:

- lignosulphonates
- melamine sulphonates
- naphthalene sulphonates
- polycarboxylate(s)/polycarboxylether

All of the raw materials are either aqueous solutions or powders, i.e. they are free of organic solvents. According to EC Directive 1999/45/EC, these raw materials are neither toxic nor harmful to health, nor are they irritating or corrosive. Due to production processes, the polycondensation products from melamine and naphthalene normally contain small quantities of free formaldehyde. However, these are below the limit value which would make labelling mandatory.
3.1.1 Lignosulphonates

Lignin is a complex, highly polymeric, natural compound which, along with cellulose, is the main constituent of wood. It is separated from cellulose by hydrolysis and sulphonation. The resulting lignosulphonates can therefore be considered a modified natural product. Very uniform qualities are available for concrete technology today.

Lignosulphonates are deemed safe from a toxicological standpoint. This has been verified by the results from acute and sub-acute toxicity studies on different species, administered orally.

Irritating effects on the skin and eyes of rabbits have not been observed. Genetic code changing properties were not determined in short-term tests (AMES test: negative).

In eco-toxicological studies on different species of fish and aquatic organisms, lignosulphonates do not cause any harm.

Lignosulphonates are inherently biodegradable. The material may neither be directly led into sewage outfall drains nor directly discharged into aquatic environments or the sewer system. Lignosulphonates are classified Water Hazard Class 1: slightly hazardous to water (KBwS).

Because lignosulphonate is easily soluble in water and has a low n-octanol/water distribution coefficient bio-accumulation can be ruled out.

Lignosulphonates are also used as a pelletising aid in the feed industry. Because of their physiological properties, lignosulphonates are officially approved for feed (EEC-No.: E 565) according to the [German] Feed Law from July 2, 1975 (German Law Gazette I, pp 1745-1753) – amended by the first act on the Amendment of the Feed Law from January 12, 1987 – German Law Gazette I pp 138-140.

3.1.2 Melamine Sulphonates

These are sulphite-modified, melamine-formaldehyde condensation products. These raw materials are especially suitable for flowing concrete and are distinguished by their good compatibility with cement.

On the basis of presently available data on acute toxicity, melamine sulphonates are considered safe. Investigations in relation to humans when handling melamine sulphonates have shown that the formaldehyde concentration lies clearly below the MAC value. Even with longer term oral administration (28 days), melamine sulphonates prove to be only slightly toxic.

Irritating effects on the skin and eyes of rabbits have not been observed. Genetic code changing properties were not determined in short-term tests (AMES test: negative).

Eco-toxicological studies on goldorfs have shown that the harmful effect of melamine sulphonate on fish is minimal.

Melamine sulphonates do not fulfil the criteria for being readily biodegradable. They may neither be directly led into sewage outfall drains nor discharged directly into aquatic environments or the sewer system.
Melamine sulphonates are classified Water Hazard Class 1: slightly hazardous to water (KBwS). Because they are easily soluble in water and have a low n-octanol/water distribution coefficient bio-accumulation can be ruled out. Water soluble melamine sulphonates are predominately used for mineral building materials.

### 3.1.3 Naphthalene Sulphonates

Naphthalene results during dry distillation of bituminous coal on the basis of a decomposition reaction. Through sulphonation of naphthalene and conversion with formaldehyde a sulphonated naphthalene condensation product results. In concrete technology, naphthalene sulphonates have been used since approximately 1930 to plasticize concrete. Today, especially medium and high molecular naphthalene sulphonates are used as superplasticizers.

As far as acute toxicity is concerned, naphthalene sulphonates are deemed safe.

Irritating effects on the skin and eyes of rabbits have not been observed.

Previous studies have shown that acute toxicity for bacteria and fish is so low that classification and labelling according to EC Directive 1999/45/EC is not mandatory.

Genetic code changing properties were not determined in short-term tests (AMES test: negative).

Naphthalene sulphonates do not fulfil criteria for being readily biodegradable. They may neither be directly led into sewage outfall drains nor discharged directly into aquatic environments or the sewer system.

Naphthalene sulphonates are classified Water Hazard Class 1: slightly hazardous to water (KBwS). Because naphthalene sulphonates are easily soluble in water and have a low n-octanol/water distribution coefficient, bio-accumulation can be ruled out. Naphthalene sulphonates are used as accompanying and auxiliary agents in the textile and leather goods industry. They are also used on a large scale for dispersing solid matter sludge (flotation processes).

### 3.1.4 Polycarboxylates/Polycarboxylic Ether (PCE)

Water soluble polycarboxylate/polycarboxylic ether is used in its sodium salt form as a raw material for concrete plasticizers and superplasticizers. They are derived from unsaturated organic carboxylic acids.

Normally, polymerisation products from acrylates and maleinates as well as different derivatives of these with polyglycol ethers are used in concrete admixtures.

The polycarboxylate/polycarboxylic ether that is used for the production of concrete admixtures is not acutely toxic which has been proved by studies on rats and rabbits (oral and dermal administration). Skin and mucous membrane irritation may occur with acrylates; maleinates and polycarboxylic ether are described as „non-irritating“. Labelling is not mandatory for these raw materials according to GefStoffV and EC Directives.

The biodegradability of polycarboxylate/polycarboxylic ethers ranges from not readily biodegradable to poorly biodegradable. They may neither be directly led into sewage outfall drains nor discharged directly into aquatic environments or the sewer system. Polycarboxylate/polycarboxylic ether is classified Water Hazard Class 1: slightly hazardous to water (Annex 3 VwVwS).
Polycarboxylates have been used for decades as dispersing agents in the paint industry. For many years now they have also been widely used as an aid in the detergent area as a so-called „builder“.

3.2 Auxiliary Agents and Additives for Plasticizers and Superplasticizers

Concrete admixtures may also contain preservatives and de-foaming agents, usually in the range of up to 0.5% by weight.

The main task of de-foaming agents is to limit the introduction of air pores into the concrete while being mixed. This is necessary, not only in regard to the desired strength of the concrete but also in regard to the surface quality of the concrete elements. De-foaming agents also prevent excessive foam formation when admixtures are filled into containers and when the admixture is added to the batch of concrete.

Preservatives protect an admixture from biological infestation. They also ensure that the admixture remains stable during storage and has a long shelf-life under normal conditions.

Since the concentration in which they are used is very low, the preservative or de-foaming agent has no influence on labelling. The water hazard class of the preparation is determined as a rule by the actual active ingredient.

When assessing the concrete admixture from a toxicological and eco-toxicological standpoint, the low concentrations of these additives do have to be taken into consideration.

For example: a plasticizer contains a de-foaming agent at 0.5% by mass.

If this plasticizer is added to the concrete in a quantity of 1.0% by mass related to the weight of a concrete in strength class C 30/37 with 300 kg cement/m³, the hardened concrete then contains 6 ppm de-foaming agent

3.2.1 De-foaming Agents

Tri-iso-butylphosphate and other surface-active, organic compounds are mainly used as de-foaming agents. Tri-n-butylphosphate is no longer used because of its classification.

According to the toxicological and ecological data available, tri-iso-butylphosphate has a more favourable classification than tri-n-butylphosphate.

Based on the toxicological findings presently available on acute toxicity for animals, tri-iso-butylphosphate is slightly toxic (LD50 rat oral > 5000 mg/kg body weight; LD50 rabbit dermal > 5000 mg/kg body weight). Tri-iso-butylphosphate is not or only moderately irritating to the skin and eyes of rabbits. A neuro-toxic effect was not observed in animals.

Tri-iso-butylphosphate must be labelled as follows: H317 (May cause an allergic skin reaction) und H412 (Harmful to aquatic life with long lasting effects). No cases of skin sensitisation have been observed on humans during the production of or when handling tri-iso-butylphosphate. Eco-toxicologically, tri-iso-butylphosphate is classified in Water Hazard Class 1: slightly hazardous to water (self-assessment). In compliance with the Preparations Directive RL 2006/8/EC, concrete admixtures with a content of
at least 0.1% tri-iso-butylphosphate must be labelled: „Contains tri-iso-butylphosphate. May cause allergic skin reactions.‟

Other types of de-foaming agents are based, for example, on EO/PO – block (co)polymers, ethoxylated alcohols or aliphatic fatty acids. These types of de-foaming agents are generally not acute toxic as experiment on rats (oral administration) have proved. Irritation of skin and mucous membranes may occur.

Polydimethyl siloxane has a slightly irritating effect on mucous membranes; a teratogenic effect could not be completely ruled out. It has no influence on the immune system. Skin resorption does not take place. A generally valid statement regarding water hazard class cannot be given due to the diversity of the de-foaming agents.

3.2.2 Preservatives

Preservative are used in concrete additives to protect them from infection with microorganisms (bacteria, mould, yeasts) during storage.

This ensures the quality and functionality of liquid additives until their final use in concrete.

Because of the low concentration in which they are used and their degradation to harmless daughter products in liquid concrete, the biocide ingredients in completely dry construction elements is negligible or no longer detectable by analytical means.

The placement of preservatives on the market is governed throughout Europe by the Biocidal Products Directive (BPD, RL 98/8/EC) which went into effect on May 14, 1998. Preservatives and their active ingredients are subject to a strict approval procedure based on a harmonised evaluation of health related and eco-toxicological properties. Within the scope of the BPD, comprehensive testing of the biocide ingredients on the market are presently being carried out at EU level. If the evaluation is positive, they will be taken up in the so-called Annex I of the BPD (Positive List of active ingredients). After conclusion of the evaluation procedure for the active ingredients (scheduled for May 14, 2013), biocide products (formulations, preparations) made of the registered active ingredients will be approved. Just opposite the active ingredients, approval of biocide products takes place at national level by notified bodies – in Germany e.g. by the Federal Institute for Occupational Safety and Health (BAuA), Dortmund.

To preserve concrete admixtures, preparations based on the following groups of substances are mainly used:

- compounds that give off formaldehyde
- isothiazolinone/benzisothiazolinone
- bronopol
- phenolic compounds

To optimise the efficacy of biocide products, products that combine these basic substances are often used.

Compounds that release formaldehyde dominate the market in terms of quantity. A common characteristic of this chemically heterogeneous product group is that microbiologically effective formaldehyde is only released after they are added (diluted) to the products to be protected. The use of formaldehyde depot substances is advantageous (compared to formalin) since a clearly lower concentration of formaldehyde occurs in the gas phase due to the lower volatility of the depot substances and the slow release of formaldehyde.
Concentration for use is approx. 0.1 to 0.2% by mass of the preservative with the formaldehyde depot substance related to the protective concrete admixture.

Formaldehyde and other compounds that give off formaldehyde (e.g. benzylhemiformal, tetramethylol acetylene diurea) have already been evaluated in Germany or at EU level in regard to their toxicity and use for certain purposes; they have, for example, a positive BfR evaluation (Federal Institute for Risk Assessment) for preserving raw materials that are suitable for the production of paper that will come in contact with food (Recommendation List XXXVI) and have been approved for preserving cosmetics.

Biocides and combination products that contain isothiazolinones or benzisothiazolinone are another important group of compounds that are used to preserve liquid concrete admixtures.

Important representatives of this class of substances are the mixture methylchloroisothiazolinone/methylisothiazolinone (CMIT/MIT), benzisothiazolinone (BIT) as well as n-octyl-isothiazolinone which has a fungicidal effect and is occasionally added.

As a rule, their oral and dermal toxicity (pure ingredients) are clearly higher than that of formaldehyde depot substances or phenolic compounds.

Commercially available methylchloroisothiazolinone/methylisothiazolinone based preservatives (CMIT/MIT) usually have active ingredient contents of 0.5% to 1.5%. For preservation purposes, quantities ranging from 0.02% to 0.2% by mass of these highly effective products are only needed. The percentage of the pure ingredient in concrete admixtures is thus just a few ppm.

When methylchloroisothiazolinone/methylisothiazolinone are used, products formulated with these must be labelled „skin sensitisation possible“ as of an active ingredient concentration of 15 ppm. Up to this maximum quantity, these preservatives (CMIT/MIT) are also approved for preserving cosmetics.

When preservatives on a benzisothiazolinone (BIT) base are used, the label „skin sensitisation is possible“ must be used as of 500 ppm of the active ingredient in the product to be protected. With a commercially available 20% benzisothiazolinone preparation, for example, this means that a maximum quantity of 0.25% would be permitted.

A mixture of benzisothiazolinone/methylisothiazolinone has been widely used in recent years. Compared to conventional methylchloroisothiazolinone/methylisothiazolinone preparations, this new combination has the advantage of having a less sensitising effect and thus greater possibilities for use without labelling.

Methylchlorothiazolinone/methylisothiazolinone as well as benzisothiazolinone and the methylisothiazolinone/benzisothiazolinone (1 : 1) have already been listed in the BfR Recommendations XIV (plastic dispersions) and XXXVI (paper, paperboard and cardboard for contact with food).

If the recommended concentrations for use are observed, the quantity of n-octyl-isothiazolinone that is used as a fungicide is clearly below the limit of 500 ppm which would make labelling necessary, as a rule, because of skin sensitisation.

Bronopol, which was originally developed for preserving cosmetics, has been increasingly used in recent years because it can be easily combined with isothiazolinones (particularly CMIT/MIT), also for preserving technical products.
Along with its use in cosmetics, Bronopol also qualified for listing in the BfR Recommendations XIV and XXXVI mentioned above.

Bronopol has been awarded the „Blue Angel“ environmental sign in accordance with RAL ZU 102 for coatings and paints that are used in indoor areas.

Phenolic compounds are another group of active ingredients that are of interest.

This class of products has little oral or dermal toxicity as a rule and the compounds are not mutagenic. The risk of sensitisation by the products is not given in the recommended concentrations or, at the most, is rated very low.

Important representatives of this class of substances are o-phenylphenol and p-chlorocresol.

Both of these active ingredients are listed in BfR Recommendation XIV (plastic dispersions) and o-phenylphenol also corresponds to BfR Recommendation XXXVI (paper, paperboard and cardboard for contact with food). Within certain concentration limits, both products are also approved for preserving cosmetics.

All of the presented preservative ingredients were registered for the Review Programme under the Biocidal Products Directive (RL 98/9/EG) and will be supported with respective authorisation dossiers. It can therefore be assumed that preservatives based on the above named active ingredients will be available for the preservation of concrete admixtures in the long term as well.

3.3 Concrete Plasticizers and Superplasticizers as Concrete Admixtures

Concrete plasticizers and superplasticizers mainly contain lignosulphonates, naphthalene sulphonates, melamine sulphonates or polycarboxylates/polycarboxylic ether or mixtures of these. De-foaming agents and preservatives are added as accompanying and auxiliary agents.

The concrete plasticizers and superplasticizers on the market are in liquid form as a rule. The active ingredient concentration ranges between 10 and 40% by mass. The quantity of concrete plasticizer added usually ranges between 0.2 and 0.5% by mass and for superplasticizers between 0.4 and 2.0% by mass related to the weight of the cement.

According to our state of knowledge today, the preparations of concrete plasticizers and superplasticizers normally found on the German market do not need to be treated as hazardous as far as the German Chemicals Act is concerned. Concrete plasticizers and superplasticizers fulfil the criteria for being readily biodegradable.

These admixtures may neither be directly led into sewer outfall drains nor discharged directly into aquatic environments or the sewer system. They are classified Water Hazard Class 1: slightly hazardous to water (self-assessment).

3.4 Concrete Plasticizers and Superplasticizers in Concrete

As previously stated above, concrete plasticizers are usually added to concrete in quantities of 0.2 to 0.5% by mass and superplasticizers in quantities of 0.4 to 2.0% by mass. As a result, the admixture content in concrete is very low.
Here an example: When added in a quantity of 2.0% by mass of a 40% solution related to cement weight, superplasticizers make up only 0.1% active ingredient in the hardened concrete.

According to our state of knowledge today, the raw materials normally used for concrete plasticizers and superplasticizers are adsorbed at the interface cement particle/water shortly after the admixture is added to the concrete. As a result, the concentration of the active ingredient is quickly reduced in the aqueous phase.

Adsorption studies with calcium lignosulphonate, sodium melamine sulphonate and sodium naphthalene sulphonate have shown that these active ingredients are bound into the cement paste matrix to more than 90% within seven days.

Analyses of pore water pressed out of 28 day old cement paste under high pressure (up to 5000 bar) confirm the results of the adsorption studies. After a hydration period of 28 days, the concentration determined in the pore water shows that for calcium lignosulphonate, for example, 95% of the active ingredient is incorporated into the hydrated cement clinker phases.

When evaluating the environmental compatibility of concrete that has been produced with admixtures or its ability to be recycled, what is important is not its adsorption behaviour but whether there could be a possible release of the ingredients in the admixtures. Since concrete admixtures are substances that are less volatile in general, it can be assumed that ingredients which, because of chemical equilibrium, are present in small quantities dissolved in the pore water of the cement paste will essentially only be given off into the environment through diffusion processes in the liquid phase.

Elution studies on uncrushed cement paste cylinders (w/c = 0.40, diameter and height 100 mm) in a trough test have shown that only less than 0.5% of the active ingredient quantities used were leached out within 24 hours. With further progress of time, the release rate decreases even more. Consequently, diffusion processes in normally wet exterior building elements only lead to very low leaching rates. According to newer studies, only monomer compounds are essentially leached out in the case of naphthalene sulphonates. The higher condensed compounds which represent the greater part of the concrete admixtures remain immobilised. Leaching is not possible on dry, interior building elements.

Accordingly, tests for the suitability of concrete plasticizers and superplasticizers for the construction of drinking water facilities have produced the following results:

a) The United States Environmental Protection Agency (EPA) states that the addition of 4.5% by weight Melment L 10/20% of cement weight in concrete that comes in contact with drinking water is safe.

b) Tests on mortar prisms with 2% by weight Melment L 10/20% according to the Belgian standard NBNS 29.004 showed that cement, fly ash and the superplasticizer Melment L 10/20% fulfil the requirements of the standard and can be used for lining reservoirs that are used for long-term storage of drinking water since the amounts of leached formaldehyde and melamine sulphonate lie clearly below the limit values of this standard.

c) Tests on melamine sulphonate solution or naphthalene sulphonate solution or sodium lignosulphonate solution, corresponding to DVGW [German Gas and Water Trade Association] Worksheet W270 and W 347, showed that they fulfil the requirements for use in drinking water reservoirs and for reservoir linings.
To assess the question concerning possible emission of substances in gas form from concrete that contains concrete admixtures, there are a good number of examination results related to practice:

a) In the examination of a composite slab produced with a bonding layer that contained Melment and a repair mortar containing Melment, a formaldehyde concentration of 0.01 ppm was determined in the 1 m³ chamber which corresponds to the blank value of the chamber. Therefore, the examined composite slab can be designated as practically free of formaldehyde emission.

b) When examining 28 day old concrete slabs that were produced with the maximum allowed quantity of 32 ml/kg cement Melment L 10/20%, a formaldehyde concentration of 0.03 ppm was determined in the 1 m³ chamber after a testing period of 120 hours. The emission of ammonia from this concrete slab in the 1 m³ chamber was measured at 0.02 ppm. To evaluate the emission of ammonia, 1/20 of the MAC value is recommended as a guide value, i.e. 2.5 ppm (advice from experts, special expert opinion 1987). The determined emission of ammonia lies clearly below this evaluation standard.

Two year old concrete slabs with a comparable Melment content showed a formaldehyde concentration of 0.01 ppm after testing for 192 hours.

After 28 days under the same conditions, naphthalene sulphonate (40% solution) in a quantity of 14 ml/kg cement showed a formaldehyde concentration of 0.01 ppm. These formaldehyde concentrations lie clearly below the guide value recommended by BfR for interior spaces with a room formaldehyde concentration of 0.1 ppm and also the value specified for wood materials of 0.1 ppm according to the [German] Chemical Prohibition Regulation (ChemVerbotsV) § 9(3).

c) In addition to testing hardened concrete slabs in the 1 m³ test chamber, formaldehyde emission from fresh concrete with superplasticizers containing naphthalene and melamine sulphonates under practical conditions at building sites, in ready-mix concrete works, pre-cast concrete works and in a concrete engineering laboratory were measured according to TRGS 402 [Technical Regulations for Hazardous Substances].

In summary, these examinations show formaldehyde emissions in a range of non-measurable to 0.0245 mg/m³ air. They were therefore clearly below the MAC value of 0.6 mg/m³ in all cases.

Based on these results, it can be assumed from our state of knowledge today that concrete that contains plasticizers or superplasticizers does not present a hazard for humans or the environment through the release of volatile substances.
4 RETARDERS

Retarders (VZ) must fulfil the general requirements in EN 934-1 and the additional requirements of EN 934-2, Table 8.

A retarder is defined here as:
„An admixture that increases the length of time that passes before the concrete mixture begins to change from the plastic to the solid state“.

4.1 Raw Materials Used for Retarders

The raw materials essentially used in Germany for retarders are:

- sucrose
- gluconates
- phosphates
- lignosulphonates

All of these raw materials are used either in powder form or as aqueous solutions.

4.1.1 Sucrose

Sucrose is normal cane or beet sugar, depending on origin, that is used to sweeten foods in households. Sucrose is therefore not regarded as a hazardous ingredient. However, from an eco-toxicological point of view, the situation is somewhat different. Sucrose is readily biodegradable because of its high biological oxygen demand during degradation but this places a load on aquatic environments. For this reason, products that contain sucrose are classified Water Hazard Class 1: slightly hazardous to water (self-assessment according to VwVwS).

That is why products that contain sucrose should neither be directly led into sewer outfall drains nor discharged into aquatic environments or the sewer system.

4.1.2 Organic Acids

4.1.2.1 Gluconates

Gluconates are a modified sugar and are often used in the form of sodium gluconate (sodium salt of gluconic acid).

Data found in literature indicate only little acute toxicity. An irritating effect on skin and eyes could not be proved.

Labelling is not mandatory. This product is also readily biodegradable but because of its high biological oxygen demand during degradation, it is classified Water Hazard Class 1: slightly hazardous to water (self-assessment according to VwVwS). Therefore, products that contain gluconates should not be led directly into sewer outfall drains nor directly discharged directly into aquatic environments or the sewer system.

Gluconates find application as additives in dietary foods. Gluconates are also intermediate products of human metabolism.

In the United States, Na-gluconate has „Gras“ status (generally recognised as safe). Therefore, this raw material can be deemed safe.
4.1.2.2 Fruit Acids

Fruit acids are organic acids that are often found in fruits. They contribute to their aroma and have an anti-microbial effect. Well-known representatives are citric acid, tartaric acid, gluconic acid, lactic acid and malic acid. These are hydroxy-carboxylic acids and in concrete they have a retarding effect.

The citric acid that is preferably used for the production of recycling aids has no known chronic-toxic effects and is safe as far as acute toxicity is concerned. When handled properly, adverse health effects for humans are not known nor are they to be expected. In concentrated form, citric acid irritates skin and eyes. It is readily biodegradable. Bio-accumulation does not take place and citric acid is classified as not hazardous to water (nwg) (KBwS).

Since pure citric acid is easily soluble in water and shows an acid reaction in an aqueous solution, it must be labelled GH507 and H319 according to the CLP Regulation. Contact with skin and eyes should be avoided.

Citric acid is approved as a food additive (E330) and has „Gras“ status (generally recognised as safe) according to the FDA (USA). Therefore, as a raw material, it is deemed safe from a toxicological as well as an eco-toxicological standpoint.

4.1.3 Inorganic Retarders

4.1.3.1 Phosphates

The main phosphates used are:

- tetrapotassium pyrophosphate
- sodium tripolyphosphate
- sodium hexametaphosphate

It is known that the phosphates used in retarders are not acutely toxic. These are inorganic substances for which the term biodegradable does not apply.

Tetrapotassium pyrophosphate shows an alkaline reaction in aqueous solution and therefore must be labelled GH507 (Attention). The substance is rated irritating to eyes (H319). Phosphates are classified Water Hazard Class 1: slightly hazardous to water (self-assessment according to VwVwS) and may not be led directly into sewer outfall drains nor discharged directly into aquatic environments or the sewer system. These phosphates are also often used in foods.

4.1.3.2 Phosphonic Acids

Organic derivatives of phosphonic acids are also used as retarders. These are compounds that have a phosphorous-carbon bond.

An example of this is 2-phosphono-1,2,4-butane-tricarboxylic acid (PBTC).

According to the current data available, an approx. 50 % aqueous solution of PBTC is deemed safe from a toxicological point of view. Irritating effects on the skin of rabbits were not determined and PBTC is only mildly irritating to rabbit eyes.

No indications of teratogenic properties (rat) or a mutagenic effect (AMES test, micronucleus test) were found.
In eco-toxicological tests on bacteria and fish, PBTC showed no harmful effect even in high concentrations. PBTC is classified Water Hazard Class 1: „slightly hazardous to water“ (KBwS). When used properly it does not cause disturbances in biological clarification plants. According to the CLP Regulation, labelling is not mandatory. PBTC is used to treat cooling and process water, i.e. to prevent crusts from forming, e.g. on heat exchangers, as well as in liquid cleaners for the food industry.

4.1.3.3 Lignosulphonates
For further information on lignosulphonates, see the information given in section 3.1.1.

4.2 Auxiliary Agents and Additives for Retarders

Since sucrose and gluconate are readily degradable, the types of retarders that contain these raw materials also contain preservatives.

Preservatives protect the admixture from biological infestation which ensures stability during storage as well as a long shelf-life, even under extreme conditions. It is only possible to produce durable concrete in the desired quality if the retarders retain their effect, even after longer storage periods. (Preservatives are dealt with in section 3.2.2).

4.3 Retarders as Concrete Admixtures

Retarders are aqueous solutions of the raw materials described above or aqueous solutions made of combinations of these raw materials. The active ingredient concentration normally ranges between 10 and 30% by mass.

Based on the data available for these raw materials, the retarders found on the German market are deemed practically non-toxic. From an ecological standpoint, retarders on a sucrose or gluconate base are readily biodegradable but have a high biological and chemical oxygen demand during this process.

The term biodegradability does not apply to retarders on a phosphate base. Lignosulphonates are inherently biodegradable.

Retarders are classified Water Hazard Class 1: slightly hazardous to water (self-assessment according to VwVwS).

4.4 Retarders in Concrete

Retarders are added to concrete or mortar in quantities that range between 0.2 and 2.0% by mass related to cement weight, depending on the working time desired.

According to present knowledge, retarders – similar to concrete plasticizers and superplasticizers – are also tightly bound into the cement paste matrix.
5 SET/HARDENING ACCELERATORS AND SHOTCRETE ACCELERATORS

Set/hardening accelerators and set accelerators for shotcrete must correspond to the requirements in EN 934-1 and the additional requirements of EN 934-2 and EN 934-5. They are defined here as:

Set Accelerators (BE) according to DIN EN 934-2:
„An admixture that reduces the length of time that passes before a concrete mixture changes from the plastic to the solid state“

Hardening Accelerator (BE) according to DIN EN 934-2:
„An admixture that accelerates initial strength with or without an influence on setting time“

Hardening accelerators and non-alkaline hardening accelerators for shotcrete are specified in DIN EN 934-5.

Set Accelerators for Shotcrete:
„An admixture that allows shotcrete to set very early, distinguishing them from the set accelerators defined and stipulated in EN 934-2.“

Non-Alkali Based Set Accelerators for Shotcrete:
„Set accelerators for shotcrete with an alkali content (given as an Na2O equivalent) of maximum 1.0% related to the mass of the admixture“.

5.1 Raw Materials Used for Accelerators

The raw materials essentially used in Germany for hardening, set and shotcrete accelerators are:

- aluminium sulphate
- formates
- fluorides
- aluminates
- amorphous aluminium hydroxides
- carbonates
- silicates
- ethanol amines

These raw materials are used alone or in combination, in powder form or in aqueous solutions or in the form of dispersions or suspensions.

Along with the above named raw materials, nitrates, nitrites and thiocyanates are also used.

These substances are listed in EN 934-1, Annex A.2 („substances to be declared“) and in compliance with DIN 1045-2, section 5.2.6 are not permitted for use in reinforced concrete in Germany according to DIN 1045-2 because of their possible corrosion promoting effect on steel. In addition to this, the use of accelerators on a formate base in prestressed concrete is also prohibited in Germany.

5.1.1 Aluminium Sulphate

Aluminium sulphate is a powder that dissolves in water at different speeds, depending on its water of crystallization content. It is used as a powder, solution or as an aqueous suspension.
Solid aluminium sulphate is classified GHS05 (Danger) and H318 (Causes serious eye damage). Test studies using concentrated, aqueous aluminium sulphate solutions prove that it does not have an irritating effect and is not a hazardous substance.

Aluminium sulphate is slightly hazardous to water (WGK 1 according to VwVwS from July 27, 2005).

Since it is a pure inorganic substance, the term biodegradability does not apply to aluminium sulphate. However, since the aluminium ions hydrolyse to aluminium hydroxide in water, the substance can be easily eliminated. Aluminium sulphate may not be led directly to sewage outfall drains nor to aquatic environments or the sewer system.

Aluminium sulphates are used, e.g. for treating sewage and for preparing drinking water.

### 5.1.2 Formates

**Calcium Formate**

Calcium formate may cause serious eye irritation (H319), causes skin irritation (H315), may irritate the respiratory tract (H335) and is labelled GHS07 (Attention).

Calcium formate did not show any indication of mutagenic activity in an AMES test. In long-term studies on rats, nothing conspicuous in regard to chronic or carcinogenic effects was observed with the treated animals compared to an untreated control group. Reproduction studies on rats showed unchanged growth and unchanged fertility over a period of two and five generations. Neither maternal-toxic nor embryo-toxic or teratogenic effects were observed under the experimental conditions for any of the dosage groups.

The product is classified water hazard class (WGK) 1: slightly hazardous to water (self-assessment according to VwVwS). Calcium formate may not be led directly to sewage outfall drains nor aquatic environments or the sewer system.

Calcium formate is used, e.g. as a preservative for food, for silaging green fodder and in animal nutrition.

**Aluminium Formate**

Aluminium triforate is labelled H318 (Causes serious eye damage) and GHS05 (Danger). Aluminium formate is slightly hazardous to water (WGK 1 according to VwVwS from July 27, 2005).

According to our knowledge today, aluminium formate is only used in combination with other aluminium compounds such as aluminium sulphate and aluminium hydroxide. Depending on composition and concentration of the individual components, labelling of these set accelerators may or may not be mandatory. Labelling is found in the respective data sheets for the products.

### 5.1.3 Fluorides

As a rule, only aluminium fluorides are used.

Aluminium fluoride trihydrate is a powder and labelled H302 (Harmful if swallowed) and H315, H319 and H335 (Causes skin irritation, causes serious eye irritation, may irritate respiratory tract) and GHS07 (Attention).

Aluminium fluoride trihydrate is slightly hazardous to water (WGK 1).
According to our knowledge today, just like aluminium formate, aluminium fluoride is only used in combination with other aluminium compounds such as aluminium sulphate and aluminium hydroxide. Labelling is found in the respective data sheets for the products.

5.1.4 Aluminates

Sodium aluminates or potassium aluminates as well as mixtures of these are predominately used as raw materials. Because of their high pH value they have a corrosive effect on skin and mucous membranes. According to classification under the CLP Regulation, they must be labelled with the danger pictogram GHS05 (Danger) and H314 (Causes serious burns on skin and serious eye damage) and H290 (May have a corrosive effect on metals).

Concentrated solutions are toxic for aquatic organisms. Aluminates are classified Water Hazard Class 1: slightly hazardous to water (KBwS). This rating is based primarily on the shift of the pH value of an aqueous solution to the alkaline range. They may neither be led directly into sewer outfall drains nor discharged directly into aquatic environments or the sewer system. Aluminates are used, for example, to treat sewage and for the preparation of drinking water.

5.1.5 Amorphous Aluminium Hydroxides

Amorphous aluminium hydroxides are used in powder form or as an aqueous suspension. These products are not hazardous substances as far as the CLP Regulation is concerned and labelling is not required.

If the general limit value for dust of 3 mg/m³ (alveoli penetration fraction) or 10 mg (fraction that can be inhaled) according to TRGS 900 is observed, Al(OH)₃ causes no harm if inhaled.

Amorphous aluminium hydroxides are not water soluble and are therefore classified as substances not hazardous to water (VwVwS).

5.1.6 Silicates

So-called “water glass” is used as a silicate, normally in the form of sodium or potassium salts. They are water soluble and consist of a silicic acid component (SiO₂⁻) and an alkali component (Me₂O). The lower the molar ratio SiO₂⁻ : Me₂O, the more alkaline the corresponding alkali silicates are.

From a toxicological point of view, the alkali component is of primary relevance. No classification or classification as irritating or corrosive may be necessary, depending on concentration and alkalinity.

A comparison of the classifications of soluble silicates and powder according to the CLP Regulation and Directive 67/548/EWG was carried out by CEES. According to this, the soluble silicates do not need to be labelled or must be labelled GHS07 (Attention) or GHS05 (Danger), depending on the molar ratio of SiO₂⁻ / Me₂O.

According to presently available studies, water glass is neither mutagenic nor carcinogenic. However, an influence on reproduction has been indicated. Water glass is not teratogenic.
Acute oral toxicity is low. In long-term studies (rats) with relatively high doses, treated animals showed no significant changes compared with the untreated control group.

Eco-toxicological data on water glass is available, according to which acute toxicity to fish, daphnia and bacteria is rated as low. Alkali silicates are inorganic substances and so the term biodegradability does not apply to them. They occur in nature as weathering products of certain rocks. Silicates are classified Water Hazard Class 1: slightly hazardous to water (self-assessment). This classification is mainly based on the shift of pH value in an aqueous solution to the alkaline range. They may neither be led directly into sewer outfall drains nor discharged directly into aquatic environments or the sewer system.

Silicates are used in different daily applications, e.g. for the preparation of drinking water, as a stabiliser in soil to bind heavy metals and in detergents and cleaning agents.

**5.1.7 Carbonates**

Carbonates in the form of soda (sodium carbonate) or potash (potassium carbonate) are used. Both substances have an irritating effect and according to CLP Regulation must be labelled GHS07 (Attention) and H319. Potassium carbonate must be additionally labelled with H302, H315 and H335. They are not acutely toxic orally.

If inhaled, soda has a pronounced toxic effect, especially with repeated inhalation. Soda has no teratogenic effect.

Aquatic organisms (daphnia, fish) are relatively insensitive to alkali carbonates according to the results of available studies. Effects may eventually be caused by a shift in pH. The term biodegradability is not applicable for inorganic substances. In the catalogue of substances hazardous to water, sodium and potassium carbonate are classified Water Hazard Class 1: slightly hazardous to water (KBwS). They may neither be led directly into sewer outfall drains nor discharged directly into aquatic environments or the sewer system.

Soda has been used for producing glass for more than 3000 years.

**5.1.8 Ethanolamines**

The ethanolamines used in practice are mainly diethanolamine (DEA) and triethanolamine (TEA). Both substances are used in combination with the raw materials mentioned above. In set accelerators for shotcrete, for example, DEA may be used in concentrations of several % by weight.

Diethanolamine is a very readily water soluble compound and labelled GHS08, GHS07, GHS05 (Danger), H315, H373, H302, H318. According to VvVvS, DEA is slightly hazardous to water (WGK 1), readily biodegradable and slightly toxic to aquatic organisms ($LC_{50}$ Pimephales promelas–1460 mg/l – 96 h, $EC_{50}$ Daphnia magna – 55 mg/l – 48 h).

Triethanolamine is also readily soluble in water and labelled GHS07 (Attention) and H319 (Causes serious eye irritation). According to VvVvS, TEA is slightly hazardous to water (WGK 1), readily biodegradable and only negligibly toxic to aquatic organisms ($LC_{50}$ 450–1000 mg/l/96 h (Leponis macrochirus), $EC_{50}$ 1390 mg/l/24 h (Daphnia magna), $IC_{50}$ 216 mg/l/72 h (Desmodesmus subspicatus), $EC_{50}$ 525 mg/l/30 min (Photobacterium phosphoreum).
5.2 Accelerators as Concrete Admixtures

Accelerators are used as powders, aqueous suspensions or solutions of the raw materials described or combinations of these. Active ingredient concentration normally ranges between 10 and 100% by mass.

The quantity usually used in Germany for concrete ranges between 1 and 3% by mass related to cement weight. Shotcrete accelerators are used in Germany (according to DIN 18551) in quantities between 5 and 10% by mass related to cement weight.

Depending on their pH value, both aqueous as well as powder formed preparations of silicate, aluminate and carbonate based accelerators must be labelled corrosive or irritating according to the CLP Regulation with GHS05 (Danger) or GHS07 (Attention).

Accelerators on a Ca-formate base can cause serious eye damage and must be labelled irritant (according to the CLP Regulation GHS07 (Attention), H315, H319, H335).

Set accelerators for shotcrete are predominantly water based solutions or suspensions. Their active ingredients are mainly aluminium sulphate, aluminium formate, aluminium fluoride and aluminium hydroxide or combinations of these although aluminium formate and aluminium fluoride are only used in combination with the other components. Depending on their composition, concentration and pH value, labelling may or may not be necessary for these accelerators. Labelling is found in the respective data sheets for the product.

Aluminates increase the pH value of aqueous solutions very strongly, the reason why accelerators on an aluminate base are toxic for aquatic organisms in concentrated form.

Set accelerators with an alkali content (given as an Na2O equivalent) of max. 1.0% related to the mass of the admixture are deemed alkali-free.

They are found on the market in powder form, mixed with inert fillers such as calcium carbonate as well as in the form of water based solutions or suspensions as mentioned above.

When handling these concrete admixtures, the necessary job safety measures corresponding to labelling must be taken.

When handling accelerators in powder form the dust limit value for fine dust concentrations according to the MAC value list as well as the normal job safety rules for handling powders are to be observed.

5.3 Accelerators in Concrete

As calcium salts, silicates, carbonates and aluminates are poorly soluble in water and are bound into the cement paste matrix.

In the starting phase, aluminium sulphates predominately react to ettringites.

With the high dosages that are normal for shotcrete, leaching experiments have shown that when alkali based accelerators are used, a part of the sodium and potassium ions can be leached out by water. Because of their advantages from an industrial hygiene, concrete technological and ecological viewpoint, alkali-free set accelerators are predominantly used in the shotcrete area in Europe.
6  AIR-ENTRAINING AGENTS

Air-entraining agents (LP) must correspond to the requirements in EN 934-1 and the additional requirements of EN 934-2, Table 5 where they are defined as:

„An admixture that causes the development of a certain quantity of small, evenly distributed air bubbles during the mixing process which remain in the concrete after it sets“.

For the safe use of air-entraining agents and their mode of action in concrete, Deutsche Bauchemie has published an information pamphlet titled „Informationsschrift Herstellen von Luftporenbeton“ [Information Pamphlet on the Production of Air-Entrained Concrete] which is only available in German at present.

6.1 Raw Materials Used for Air-Entraining Agents

There are a number of surface active substances called surfactants that are used to entrain air.

The term surfactant covers all chemical compounds that are capable of concentrating on interfaces and reducing interfacial tension between two immiscible phases in the process.

To improve resistance to frost and de-icing agents, it is necessary to introduce air bubbles into the concrete in a defined quantity, size and distribution.

The addition of small quantities of soaps made from natural resins or synthetic, non-ionic or ionic surfactants (e.g. alkylpolyglycol ether, alkylsulphates and alklysulphonates) have proved to be suitable for this purpose.

6.1.1 Soaps Made from Natural Resins

For the production of resin soaps, root resins, tall resins, gum resins (colophony) and derivatives of these natural resins are mainly used which are then converted with sodium or potassium hydroxide or soda into corresponding resin soaps.

Root resins are won by root extraction and gum resins from the gum that flows from artificially wounded pines (resin tapping).

Tall resins are by-products when cellulose is produced in a sulphate process.

Resins are deemed safe as far as acute toxicity is concerned; however, since they can irritate skin, eyes and the respiratory system, they are classified „irritant“. Especially in the case of colophony in the oxidised form, there may be sensitising effects which is the reason they must be labelled GHS08 as well as H334 and H 317. Preparations with a colophony content as of 1% are classified sensitising.

Natural resins are available as powders in saponified and unsaponified form. Varying concentrations of readily soluble sodium or potassium salts are offered in aqueous solutions.

Because of their alkalinity, which can irritate skin, eyes and the respiratory system, resin soaps in powder form may be classified as „irritant“ and must be labelled GHS07 as well as H315, H319 and H335. According to the CLP Regulation, saponified resins in the form of aqueous solution either do not have to be labelled or must be labelled „irritant“ or „corrosive“, depending on their alkali content.

The resins are biodegradable. Unsaponified resins are insoluble in water and are classified Water Hazard Class 1: slightly hazardous to water.
Resin soaps are classified Water Hazard Class 2: hazardous to water (self-assessment according to VwVwS) and may neither be led directly into sewer outfall drains nor discharged directly into aquatic environments or the sewer system.

Esters of natural resins are components in chewing gum. As sodium salts and in dissolved form they are used in adhesives, floor covers (linoleum), natural colouring agents, plastics and rubber (e.g. automobile tyres). Certain resin derivatives are used for hydrophobizing paper and cardboard and have been approved according to BfR (German Institute for Risk Assessment) and the FDA (Food and Drug Administration) for use in direct contact with foods.

6.1.2 Synthetic Surfactants

Alkyl polyglycol ether, alkylsulphates and alkylsulphonates are the main raw materials used. From a toxicological viewpoint, proved by studies on rats when administered orally, these are safe.

As a rule, the raw materials named above do irritate skin, mucous membranes and eyes and for this reason they must be labelled GHS05 as well as H315, H 319 and H335. However, irritation only occurs with high concentrations as a rule. Because of their high effectiveness, products based on synthetic surfactants are usually strongly diluted.

The surfactants usually used as concrete admixtures are readily biodegradable corresponding to requirements in the [German] Ordinance on Surfactants (TensV) from June 4, 1986 of the [German] Washing and Cleaning Agent Law (WRMG).

On a long-term basis, surfactants have a harmful effect on aquatic organisms.

Surfactants are classified Water Hazard Class 2: hazardous to water (self-assessment according to VwVwS) and may neither be led directly into sewer outfall drains nor discharged directly into aquatic environments or the sewer system.

Surfactants are also used in cosmetics, detergents and cleaning agents.

6.2 Air-Entraining Agents as Concrete Admixtures

The active ingredient content of the air-entraining agents normally used in Germany ranges between 1 and 5% by mass (concentrates up to 20% by mass) with quantities of 0.05 to 1.0% by mass related to cement weight.

Because synthetic surfactants are readily biodegradable, air-entraining agents made of these are formulated with a preservative as a rule.

Preservatives protect the admixture from biological infestation. Under normal conditions they ensure that the product remains stable in storage and has a long shelf-life of months or even years. Concrete that is resistant to frost and de-icing salt can only be produced in the desired quality if the air-entraining agent retains its effect, even when stored for longer periods.

(Preservatives are dealt with in section 3.2.2.)
6.3 Air-Entraining Agents in Concrete

Because of the structure of air-entraining agents which consist of a hydrophobic and a hydrophilic component, the surfactant concentrates on the edge of the air bubble while the hydrophilic component is soundly anchored in the cement paste matrix.

Because they are highly effective, surfactants are only added to concrete in small quantities and the quantity of surfactants in hardened concrete is correspondingly low.

Here an example: An air-entraining agent contains 5% by mass surfactant. If the air-entraining agent is added to concrete in strength class C 30/37 with 320 kg/cement/m³ with a dosage of 0.3% by mass, the hardened concrete contains 20 ppm of this surfactant.

7 OTHER ADMIXTURES

7.1 Waterproofing Agents

Waterproofing agents (DM) must fulfil the requirements in EN 934-1 and the additional requirements of EN 934-2, Table 9 where they are defined as follows:

„An admixture that reduces the capillary water absorption of hardened concrete“.

In Germany, however, only waterproofing agents with a proved effectiveness according to EN 934-2, Table 9 with the same water-cement value may be used for concrete according to DIN 1045-2.

7.1.1 Raw Materials for Waterproofing Agents

Salts of higher fatty acids are mainly used as raw materials. In general, this is calcium stearate which is used as a powder or in the form of an aqueous dispersion. In both cases, the product is free of solvents. From today’s point of view, calcium stearate is neither toxic nor harmful to health, nor is it irritating or corrosive. Labelling is not mandatory according to the CLP Regulation. Calcium stearate is readily biodegradable and is classified either in Water Hazard Class 1 or as not hazardous to water (nwg), depending on manufacturer.

7.1.2 Auxiliary Agents and Additives for Waterproofing Agents

Waterproofing agents may also contain small quantities of de-foaming agents or preservatives. For this, see the information given in section 3.2.1 or 3.2.2.

7.1.3 Waterproofing Agents as Concrete Admixtures

The active ingredient content of waterproofing agents normally used in Germany ranges between 20 and 50% by mass, using quantities of 1 to 5% by mass related to cement weight.

7.1.4 Waterproofing Agents in Concrete

Because waterproofing agents have a water repelling effect, the danger of their being leached out of the concrete is minimal.
7.2 Admixtures for Intrusion Grout in Prestressing Tendons (Grout Aids)

Admixtures for intrusion grout in prestressing tendons (grouting aids (EH)) must correspond to the general requirements in EN 934-1 and the additional requirements of EN 934-4.

The purpose of grouting aids (EH) is to improve flowing capacity, reduce water demand, reduce settlement or achieve moderate swelling of the grout. In Germany, only powder form grouting aids are used.

7.2.1 Raw Materials Used for Grouting Aids

Grouting aids may contain plasticizers, superplasticizers and retarders. For more information, see sections 3 and 4.

The desired swelling effect is achieved through metallic aluminium in powder form which completely converts in the alkaline environment of the grouting aid before setting begins through the development of hydrogen. This reaction begins by so-called phlegmatization of the aluminium in which a thin, protective film of paraffin encapsulates the powder after approx. 30 minutes.

No toxic properties are known for aluminium powder. It is used as a component in paints and corresponds to the purity criteria for paints that come in contact with foods. Aluminium powder is classified as not hazardous to water (nwg).

7.2.2 Grouting Aids as Admixtures

Because they have a strong swelling effect, the content of active ingredients in conventional grouting aids is very low.

In general, they range between 0.1 and 1.0% by mass and are used in quantities of 0.2 to 1.0% by mass related to cement weight.

Metallic aluminium reacts in fresh intrusion grout before setting begins, converting into hydration products that cannot be distinguished from those of the cement. They become an integral part of the hydrated cement.

7.3 Stabilisers/Sedimentation Reducers

Stabilizers (ST) must fulfil the general requirements in EN 934-1 and the additional requirements of EN 934-2, Table 4.

A stabilizer is defined here as: „An admixture that reduces the secretion of mixing water by reducing bleeding“.

Sedimentation reducers, defined according to the DIBt approval principles for concrete admixtures serve the purpose of „reducing sedimentation of the constituents in fresh concrete“. 
7.3.1 Raw Materials Used for Stabilisers/Sedimentation Reducers

The following classes of substances are mainly used as raw materials for stabilizers/sedimentation reducers:

- Starch derivatives, polysaccharides (e.g. starch ether, cellulose ether, xanthan gum, welan gum)
- Synthetic, high molecular polymers (e.g. poly(ethylene) oxides and polyacrylates)
- Fine grained, inorganic substances with large specific surfaces (e.g. silica dust and silica suspension, silica sol)

Starch derivatives are won by digestion and modification of plants that contain starch such as potatoes and grain. Starch ethers are modifications of natural starches. Cellulose ethers are won through etherification of natural cellulose, e.g. from cotton and wood. Polysaccharides are isolated from suitable micro-organisms in fermentation processes.

Starch derivatives and polysaccharides are neither acutely toxic nor do they irritate skin or mucous membranes.

Labelling is not required according to the CLP Regulation and starch derivatives and polysaccharides are not hazardous to aquatic organisms.

Because they are readily biodegradable and have a high oxygen demand, these substances are classified Water Hazard Class 1: slightly hazardous to water (self-assessment). They may neither be led directly into sewer outfall drains nor discharged directly into aquatic environments or the sewer system.

Synthetic, high molecular polymers are produced through polymerisation of ethylene oxide and/or acrylates.

The polyethylene oxides conventionally used for producing stabilizers are in powder form and labelling is not required according to the CLP Regulation. They are not acutely toxic, there is no proof that they impair the ability to reproduce, studies on gene toxicity have not shown any effect and in animal experiments they have not proved to be carcinogenic.

The products are not readily biodegradable and classified Water Hazard Class 1: slightly hazardous to water (self-assessment).

Polyalkylene glycols are used in many different types of applications, e.g. the production of packaging materials, in foods and the personal care product area as well as in pesticides.

As a rule, polyacrylates are used as aqueous dispersions. They are not hazardous substances and labelling is not mandatory. They are not acutely toxic, an impairment of the ability to reproduce was not determined, studies on gene toxicity showed no effect in this respect and in animal experiments they have not proved to be carcinogenic.

The products are not readily biodegradable and classified Water Hazard Class 1: slightly hazardous to water (self-assessment).

Fine grained, inorganic substances with large specific surfaces are used, e.g. in the form of silica dust and silica suspension or silica sols. These are not acutely toxic and they neither impair the ability to reproduce nor do they have a toxic effect on genes.

Since they are inorganic substances, the term biodegradability does not apply. They are classified Water Hazard Class 1: slightly hazardous to water.
7.3.2 Auxiliary Agents and Additives for Stabilisers/Sedimentation Reducers

With the exception of products produced with inorganic substances, stabilisers/sedimentation reducers contain slight amounts of preservatives and sometimes de-foaming agents. See also the information given in section 3.2.1 and 3.2.2.

7.3.3 Stabilisers/Sedimentation Reducers as Concrete Admixtures

Stabilizers/sedimentation reducers are added to concrete in liquid or powder form. A standard quantity cannot be stated but the quantity of active ingredient in the concrete from products on an organic substance base is extremely low and as a rule clearly less than 1% by mass related to cement weight.

Stabilizers/sedimentation reducers made of inorganic substances must be added in higher quantities. A quantity of up to 5% by mass may be necessary.

To assess the stabilizers/sedimentation reducers used here, the underlying types of pure raw materials can be taken since mixtures are not customary as a rule.

7.3.4 Stabilisers/Sedimentation Reducers in Concrete

Stabilizers/sedimentation reducers are increasingly being used in easily consolidated and in self-consolidating concrete. Examination results prove that the stabilizers/sedimentation reducers become an integral part of the cement matrix.

7.4 Chromate Reducers

Chromate reducers are used to reduce the content of water soluble chromium (VI) in cement paste to below the limit value of 2 ppm to water insoluble chromium (III). The chromate that goes into solution after the cement is mixed with water (cement paste) is deemed responsible for so-called „chromium eczema“ or „mason’s itch“.

7.4.1 Raw Materials Used for Chromate Reducers

The essential raw material presently used is iron (II) sulphate. This is a by-product in the production of titanium dioxide.

Tin (II) sulphate preparations are also still used as highly effective, stable chromate reducers.

Iron (II) sulphate must be labelled with GHS07 as well as H 315 and H 319. Irritation of skin (H315) and eyes (H319) is possible.

Tin (II) sulphate must be labelled with GHS07 as well as H315, H319 and H335.

Iron (II) sulphates are often used in hydrochemistry (precipitation agents and coagulants for eliminating phosphate and hydrogen sulphide in sewage plants), in special fertilisers in agriculture, as a trace element medium in feed mixtures and for the desulphurisation of bio-gas.

Iron (II) sulphates are also used in electropainting techniques (anodising) and for treating the surface of sheet metal (tin cans used for food).
7.4.2 Chromate Reducers as Concrete Admixtures

Chromate reducers on an iron (II) sulphate base are offered in powder form, as a granulate or a liquid. When quantities of 0.2 to 0.5% by mass of the active ingredient related to cement weight are added, a sufficient chromate reducing effect can be presumed. When handling these substances, the information given in section 7.5.1 should be observed.

Chromate reducers on a tin (II) sulphate base with a long shelf-life are available in powder and liquid form. Quantities of 0.02 to 0.07% by mass of the active ingredient related to cement weight reduce chromate without causing stains.

7.4.3 Chromate Reducers in Concrete

In the alkaline environment of concrete, most of the iron (II) sulphate used is converted, not only by oxidation through the chromate but also from the air oxygen content, into poorly soluble hydrated iron (III) oxide. An environmental hazard through elution is not to be expected.

Tin (II) sulphate is converted into water insoluble compounds in the highly alkaline concrete matrix. An environmental hazard through elution is not given.

7.5 Foaming Agents

According to the approval principles for concrete admixtures issued by the German Institute for Construction Technology (DIBt), foaming agents are defined as follows:

„Foaming agents are used to introduce air pores for the production of foamed concrete or concrete with porous cement paste. “

7.5.1 Foaming Agents in Concrete

Foaming agents mainly consist of synthetic, anionic and non-ionic surfactants. Among these are, for example, alkyl sulphates and polyglycol sulphates and amine oxides or betaines.

The substances used have little toxicity although they can irritate skin and mucous membranes and cause eye damage. They are thus classified H311, H302, H335, H315 and H318 as well as H319 and labelled with the danger pictogrammes „Attention“ or „Danger“. Betaines are classified „irritant“ and labelled with the danger symbol „Xi“.

The products are assigned to Water Hazard Class 2: Hazardous to water (self-assessment according to VwVwS). They may neither be led directly to sewage outfall drains nor to aquatic environments or the sewer system.

Surfactants harm aquatic organisms over the long term, the reason why foaming agents should not be allowed to penetrate into the ground or reach surface or ground water.

The synthetic surfactants used in foaming agents are predominately readily biodegradable and meet the requirements for detergents and cleaning agents.

Because of their concentration in foaming agents, the use of a preservative is often not necessary.
7.5.2 Foaming Agents as Concrete Admixtures

Foam is normally produced with the aid of a foaming agent in a foam generator. The quantity added is calculated according to the volume of foam to be produced. To produce 100 litres of foam, 0.1 to 0.2 litres of foaming agent is needed. The foam is then mixed into the mortar or concrete.

Foamed concrete or light-weight aerated concrete has an air pore content of more than 30% by volume as a rule.

7.5.3 Foaming Agents in Concrete

The make-up of surfactant molecules, which consist of a polar and a non-polar component, causes them to attach to the interface of cement paste and air in the concrete. The polar component acts as an active group and the non-polar component projects into the air pore.

7.6 Shrinkage Reducers

Shrinkage reducers are presently not governed by the building inspectorate in Germany. They are preferably used to significantly reduce shrinkage of the concrete while drying without changing water content.

7.6.1 Raw Materials for Shrinkage Reducers

Higher molecular glycols are the raw materials most used for shrinkage reducers.

This group of substances is found in the list of recognised substances for concrete admixtures EN 934-1, Annex A.1.

A typical representative of higher molecular glycols is dipropylene glycol. According to the CLP Regulation, dipropylene glycol does not need to be labelled.

Dipropylene glycol is used as an inactive carrier in cosmetics and, for example, in more than 900 medicines that are approved in Germany.

Acute toxicity of dipropylene glycol is very low. The LD$_{50}$ value, determined on rats, is 13,300 mg/kg. Skin resorption of harmful quantities is not likely, even with longer exposure. The LD$_{50}$ value determined on rabbits is greater than 5,000 mg/kg.

No sensitisation, carcinogenic effect or disturbance of the ability to reproduce could be proved in examinations of this substance.

Dipropylene glycol is readily biodegradable according to OECD and not harmful for aquatic organisms.
7.6.2 Shrinkage Reducers as Concrete Admixtures

Glycols or mixtures of glycols with a 100% active ingredient content are used as shrinkage reducers and added to concrete in quantities between 3 and 7 l/m³. Plasticizing concrete admixtures that contain glycol are also on the market and are added in quantities between 1 and 2% by mass related to cement.

7.6.3 Shrinkage Reducers in Concrete

Glycols are dissolved or dispersed in the pore water of fresh concrete. They lie in the hydrated cement matrix in hardened concrete and are bound in the capillary pore system through adsorption.

Examinations on the development of interior room air concentrations over time after release from screed mortars, which were executed in accordance with the AgBB Evaluation Scheme for VOC from building products issued by AgBB (Committee for health-Related evaluation of Building Products), showed very high room air concentration values for the shrinkage reducer used when there was a high water-cement value of approx. 0.65. This was determined during these examinations for this particular glycol after 3 and 28 days (examinations executed by the Fraunhofer Institute for Construction Physics, IBP 2011). These results cannot be simply transferred to concrete applications and other glycols or mixtures of glycols.

The development of room air concentration that is caused by glycols in concrete strongly depends on the composition of the glycol based shrinkage reducer, the composition of the concrete and the concentration of the active ingredients used.

The mobilisation of glycols through evaporation from the concrete also depends on the type of the glycols used and strongly decreases within a short period of time as a rule. After buildings are taken into service, the emission of glycols from the concrete in quantities worth mentioning are not to be expected.

8 CONCRETE ADMIXTURES WHEN RECYCLING CONCRETE

Old concrete is now being recycled more and more often. It is crushed and used as a road building material or as a mineral aggregate for producing concrete. Due to the immobility of all the firmly bound active concrete admixture ingredients, the conclusion can be drawn that there is no reason why old concrete should not be recycled. Fundamental research in this area has confirmed the good results that have been achieved in practice.
ANNEX 1: TOXICOLOGICAL AND ECO-TOXICOLOGICAL TERMS

additive
A substance that is added to other substances or products in small quantities to alter their properties in a certain way

alveoli-penetrating dust fraction
Dust fractions which, due to their very small particle size, can be not only inhaled but also reach the pulmonary alveoli (air cells) where they may be deposited

AMES test
A test on bacteria to determine the mutagenic properties of a chemical compound

aquatic
Pertaining to water; originating in water; found in water; living in water

BfR
German Institute for Risk Assessment: a scientific institute run by the Federal Republic of Germany that prepares expert opinions and statements on questions concerning the safety of foods and consumer health protection based on internationally recognised, scientific evaluation criteria (formerly BgW, German Institute for the Protection of Consumer Health and Veterinary Medicine).

biodegradable
The property of chemicals to convert (degrade) into simple, natural compounds (H₂O, CO₂, etc.) through naturally occurring enzymes of micro-organisms

carcinogen
Cancer-causing

[German] Chemical Act (ChemG)
German law on protection against hazardous substances

[German] Chemicals Prohibition Ordinance (ChemVerbotsV)
Ordinance on the prohibition and restriction of marketing hazardous substances, preparations and products that falls under the German Chemicals Act

CLP Regulation
European Regulation (EC) No. 1272/2008 with which the „Globally Harmonized System (GHS) of Classification, Labelling and Packaging of Chemicals“ issued by the United Nations has been implemented into European law

depot substance
Substances with a long-term effect

dermal
The uptake of substances through skin that is intact

DVGW
German Gas and Water Trade Association e.V., Bonn

EC₀
Highest tested concentration without effectiveness effect (EC = effective concentration)

EC₅₀
Concentration at which 50% of the examined individuals show the observed effects

EG, EU
Abbreviations for European Community/European Union
**eco-toxicology**
The science of the distribution and effects of chemical substances on organisms as far as direct or indirect damage to nature or humans results.

**embryo-toxic**
Harmful, toxic effect during the embryonal period.

**FDA**
[American] Food and Drug Administration

**gene-toxic**
A generic term for damage to the genome, i.e. the sum of genes in a cell.

**GHS**
Globally Harmonized System

Hazard statements (excerpt from GHS)
- H302 Harmful if swallowed.
- H311 Toxic in contact with skin.
- H314 Causes severe skin burns and eye damage.
- H315 Causes skin irritation.
- H317 May cause an allergic skin reaction.
- H318 Causes serious eye damage.
- H319 Causes serious eye irritation.
- H335 May cause respiratory irritation.
- H373 May cause damage to organs through prolonged or repeated exposure.
- H412 Harmful to aquatic life with long lasting effects.

Pictograms (excerpt from GHS)
- GHS05 Corrosive
- GHS07 Attention (health risk)
- GHS08 Danger (health hazard)

**GISBAU**
Hazardous substance information system maintained by the German construction industry trade association.

**GISCODE**
A classification system used by GISBAU for the classification of product groups according to their potential risk; for concrete admixtures, three product groups are distinguished:
- BZM 1 concrete admixture, labelling not mandatory
- BZM 2 concrete admixture, irritating
- BZM 3 concrete admixture, corrosive

**Gras status**
Abbreviation for „Generally recognized as safe“

**hazardous substance**
A substance that shows at least one of the so-called hazardous characteristics (e.g. toxic, harmful, corrosive, carcinogenic, genetic code altering, risk of explosion, fire-promoting, flammable).

**IC**
Abbreviation for „Inhibition Concentration“
immobilisation
The binding of a substance or a small particle to a solid matrix

inhalation
Intake of substances, particles, etc. through the respiratory tract

KBwS

LC0
Highest tested concentration without a lethal effect (LC = lethal concentration)

LD50 value
The lethal dose at which 50% of the experiment organisms die within a certain period of time.

MAC value
Maximum allowable concentration – the highest allowable concentration of a working material as a gas, vapour or suspended particle in air at the place of work.

maternal toxic
Toxic effect on the mother animal

matrix
In a chemical sense, the (rigid or highly viscous) sheathing material that encloses another (dissolved) material.

mutagenic
Property of an agent to cause irreversible change in genetic code.

NOEL
Abbreviation for „no observable effect level“; quantity of a substance which, when administered to an experiment animal, does not cause either functional or structural changes.

OECD
Abbreviation for „Organisation of Economic Cooperation and Development“

oral
Intake of substances, particles, etc. through the mouth

[German] Ordinance on Hazardous Substances (GefStoffV)
German ordinance on protection against hazardous substances

pH value
The negative decimal logarithm of hydrogen ion concentration in an aqueous medium. pH 7 indicates a neutral reaction, pH values <7 stand for acidic, pH values >7 for alkaline reactions

polymers
Synthetic products that result through polymerisation, i.e. through a chemical process in which many small molecules of one or more substances assemble into large molecules with new properties

raw materials
Basic materials that are vegetable, animal, mineral or chemical in origin for the purpose of further processing
reproduction toxic
Influence of harmful chemical and physical effects on reproduction

sensitisation
Administration of an exogenic substance to an organism which then shows a specific, changed reaction if the substance is repeatedly administered or is brought in contact with the organism. Sensitisation precedes an allergy.

sewage outfall drains
Flowing water that can be used to take up water from drainage systems from industry and households or from sewage disposal works

solvents
Substances that are used to dissolve, dilute, emulsify or suspend other substances so that these substances can be worked or removed. Solvents are liquid under normal conditions.

sub-acute
A characterisation of the toxicity of a chemical substance within a testing period of a max. of 28 days

teratogenic
The ability of an agent, through the effect of a sufficient dose, to cause congenital deformity

toxicology
The science of disturbances in living systems caused by substances, i.e. toxic effects

TRGS
[German] Technical Regulations for Hazardous Substances

VwVwS
[German] Administration rules for substances hazardous to water

[German] Water Hazard Class
German abbreviation: WGK. Designation for a system consisting of three classes to characterise the degree of hazardousness of substances

WGK 1: slightly hazardous to water
WGK 2: hazardous to water
WGK 3: very hazardous to water

In Germany, substances that are not deemed hazardous to water are designated „not hazardous to water“ („nwg“) and are found in a „List of Substances Not Hazardous to Water“ issued by the German Federal Environment Office.
ANNEX 2: BIBLIOGRAPHY

1 In General

1.1 Toxikologie – Eine Einführung für Naturwissenschaftler und Mediziner

1.2 The Handbook of Environmental Chemistry
Hutzinger, O.; Springer-Verlag, Berlin – Heidelberg – New York

1.3 VCI-Broschüre „Kriterien zur Produktbewertung“
VCI, Frankfurt/Main (1997)

1.4 Fixation des adjuvants de type polynaphthalène ou polymélamine sulfonate
dans les mortiers et bétons
Pollet, B., Germaneau, B., Defossé, C.
Materials and Structures/Materiaux et Constructions, Vol. 30, December 1997,
pp 627–630

1.5 Interaction of Calcium Lignosulfonate with Tricalcium Silicate, Hydrated
Tricalcium Silicate, and Calcium Hydroxide
Ramachandran, V. S.
Printed in the United States.

1.6 Influence of sulphonated melamine formaldehyde superplasticizer on cement
hydration and microstructure
Yilmaz, V. T., Glasser, F. P.

1.7 Interactions Between Cement Minerals and Hydroxyacrylic-Acid
Retarders: I. Apparent Adsorption of Salicylic Acid on Cement and Hydrated
Cement Compounds
Sidney Diamond, Journal of The American Ceramic Society, Vol. 54, No. 6,
S. 273–276, June 1971

1.8 Early Hydration of Tricalcium Aluminate-Gypsum Mixtures in the Presence of
Sulphonated Melamine Formaldehyde Superplasticizer
Yilmaz, V.T., Glasser, F. P.

1.9 Effect of Admixture on Hydration of Cement, adsorptive behavior of
Admixture and fluidity and setting of fresh Cement Paste
Uchikawa, Hiroshi, Hanehara, Shunsuke Shirasaka, Tokuhiko, Sawaki, Daisuke.

1.10 Adsorption Characteristics of Sulfonated Melamine Formaldehyde
Condensates by high performance Size Exclusion Chromatography
Cunningham, J. C., Dury, B. L., Gregory, T.

1.11 The Degradation of Cement Superplasticizers in a high Alkaline Solution
Yilmaz, V. T., Odabasoglu, M., Icbudak, H., Ölmez, H.
Cement and Concrete Research, Vol. 23, pp. 152–156, 1993

1.12 Adsorption of Admixtures on Portland Cement, Hydration Products
Rossington, D. R., Runk, Ellen J.

1.13 The Effect of Calcium Sulphate Concentration of the Adsorption of a
Superplasticizers on a Cement: Methods, Zeta Potential and Adsorption Studies
Andersen, P. J., Kumar, A., Roy, D. M., Wolfe-Confer, D., Cement and Concrete

1.14 Measurement of the amount of adsorbed organic Admixture using ultra
violet Spectrophotometry
Uchikawa, H., Uchida, S., Ogawa, K.
il cemento 4 / 1985, S. 211–220

1.15 The Effects of Adsorption of Superplasticizers on the surface of Cement
Andersen, P. J., Roy, D. M., Gaidis, J. M.
1.16 Portland Cement Dispersion by Adsorption of Calcium Lignosulfonate
Ernberger, Fred M., France, Wesley G.
Industrial and Engineering Chemistry, Vol. 37, No. 6, 1945, S. 598–600

1.17 Interaction Between Superplasticizers and Calcium Aluminate Hydrates
Massazza, F., Costa, U., Barrila A.

1.18 Dégradation et migration d'adjuvants des matériaux a base de ciment
Zhang, M., Leroy, P., Danjou, J., Rauzy, S.

1.19 Adsorption of Superplasticizers on b-C2S – Change in Zeta Potential of Particles and the Rheology of Pastes
Costa, Umberto, Massazza, Franco
Il cemento 3 / 1984, S. 127–140

1.20 Study of Sorption of Ligninsulphonates on the Limiting Surface of Cement Particles and Intergrain Solution

1.21 Adsorption of Admixtures on Portland Cement

1.22 Beton – keine Gefahr für Boden und Grundwasser
Mayer, L; Beton- und Stahlbetonbau 89 (1994), Heft 3, 64–69

1.23 Freisetzung flüchtiger Substanzen aus zementgebundenen Bauprodukten (Teil1)
Spanka, G, Thielen, G; Beton 2 / 99, 111–114

1.24 Freisetzung flüchtiger Substanzen aus zementgebundenen Bauprodukten (Teil2)
Spanka, G, Thielen, G; Beton 3 / 99; 173–177

1.25 Untersuchungen zum Nachweis von verflüssigenden Betonzusatzmitteln und zu deren Sorptions- und Elutionsverhalten
Spanka, G, Thielen, G; Beton 5 / 95; 320–327

1.26 Freisetzung von umweltrelevanten organischen Bestandteilen aus Betonen mit Betonzusatzmitteln
Forschungsbericht F 587; ibac Institut für Bauforschung Rheinisch-Westfälische Technische Hochschule Aachen;
W. Brameshuber, S. Uebachs; 05.07.2000

1.27 Umweltverträglichkeit von Baustoffen

1.28 Environmental compatibility of cement-based building materials
P. Schießl, I. Hohberg, Proceedings of the 12th European Ready Mixed Concrete Congress; Lissabon 1998; 236-245

1.29 Assessment of environmental compatibility of concrete admixtures
R. Gälli, M. Ochs, U. Mäder; Proceedings of the 12th European Ready Mixed Concrete Congress; Lissabon 1998; 258-266

1.30 Concrete admixtures and the environment
H. G. Hauck; Proceedings of the 12th European Ready Mixed Concrete Congress; Lissabon 1998; 267–281

1.31 Environmental Impact of Superplasticizers
R. Gälli, G. Kiayias; Internationale Zeitschrift für Bauinstandsetzen (2) 1996; S; 427-448

1.32 Environmental Exposure Assessment of Sulfonated Naphthalene Formaldehyde Condensates and Sulfonated Naphthalenes Applied as Concrete Superplasticizers
S. Ruckstuhl; Dissertation No. 14477; ETH Zürich; 2001

1.33 Sachstandsbericht – Umweltverträglichkeit zementgebundener Baustoffe
I. Hohberg u. a.; Hrsg.: Deutscher Ausschuss für Stahlbeton (DAfStb); Heft 458, Beuth Verlag, Berlin 1996
1.34 Sachstandsbericht - Nachhaltig Bauen mit Beton
H. W. Reinhard u. a.; Hrsg.: Deutscher Ausschuss für Stahlbeton (DAfStb); Heft 521, Beuth Verlag, Berlin 2001

1.35 Forschungsbericht „Einfluss von Stabilisatoren auf die Porenstruktur und die Dauerhaftigkeit von Beton“ vom 13.01.2003, ibac, Institut für Bauwissenschaft, Aachen

1.36 Concretes of the Future: The Impact of Concrete Admixtures on the Environment,
R. Gälli, M. Ochs, U. Mäder; Proceedings of the 12th European Ready Mixed Concrete Congress; Lissabon 1998; 258-266

1.37 Umwelterklärungen für Fließmittel und Betonverflüssiger, (Environmental declarations June 2002), www.efca.info

1.38 Deutsches Institut für Bautechnik (DIBt): Grundsätze zur gesundheitlichen Bewertung von Bauprodukten in Innenräumen. Oktober 2008


1.42 O. Ilvonen; D. Kirchner: Europäische Harmonisierung der Prüfnormen für die Freisetzung gefährlicher Stoffe aus Bauprodukten – auf dem Weg zu einer CE-Kennzeichnung mit Emissionsklassen. DIBt-Mitteilungen 4/2010

1.43 Schwerdt, R.; Schwaitalla, Ch., Scherer, Ch.: Umwelteigenschaften mineralischer Werkmörtel. Fraunhofer-Institut für Bauphysik. IBP-Bericht 2011

1.44 Schröter, N., Fischer, P; Entwicklungen und Trends bei Betonzusatzmitteln. beton Heft 6/2010

1.45 TRGS 900 Technische Regeln für Gefahrstoffe, Arbeitsplatzgrenzwerte, Januar 2006


2 Lignosulphonates

- 2.1 AIDA-Grunddatensatz zu Natriumligninsulfonat, Hersteller: Bayer AG
- 2.2 Kenndaten für Ligninsulfonate, Inhaltsverzeichnis und Kurzfassung von Originalberichten von Lignotech GmbH
- 2.3 LC₅₀-Bestimmung einer Sulfitablauge an Goldorfen (leuciscus idus) Institut für gewerbliche Wasserwirtschaft und Luftreinhaltung e.V.
- 2.4 Bakterienaktivität in aquatischen Systemen Institut für gewerbliche Wasserwirtschaft und Luftreinhaltung e.V.
- 2.5 Die akute Giftigkeit von Ligninsulfonaten bei Ratten Huntington Research Center
- 2.6 Untersuchung von Holmen-Produkten auf ihre biologische Abbaubarkeit mittels statischem Test nach DIN 38412, Teil 25 Technische Hochschule Darmstadt
- 2.7 Retention und biologische Abbaubarkeit eines Leimpressmittels auf Ligninsulfonatbasis, Wochenblatt für Papierfabrikation 11/12,1988
- 2.8 Ökologie, Abbaubarkeit in Wasser
- 2.9 Lignin-Makromolekül, Zellwandkomponente, Rohstoff Institut für Holzforschung der Universität München
- 2.10 Untersuchung der Probe „Welltex“ (Calciumligninsulfonat) Forschungs- und Materialprüfungsanstalt Baden-Württemberg, Chemisch-Technisches Prüfamt Karlsruhe
- 2.11 Schreiben des Swedish Pulp and Paper Research Institutes vom 06.10.88 (auf schwedisch)
- 2.12 Produktionsschema Ligninsulfonat von Lignotech GmbH
- 2.13 Ligninsulfonat-Tariflierungen
- 2.14 Code of Federal Regulations, USA
- 2.15 Brenn- und Explosionsgrößen von Laugepulver „Lignex BC 100“ Westfälische Berggewerkschaftskasse, Bergbauversuchsstrecke
- 2.16 Huminifizierung von Ligninsystemen und Ligninsulfonaten als Düngemittel Hersteller: Lignotech GmbH
- 2.17 Mutagenitätstest (Ames-Test) Zentrales Institut für Industrielle Forschung, Oslo
- 2.18 Unbedenklichkeitsbescheinigung Sulfitablauge F/G, Hygieneinstitut des Ruhrgebiets, Gelsenkirchen
- 2.19 Report on a Study of the Acute Toxicity for Fish of Borresperse CA Battelle-Institut e.V., Frankfurt
- 2.20 Report of a Study on the Determination of Toxicity on Water Microorganisms Battelle-Institut e.V., Frankfurt
- 2.21 Assessment of the acute oral toxicity of „Borresperse NH“ to rats Scantox Biological Laboratory Ltd.
- 2.22 Primary Skin Irritation according to OECD Guideline No. 404, 1981 Scantox Biological Laboratory Ltd.
- 2.23 Study on the Inherent Biodegradability of Borresperse NH Battelle-Institut e.V., Frankfurt
- 2.24 Study of eye irritation of „Borrebond“ to rabbits, Scantox Biologisk Laboratorium A/S
- 2.25 Stellungnahme über die Eignung von Werkstoffen bezüglich der Korrosionen unter Einwirkung von Ligninsulfonat (pH-Wertbereich 3–11) TÜV Südwest, Karlsruhe
- 2.26 Report on a Study of the Inherent Biodegradability of Borresperse NA Battelle-Institut e.V., Frankfurt
- 2.27 Liquid lignosulfonate (Borregaard, Norway) – Environmental Declaration NEPD nr: 134N (approved according to ISO14025, January 13, 2010)

3 Naphthalinsulfonate

- 3.1 Einstufung eines Produktes in eine Wassergefährdungsklasse (Rütament 310 N) Institut Fresenius
3.2 Einstufung eines Produktes in eine Wassergefährdungsklasse (Rütament 310 C; Calciumsalz) Institut Fresenius

3.3 Acute Toxicity Study in Fish (semi-static test), Exp. No. 900460, Flube OS 39
RBM Istituto di Ricerche Biomediche, Italia

3.4 Acute Immobilization Study in Daphnia Magna, Exp. No. 900461
RBM Istituto di Ricerche Biomediche, Italia

3.5 Acute Oral Toxicity Study in Rats, RBM Exp. No. 940675
RBM Istituto di Ricerche Biomediche, Italia

3.6 Biologische Abbaubarkeit nach OECD 301 E, Flube OS 39
Giovanni Bozzetto S.p.A.

3.7 Biologische Abbaubarkeit nach der modifizierten Version des Zahn-Wellens-Tests, Flube OS 39
Giovanni Bozzetto S.p.A.

3.8 Löslichkeit nach OECD 105 (Flask method) (Wasser), Flube OS 39
Giovanni Bozzetto S.p.A.

3.9 Acute dermal irritation study in rabbits (occlusive patch), RBM Exp. No. 940676, Flube OS 39
RBM Istituto di Ricerche Biomediche, Italia

3.10 Zusammenfassung von Versuchsergebnissen
Giovanni Bozzetto S.p.A., Filago 23.09.94

3.11 Sicherheitsdatenblatt gemäß 91 / 155 / EWG, Flube OS 39
Hersteller: Giovanni Bozzetto S.p.A.

3.12 Acute Eye Irritation Study in Rabbits, RBM Exp. No. 940677, Flube OS 39
RBM Istituto di Ricerche Biomediche, Italia

3.13 AMES TEST, Exp. No. 940678, Flube OS 39
RBM Istituto di Ricerche Biomediche, Italia

3.14 Bestimmung des Verteilungskoeffizienten n-Oktaol/Wasser nach OECD
107 für Flube OS 39
Giovanni Bozzetto S.p.A.

3.15 WGK-Einstufung, UBA, Juni 1997

3.16 EG-Sicherheitsdatenblatt Tamol* NH 3703
Hersteller: BASF AG, 12.02.2003

4 Melamine sulphonates

4.1 Bestimmung der akuten oralen Toxizität von Melment F 10 in Ratten
TNO-Institut, Niederlande

4.2 Primäre Haut- und Schleimhautverträglichkeit mit 2 Mustern „SKW Melment“
TNO-Institut, Niederlande

4.3 Acute inhalation toxicity study with Melment F10 in rats
TNO-Institut, Niederlande

4.4 Bericht über das toxikologische Gutachten U 166 Melment L 10
Universität Lüttich

4.5 Trinkwasserverträglichkeit von Beton mit Melment L10 A Liquid
United States Environmental Protection Agency, Washington D.C., USA

4.6 Trinkwasserverträglichkeit von Beton mit Melment F 10 Powder
United States Environmental Protection Agency, Washington D.C., USA

4.7 Gutachtliche Stellungnahme zur Verwendung des Fließmittels Melment L 10 bei der Herstellung des Betons für die wasserseitige Verstärkungsschale der Staumauer Oletalsperre
Rheinisch-Westfälische Technische Hochschule, Aachen

4.8 Bestimmung der Formaldehydabgabe von einer Verbundplatte
Fraunhofer-Institut für Holzforschung, Braunschweig

4.9 Evaluation of Melment F 10 in the salmonella-microsome mutagenicity test
TNO-Institut, Niederlande

4.10 Subacute 28-day oral toxicity with Melment F 10 by daily gavage in the rat
RCC Notox, Niederlande
4.11 Ready biodegradability: modified Sturmtest with Melment F 10
RCC Notox, Niederlande
4.12 The effect of Melment F 10 on the growths of the bacterium pseudomonas
putida (Bakterientoxizität)
TNO-Division of Technology for Society
4.13 The acute toxicity of Melment F 10 to leuciscusidus (Goldorfe)
TNO-Division of Technology for Society
4.14 Determination of the water solubility of Melment F 10,
RCC Notox, Niederlande
4.15 Determination of the partition coefficient (NOctanol/water) of Melment F 10
4.16 EG-Sicherheitsdatenblatt Melment F 10
4.17 EG-Sicherheitsdatenblatt Melment L 10 / 20 %; Melment L10 / 40 %
Hersteller: BASF Construction Polymers GmbH, 10.08.2008
4.18 EG-Sicherheitsdatenblatt Melment L 15 / 40 %
Hersteller: BASF Construction Polymers GmbH, 10.08.2008
4.19 EG-Sicherheitsdatenblatt Melment F 15
Hersteller: BASF Construction Polymers GmbH, 08.08.2008
4.20 Melment L 10 / 40 %: Acute dermal irritation test in the rabbit
SafePharm Laboratories Limited, Project number 524 / 8, Report of September
1993
4.21 Melment L 10 / 40 %: Acute eye irritation test in the rabbit
SafePharm Laboratories Limited, Project number 524 / 9, Report of March 1994
4.22 Melment in Concrete – Long Term Behaviour and Selected Case Histories
Aignesberger, A. and Reichert, J.
Superplasticizers in Concrete, Vol. I, Proceedings of an International Symposium,
held in Ottawa, Canada, 29–31 May 1978
4.23 Bestimmung der Formaldehyd- und Ammoniakabgabe an Betonplatten
Prüfbericht Nr. B2000 / 93: FhG-WKI Wilhelm-Klauditz-Institut, Fraunhofer-
Arbeitsgruppe für Holzforschung vom 6.5.1993
4.24 Chemische Untersuchung des Zusatzmittels Melment L 10 / 20 %, der
Flugaschen und des Zements HK 40 nach der Norm NBN S 29.004
Prüfbericht Nr. 726 / 92 der Universität Lüttich vom 23. Juli 1992
4.25 MELMENT: Toxikologische und ökotoxikologische Bewertung beim Einsatz
als Betonzusatzmittel
Dipl.-Chem. Prof. Dr. med. Christian Gloxhuber, 17.3.1995
4.26 Elektronenmikroskopische Studien der Erhärtungsvorgänge von Zement mit
Zusätzen von Melaminharzen
Aignesberger, A., Rey, Th. und Schräml, W.
Zement-Kalk-Gips 22 (1969), Heft 7, Seiten 297–305
4.27 Langzeitverhalten eines Betons mit Zusatz eines anionischen Melamin-
Formaldehyd-Kondensationsproduktes
Aignesberger, A. und Rosenbauer, H.–G.
Tonind.-Ztg. 97 (1973), Heft 8, Seiten 205–207
4.28 Bericht über die Durchführung von Arbeitsplatzmessungen
(Expositionsmessungen) gemäß TRGS 402 beim Betonieren einer Bodenplatte
(im Freien) unter Verwendung Fließmittel Melment L 10 / 40 %; Auftrags-Nr.
98 / 13545–00; 30.06.1998.
Institut Fresenius, Geschäftsbereich Fresenius Umwelt Consult, Taunusstein
4.29 Bericht über die Durchführung von Arbeitsplatzmessungen
(Expositionsmessungen) gemäß TRGS 402 beim Betonieren einer Bodenplatte
(Halle) unter Verwendung
Fließmittel Melment L 10 / 40 %; Auftrags-Nr. 98/13545–00; 30.06.1998.
Institut Fresenius, Geschäftsbereich Fresenius Umwelt Consult, Taunusstein
4.30 Bericht über die Durchführung von Arbeitsplatzmessungen
(Expositionsmessungen) gemäß TRGS 402 bei der Herstellung von
Betonfertigteilen bezüglich Formaldehyd; Auftrags-Nr. 98/13545–00; 30.06.1998.
Institut Fresenius, Geschäftsbereich Fresenius Umwelt Consult, Taunusstein
5 Gluconates
- 5.1 Scientific literature reviews on generally recognized as safe (GRAS food ingredience) – gluconate salt
  NTIS – National Technical Information Service, US-Department of Commerce
- 5.2 Evaluation of the health aspects of sodium, potassium, magnesium, and zinc gluconates as food ingredience, Life Sciences Research Office, Federation of American Societies for Experimental Biology
- 5.4 EG Sicherheitsdatenblatt Natriumgluconat, Hersteller: Jungbunzlauer S.A., 26.01.2011

6 Polycarboxylates
- 6.1 Technical Information Narlex LD-36 V
  Hersteller: National Starch and Chemical Ltd.
- 6.2 Safety Data Sheet Narlex LD-36 und Narlex LD-36 V
  Hersteller: National Starch and Chemical Ltd.
- 6.3 EG-Sicherheitsdatenblatt Melflux 2453 L/30%
  Hersteller: BASF Construction Polymers GmbH, 23.08.2008
- 6.4 EG Sicherheitsdatenblatt Melflux 2500 L/30%
  Hersteller: BASF Construction Polymers GmbH, 25.08.2008
- 6.5 EG-Sicherheitsdatenblatt MIGHTY 21 ES,
  Hersteller: Kao Chemicals GmbH, 03.08.2004
- 6.6 EG-Sicherheitsdatenblatt ViscoCrete-20 Gold,
  Hersteller: Sika Deutschland GmbH, 09.01.2009
- 6.7 EG-Sicherheitsdatenblatt ViscoCrete-1020 X,
  Hersteller: Sika Deutschland GmbH, 08.12.2008
- 6.8 EG-Sicherheitsdatenblatt ViscoCrete-20 HE,
- 6.9 EG-Sicherheitsdatenblatt ViscoCrete-1050,
  Hersteller: Sika Deutschland GmbH, 07.09.2010

7 Polyglycol ether
- 7.1 EG-Sicherheitsdatenblatt Polyglykol 35000 S
  Hersteller: Clariant GmbH, 30.06.2004
- 7.2 EG-Sicherheitsdatenblatt Polymerisationsprodukt aus Propylenoxid und Ethylenoxid (Genapol PF 80 Pulver)
  Hersteller: Clariant GmbH, 12.07.2004
- 7.3 EG Sicherheitsdatenblatt Dipropylenglykol,
  Hersteller: Brenntag GmbH, 19.01.2010

8 Root resins
- 8.1 Material Safety Data Sheet Vinsol Resin, solid, flaked or pulverized,
  Hersteller: Hercules Incorporated, Wilmington, USA
- 8.2 Material Safety Data Sheet Vinsol NVX and MM Resins Sodium Resinate
  Hersteller: Hercules Inc., Wilmington, USA
- 8.3 MSDS Vinsol NVX
  Hersteller: Hercules International Trade Corporation, 10.08.2003
- 8.4 Sicherheitsdatenblatt Vinsol Resin Wurzelharz (Kolophonium)
  Hersteller: Hercules International Trade Corporation
- 8.5 Sicherheitsdatenblatt zu Sacopor DH 30/S (Seifen von Harzsäuren)
  Hersteller: Krems Chemie
- 8.6 Sicherheitsdatenblatt zu Kolophonium (Balsamharz)
  Lieferant: Willers, Engel & Co., Hamburg
- 8.7 EG Sicherheitsdatenblatt Kolophonium,
  Hersteller: Caesar & Loretz GmbH, 10.02.2010
9 Surfactants

9.1 Aufstellung über toxische und ökotoxische Daten zu Alkoholethersulfaten, a-Olefi nsulfonaten, Nonylphenol-Ethoxylaten TEGEWA

9.2 EG-Sicherheitsdatenblatt Lutensit* A-LBN 50, Hersteller: BASF AG, 06.04.2004


9.5 EG Sicherheitsdatenblatt Natriumdecylsulfat, Hersteller: Sigma–Aldrich Chemie GmbH, 05.08.2011


9.7 EG Sicherheitsdatenblatt TEXAPON KE 3347, Hersteller: Cognis GmbH, 15.10.2010

10 Cellulose / starch ether, polysucrose

10.1 EG-Sicherheitsdatenblatt Methylhydroxyethylcellulose (Tylose MH 6000 YP2) Hersteller: SE Tylose GmbH & Co. KG, 29.01.2004

10.2 EG-Sicherheitsdatenblatt Methylhydroxyethylcellulose (Tylose MH 10000 YP2) Hersteller: SE Tylose GmbH & Co. KG, 29.01.2004

10.3 EG-Sicherheitsdatenblatt Hydroxyethylcellulose (Tylose H 20 P2) Hersteller: SE Tylose GmbH & Co. KG, 29.01.2004

10.4 Toxicological evaluation of certain food additives and contaminants World Health Organisation, Geneva, 1990

10.5 Final report on the safety assessment of hydroxyethylcellulose, hydroxypropylcellulose, methylcellulose, hydroxypropylmethylcellulose and cellulose gum, Journal of the American College of Toxicology

10.6 EG-Sicherheitsdatenblatt zu Methylhydroxypropylcellulose Walocel MK 3000 PF, Hersteller: Wolff Walsrode AG, 15.07.2004

10.7 EG-Sicherheitsdatenblatt Natriumcarboxymethylcellulose Walocel CRT100, Hersteller: Wolff Walsrode AG, 15.07.2004

10.8 EG-Sicherheitsdatenblatt Kelco-Crete 200, CP Kelco Germany GmbH, 15.04.2003

10.9 EG-Sicherheitsdatenblatt Xanthan-Gum, CP Kelco Germany GmbH, 01.06.2004

10.10 EG-Sicherheitsdatenblatt Kelco-Crete K1A96, CP Kelco Germany GmbH, 25.03.2004

10.11 EG-Sicherheitsdatenblatt WALOCEL CRT 4000 GA Sodium (Carboxymethylcellulose), Hersteller: Dow Wolff Cellulosics GmbH, 21.12.2010

11 Poly(ethylene)oxides and polyacrylates

11.1 EG-Sicherheitsdatenblatt Polyox WSR 301, Hersteller: DOW Deutschland GmbH & Co. OHG, 24.08.2004

11.2 EG-Sicherheitsdatenblatt Polyox WSR N-750, Hersteller: DOW Deutschland GmbH & Co. OHG, 24.08.2004

11.3 EG-Sicherheitsdatenblatt Rohagit SD15, Hersteller: Polymer Latex GmbH & Co. KG, 13.07.01

12 Silica dust, silica suspension, kieselsol

12.1 EG-Sicherheitsdatenblatt Silikastaub „Elkem Mikrosilica Grade 920-940 D (ST), BASF Construction Polymers GmbH, 07.06.2004

12.2 EG-Sicherheitsdatenblatt Kostrosol, Chemiewerk Bad Köstriz GmbH, 30.04.2004

12.3 EG-Sicherheitsdatenblatt Levasil, H.C. Stark GmbH, 2.04.2003
13 Sugar

14 Phosphates

- 14.1 EG-Sicherheitsdatenblatt Natriumhexametaphosphat
  Hersteller: Biesterfeld Chemiedistribution GmbH, 19.02.2003
- 14.2 EG-Sicherheitsdatenblatt Tetrakaliumpyrophosphat
  Hersteller: Prayon Deutschland GmbH, 10.04.2002
- 14.3 EG-Sicherheitsdatenblatt Tetrakaliumpyrophosphat, Lösung 60%
  Hersteller: Prayon Deutschland GmbH, 12.05.2004
- 14.4 Angaben zu Alkaliphosphaten für Beton und Mörtelzusatzmittel,
  Chemische Fabrik Budenheim, Rudolf A. Oetker
- 14.5 EG-Sicherheitsdatenblatt Tetrakaliumdiphasphat (TARGON 34)
  Hersteller: BK Giulini GmbH, 22.02.2005
- 14.6 EG-Sicherheitsdatenblatt Pentanatriumtriphosphat (TARGON TM)
  Hersteller: BK Giulini GmbH, 24.03.2010
- 14.7 EG-Sicherheitsdatenblatt Natriumtripolyphosphat Plv.
  Hersteller: BK Giulini GmbH, 27.09.2010
- 14.8 EG-Sicherheitsdatenblatt Tetrakaliumpyrophosphat Granulat
- 14.9 EG-Sicherheitsdatenblatt Natriumhexametaphosphat
  Hersteller: BK Giulini GmbH, 06.04.2009
- 14.10 EG-Sicherheitsdatenblatt Natriumtriphosphat Pulver
  Hersteller: BK Giulini GmbH, 23.01.2009
- 14.11 EG-Sicherheitsdatenblatt Natriumhexametaphosphat Plv.

15 Silicates

- 15.1 Chemische, toxikologische und ökologische und rechtliche Aspekte bei
  Herstellung, Transport, Handhabung und Anwendung von löslichen Alkali-
  silikaten („Wasserglas“), CEES (Europäisches Zentrum für Silikatforschung), 2000
- 15.2 Wässrige Silikatprodukte – Darstellung der toxikologischen und umwelt-
  relevanten Eigenschaften, W. Rieber, Woellner Silikat GmbH, April 2001
- 15.3 DIN-Sicherheitsdatenblatt Natronwasserglas, filtr. 37 / 40,
  Hersteller: van Baele & Co., Chemische Fabrik, 08.08.2002
- 15.4 Technisches Merkblatt Flüssige Natronwassergläser,
  Hersteller: van Baele & Co., Chemische Fabrik
- 15.5 Datenblatt für Altstoffe: Kieselsäure, Natriumsalz
  Hersteller: Henkel KGaA
- 15.6 Datenblatt für Altstoffe: Kieselsäure, Kalium-Salz
  Hersteller: Henkel KGaA
- 15.7 Soluble silicates
  American Chemical Society Symposium Series 194, 1982
- 15.8 Ergänzende Angaben zur Toxikologie und Ökotoxikologie von Silikaten
  Woellner-Werke GmbH & Co.
- 15.9 EG-Sicherheitsdatenblatt Natronwasserglas 40 / 42
  Hersteller: Woellner-Werke GmbH & Co., 19.06.2002
- 15.10 EG-Sicherheitsdatenblatt Natronwasserglas 48 / 50
  Hersteller: Woellner-Werke GmbH & Co., 17.06.2002
- 15.11 Daten zur toxikologischen und ökotoxikologischen Bewertung von
  Alkalisilikaten (Molverhältnis SiO2 :Me2O >3,3)
  Hersteller: Woellner-Werke GmbH & Co.
- 15.12 Wasserglas (Na-Silikat). Ökologische und toxikologische Daten für die
  Mindestbewertung vom 14.10.94, Henkel KGaA
- 15.13 Gegenüberstellung der Einstufungen löslicher Silikate und Pulver nach der
  CLP-Verordnung und der Richtlinie 67 / 548 / EWG, CEES Europäisches Zentrum für
  Silikatforschung, Oktober 2010
16 Aluminates
- 16.1 EG-Sicherheitsdatenblatt Natriumaluminat 53 / 55 fein
  Hersteller: BK Giulini GmbH, 04.11.2004
- 16.2 EG-Sicherheitsdatenblatt Natriumaluminat
  Hersteller: BK Giulini GmbH, 08.09.2009

17 Aluminium sulphates
- 17.1 EG-Sicherheitsdatenblatt Aluminiumsulfat 17 / 18 %
- 17.2 EG-Sicherheitsdatenblatt Aluminiumsulfat 22 / 23 %
  Hersteller: BK Giulini GmbH, 02.11.2009
- 17.3 EG-Sicherheitsdatenblatt Aluminiumsulfat wasserfrei
  Hersteller: BK Giulini GmbH, 02.11.2009

18 Carbonates
- 18.1 Grunddatensatz für Altstoffe Natriumcarbonat, Soda
- 18.2 EG-Sicherheitsdatenblatt Soda kalzinierter
  Hersteller: BASF AG, 21.02.2003
- 18.3 Technisches Merkblatt schwere Soda
  Hersteller: Solvay Soda Deutschland GmbH & Co. KG, 08/2003
- 18.4 EG-Sicherheitsdatenblatt Natriumcarbonat, schwere Soda
  Hersteller: Solvay Chemicals GmbH, 03.05.2004
- 18.5 EUCLID Data Sheet (Grunddatensatz) Sodium Carbonate Solvay S.A.
  (Ausgabe 06.06.94)
- 18.6 EG-Sicherheitsdatenblatt Kaliumcarbonat
  Hersteller: Sigma-Aldrich GmbH, 18.12.2010
- 18.7 EG-Sicherheitsdatenblatt Sodium carbonate
  Hersteller: Sigma-Aldrich GmbH, 01.09.2010
- 18.8 EG-Sicherheitsdatenblatt Kaliumcarbonat >=99 %, Ph.Eur.,
  Hersteller: Carl Roth GmbH & Co. KG, 29.07.2011
- 18.9 EG-Sicherheitsdatenblatt Natriumcarbonat >=99,5 %, Ph.Eur., USP, BP,
  wasserfrei, Hersteller: Carl Roth GmbH & Co. KG, 31.01.2011

19 Formates
- 19.1 AIDA-Grunddatensatz Formic acid, calcium salt,
  Hersteller: LANXESS Deutschland GmbH (ehem. Bayer AG)
- 19.2 EUCLID Data Sheet (Grunddatensatz) Calcium Diformiate
  (neue Ausgabe 28.09.94)
  LANXESS Deutschland GmbH (ehem. Bayer AG)
- 19.3 Angaben zur Toxikologie und Ökotoxikologie von Calciumformiat
  Schriftliche Mitteilung von Degussa
- 19.4 Broschüre Calciumformiat, Einsatz in der Tierernährung,
  Hersteller: Degussa
- 19.5 AIDA-Grunddatensatz Formic acid, sodium salt,
  Hersteller: Hüls AG
- 19.6 AIDA-Grunddatensatz Formic acid (7 Cl, 8 Cl, 9 Cl),
  Hersteller: BASF AG
- 19.7 Kurzbericht Ameisensäure (Zusammenfassung der o. g. AIDA
  Grunddatensätze)
  Hersteller: LANXESS Deutschland GmbH (ehem. Bayer AG)
- 19.8 Product Data Sheet Calcium formate,
  Hersteller: Perstorp, 01.06.2000
- 19.9 EG-Sicherheitsdatenblatt Calcium formate,
  Hersteller: Perstorp, 01.06.2000
- 19.10 Product Data Sheet Prosid CF30,
  Hersteller: Perstorp, 01.06.2000
- 19.11 EG-Sicherheitsdatenblatt Prosid CF30,
  Hersteller: Perstorp, 14.11.2003
20 Metal soaps
- 20.1 EG-Sicherheitsdatenblatt LIGA Kaliumoleat 60
  Hersteller: Peter Greven Fettchemie GmbH & Co. KG, 29.05.2002
- 20.2 EG-Sicherheitsdatenblatt LIGA Natriumoleat 90%, 90 % F
  Hersteller: Peter Greven Fettchemie GmbH & Co. KG, 26.09.2002
- 20.3 EG-Sicherheitsdatenblatt LIGA Sprühseife IS/F, IS/G, IS/M, LIGA Stearat N41
  Hersteller: Peter Greven Fettchemie GmbH & Co. KG, 06.04.2000
- 20.4 EG-Sicherheitsdatenblatt LIGA Zinkstearat 101
  Hersteller: Peter Greven Fettchemie GmbH & Co. KG, 07.08.2002
- 20.5 EG-Sicherheitsdatenblatt LIGAFLUID CA 50 F
  Hersteller: Peter Greven Fettchemie GmbH & Co. KG, 14.02.2003
- 20.6 EG-Sicherheitsdatenblatt Calciumstearatdispersion CC 50 EF
  Hersteller: ELBE Fetthandel GmbH
- 20.7 Comparative toxicity of metal stearates
  International Archives of Occupational and Environmental Health, Springer-Verlag 1976
- 20.8 Ökotoxikologische Daten zu Calciumstearat und Zinkstearat, TÜV Bayern
- 20.9 EG Sicherheitsdatenblatt Calciumstearat,
  Hersteller: F.B. Silbermann GmbH & Co. KG, 09.09.2008

21 Metal powders
- 21.1 EG-Sicherheitsdatenblatt Standardaluminiumpulver, Aluminiumpigmente
  pulverförmig,
  Hersteller: Eckart GmbH & Co. KG, 13.01.2005
- 21.2 EG-Sicherheitsdatenblatt Aluminiumpigmente, pastös
  Hersteller: Eckart GmbH & Co. KG, 07.01.2005
- 21.3 Unbedenklichkeitsbestätigung für Aluminiumpigmente,
  Eckart GmbH & Co. KG, Oktober 2000
- 21.4 EG-Sicherheitsdatenblatt STANDART Aluminiumpulver (alle Typen)
  Hersteller: Eckart GmbH & Co. KG, 27.02.2003
- 21.5 EG-Sicherheitsdatenblatt STAPA Alupor...
  Hersteller: Eckart GmbH, 31.05.2010
- 21.6 EG-Sicherheitsdatenblatt Aluminium, fein gepulvert
  Hersteller: Merck KGaA, 08.01.2003

22 De-foaming agents
- 22.1 Toxikologische und ökotoxikologische Daten zu Polydimethylsiloxan
  Hersteller: Momentive Performance Materials (ehem. Bayer AG)
- 22.2 EG-Sicherheitsdatenblatt Antifoam E,
- 22.3 EG-Sicherheitsdatenblatt Tributoxyethylphosphat,
  Hersteller: Great Lakes Chemical Corporation, GB, 31.03.03
- 22.4 Kurzbewertung Tributoxyethylphosphat
  Hersteller: Hoechst AG
- 22.5 EG-Sicherheitsdatenblatt Tributylphosphat, Entschäumer T,
  Hersteller: LANXESS Deutschland GmbH, 01.10.02
- 22.6 AIDA-Grunddatensatz Tributylphosphat
- 22.7 EUCLID Data Sheet (Grunddatensatz) Tributylphosphat
  (neue Ausgabe 28.9.94)
  Hersteller: LANXESS Deutschland GmbH (ehem. Bayer AG)
- 22.8 EG-Sicherheitsdatenblatt Tri-iso-butylphosphat
  Hersteller: LANXESS Deutschland GmbH, 04.10.2010
22.9 ECETOC Joint Assessment of Commodity Chemicals No. 26, Linear Polydimethylsiloxanes
22.10 Toxikologische und ökotoxikologische Mindestbewertung von Polydimethylsiloxan nebst Umweltinformation, Stand 05/1995
   Hersteller: Dow Corning
22.11 Summary of toxicology on cyclic and linear dimethylsiloxane, oligomers and polymers,
   Hersteller: Dow Corning
22.12 Health and Environmental Aspects of Polydimethylsiloxane Fluids Industrial Bio-Test Laboratories, Inc. and Dow Corning Corporation, USA
22.14 Toxikologische Bewertung Triisobutylphosphat
   BG Chemie Nr. 112, (Ausgabe 11/00)

23 Preservatives
23.1 EG-Sicherheitsdatenblätter der technischen Konservierungsmittel Mergal K9N, Mergal K14, Mergal 723K, Mergal V133
   Hersteller: Troy Chemie GmbH
23.2 Summary of toxicity and ecotoxicity für Preventol-Typen D 2, D 7, D 6, D extra, OF, ON extra, CMK, CMK-Na und WB
   Hersteller: LANXESS Deutschland GmbH (ehem. Bayer AG)

24 Aluminium hydroxides
24.1 Sicherheitsdatenblatt Amorphe Aluminiumhydroxide
   Hersteller: BK Giulini GmbH
24.2 EG Sicherheitsdatenblatt Gecedral BZ 111
   Hersteller: BK Giulini GmbH, 24.02.2011

25 Phosphonic acids
25.1 EG-Sicherheitsdatenblatt Bayhibit AM (PBTC), LANXESS Deutschland GmbH, 21.03.2011
25.2 Produktspesifikation Bayhibit AM (PBTC), LANXESS Deutschland GmbH, 27.08.2009
25.3 EG-Sicherheitsdatenblatt 2-Phosphonobutan-1,2,4-tricarbonsäure (PBTC),

26 Fruit acids
26.1 EG-Sicherheitsdatenblatt Zitronensäure,
   Jungbunzlauer Ges. m.b.H., 01. 2003
26.2 EG-Sicherheitsdatenblatt Zitronensäure Monohydrat,
   E. Begerow GmbH, 28.01.2002
26.3 EG-Sicherheitsdatenblatt Zitronensäure,
   Hersteller: Carl Roth GmbH & Co.KG, 21.03.2011

27 Raw materials for chromate reducers
27.1 EG-Sicherheitsdatenblatt Ferrogranul 20, Kronos International, Inc., 22.02.2011
27.2 EG-Sicherheitsdatenblatt HANSA CR 33,
   Chemische Werke Zell-Wildshausen GmbH, Ausgabe 10/02
27.3 EG-Sicherheitsdatenblatt HANSA CR 100, Chemische Werke Zell-Wildshausen GmbH, Ausgabe 10/02
27.4 EG-Sicherheitsdatenblatt Eisen II sulfat flockig,
   Hersteller: F.B. Silbermann GmbH & Co. KG, 03.09.2010
27.5 EG-Sicherheitsdatenblatt Zinn (II) sulfat, kristallin, spezial / Pulver,
   Hersteller: F.B. Silbermann GmbH & Co. KG, 01.04.2011
28  Raw materials for foaming agents
   ▶  28.1 Stoffdatenblatt Natriumdodecylsulfat (IFA GESTIS)
   ▶  28.3 EG-Sicherheitsdatenblatt Hansateric CAPB 35, Hansa Group AG, 28.09.2005

29  Ethanol amines
   ▶  29.1 EG-Sicherheitsdatenblatt Diethanolamine, Sigma-Aldrich Chemie GmbH, 12.03.2010
   ▶  29.2 EG-Sicherheitsdatenblatt Triethanolamine, Sigma-Aldrich Chemie GmbH, 26.02.2010
   ▶  29.3 EG-Sicherheitsdatenblatt Triethanolamine, Carl-Roth GmbH, 01.10.2009

Note: Upon request, general literature cited can be obtained through Deutsche Bauchemie. The Technical Data Sheets and Safety Data Sheets listed can also be requested directly from the manufacturers named.

Specialist information concerning concrete technology can be easily ordered online: www.deutsche-bauchemie.de