Geosil – ready to use alkaline activator solutions for Geopolymers
Motivation

- laboratories don’t focus on industrial produced waterglass
- essential for future industrial application
- qualified production processes ensure constant product quality
Introduction

- owned by Dr. Eduard Wöllner family foundation
- 122 years of experience (founded in 1896)
- Head office in Ludwigshafen / Germany
- Main product groups:
  - industrial silicates
  - raw materials and additives for paints, plasters and construction materials
  - process chemicals for industrial water circuits
- Approx. 150 employees
- Annual turnover approx. 50M€
Production Sites & distribution network

**Ludwigshafen:** headquarters and production site

**Bad Köstritz:** production site

**Gratwein-Straßengel:** sales department and production site

**Distributor network:**
Australia, New Zealand, China, Malaysia, Singapore, Thailand, South Africa, Israel, Turkey

Distributor network:
- production site
- Distributor
Brands of Wöllner

- **Betolin®**
  Specialties for Paints, Coatings and Construction

- **Collosil®**
  Special Adhesives

- **Betol®**
  Inorganic Binders

- **Sikalon®**
  Powder silicate

- **Ligasil®**
  Stabisil ®
  Foundation engineering

- **Geosil®**
  liquid alkaline activator
Waterglass

- oldest anthropogenic chemical in the world
- glassy frozen melts of alkali silicates with varying composition
- not distinct stoichiometric chemical substances
- no specific chemical formula
- glasses or aqueous solutions of glasses
Furnace route

Quartz
Alkali Carbonate

Glass furnace

Glass furnace

Autoclave

Storage tank

Filter

Wöllner

storage

glass lumps

water

fine tuning
Hydrothermal route

$2 \text{MOH} + x \text{SiO}_2 \rightarrow \text{M}_2\text{O} \cdot x \text{SiO}_2 + \text{H}_2\text{O}$

$M = \text{Na, K, Li}$
Definition molar ratio

weight ratio:
\[ WR = \frac{\text{wt.}\% \text{ SiO}_2}{\text{wt.}\% \text{ M}_2\text{O}} \]

molar ratio:
\[ MR = \frac{\text{mol SiO}_2}{\text{mol M}_2\text{O}} \]

Molar Ratio ↔ Weight Ratio

sodium silicate: molar Ratio = 1,032 • weight Ratio
potassium silicate: molar Ratio = 1,566 • weight Ratio
## Properties according to molar ratio

<table>
<thead>
<tr>
<th>Molar Ratio</th>
<th>Alkalinity</th>
<th>pH Buffer</th>
<th>Solubility</th>
<th>Reactivity</th>
<th>Dried Strength</th>
<th>Viscosity</th>
<th>Drying</th>
<th>Cold Sensitivity</th>
<th>Chemical Resistance</th>
<th>Bonding Force</th>
<th>Loss of Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.6</td>
<td>↑</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>2.0</td>
<td>↑</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>2.4</td>
<td>↑</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>2.8</td>
<td>↑</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>3.2</td>
<td>↑</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
</tr>
</tbody>
</table>

**Graph:**
- The graph shows the changes in properties as the molar ratio increases from 1.6 to 3.2.
- Properties are shaded to indicate their change in value: 
  - **↑** indicates an increase,
  - **↓** indicates a decrease.

**Table:**
- The table lists the properties and their corresponding changes for each molar ratio.

**Notes:**
- Alkalinity and pH buffer are inversely proportional.
- Solubility and Reactivity are inversely proportional.
- Dried strength, viscosity, drying, cold sensitivity, chemical resistance, and bonding force are directly proportional.
- Loss of water is directly proportional.
Basics of waterglass

technically significant liquid silicates:

Sodium silicate: molar ratio 1.7 – 4.0
Potassium silicate: molar ratio 1.0 – 4.0
Lithium silicate: molar ratio: 2.5 – 5.0
## Classification (soluble silicate solutions)

<table>
<thead>
<tr>
<th>Molar ratio \n\SiO_2 : \text{M}_2\text{O}</th>
<th>„Old“ Classification (Handling)</th>
<th>Dangerous Goods Classification (Transport)</th>
<th>CLP-Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 3,2  (\text{conc.} &lt; 40 %)</td>
<td>none</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>&gt; 3,2  (\text{conc.} &gt; 40 %)</td>
<td>Xi irritant \text{R} 36/38</td>
<td>none</td>
<td>Warning (\text{Skin Irrit.} 2 \text{H315} \text{ Eye Irrit.} 2 \text{H319})</td>
</tr>
<tr>
<td>&gt; 2,6 (\leq 3,2)</td>
<td>Xi irritant \text{R}36/38</td>
<td>none</td>
<td>Warning (\text{Skin Irrit.} 2 \text{H315} \text{ Eye Irrit.} 2 \text{H319})</td>
</tr>
<tr>
<td>&gt; 1,6 (\leq 2,6)</td>
<td>Xi irritant \text{R}38, 41</td>
<td>none</td>
<td>Danger (\text{Skin Irrit.} 2 \text{H315} \text{ Eye Dam.} 1 \text{H318})</td>
</tr>
<tr>
<td>(\leq 1,6)</td>
<td>\text{C corrosive R34}</td>
<td>Cl. 8 / Packing Group II</td>
<td>Danger (\text{Skin Corr.} 1B \text{H314} \text{ Eye Dam.1} \text{ H318} \text{ Met. Corr.1} \text{ H290})</td>
</tr>
</tbody>
</table>
Packaging of goods

- 30 lt. can
- 180 lt. plastic drum
- 280 lt. steel drum
- 1000 lt. IBC
- 20’ Full container load (FCL)
- 23 mt bulk in road tanker
- 24 mt Flexitank Container
### Alkaline activator solution

**hydroxide**
- for basic trials
  - soluble silica is missing
  - Geopolymer binder with low physical properties

**Silica sol & hydroxide**
- simple to use in labs
  - Silica sol is made from liquid sodium silicate

**Standard waterglass & hydroxide**
- flexible adjustment of molar ratio
- available worldwide
  - increased handling with hydroxide
  - transport and storage separately
  - limitation of solids content
Geosil® liquid alkaline activator solution

- Geosil are not blends of Standard silicate with hydroxide
- new production process technology
- highest possible solids content & optimal Q-Structure distribution

Pros
- userfriendly - no hydroxide handling
- high purity of raw materials
- reproducible & controlled production process
- stable solution & long shelf life
- available in many countries
- REACH registered

Cons
- fixed molar ratio
# GEOSIL® Products

<table>
<thead>
<tr>
<th></th>
<th>Name</th>
<th>Type</th>
<th>Viscosity [20°C]</th>
<th>MR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Geosil 14515</td>
<td>Potassium silicate</td>
<td>20 mPas</td>
<td>1,5</td>
</tr>
<tr>
<td>2</td>
<td>Geosil 14517</td>
<td>Potassium silicate</td>
<td>20 mPas</td>
<td>1,7</td>
</tr>
<tr>
<td>3</td>
<td>Geosil 15517</td>
<td>Potassium silicate</td>
<td>130 mPas</td>
<td>1,7</td>
</tr>
<tr>
<td>4</td>
<td>Geosil 34417</td>
<td>Sodium silicate</td>
<td>450 mPas</td>
<td>1,7</td>
</tr>
<tr>
<td>Name</td>
<td>pros</td>
<td>cons</td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------</td>
<td>-------------------------------------------</td>
<td>-------------------------------------------</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Geosil 14515 | high reactivity  
 high activation power  
 high mechanical properties | dangerous good                            |
| Geosil 14517 | good reactivity  
 good activation power  
 not dangerous good | lower reactivity & mechanical properties than “Geosil 14515” |
| Geosil 15517 | highest solid content  
 good activation power  
 not dangerous good | lower reactivity  
 lower mechanical properties than “Geosil 14515” |
| Geosil 34417 | cheapest activator solution  
 good mechanical properties | efflorescence  
 thixotropic effect |
4

binder rich system

Alumosilicate

Geosil®

mix

aggregate

cast

hardening ambient temp.

high solid system

Alumosilicate

Filler

Geosil®

mix

compact

hardening with temperature
## Application with Geosil® Binder

**Binder rich**
- geopolymer concrete
- geopolymer mortar
- inorganic foam A1 class
- toxic waste immobilisation
- composites
- geopolymer adhesive
- steel coating

**High solids**
- acoustic panels
- thermal insulation boards
- fire protection boards
- refractory bricks
- pavement stone
- facade elements
- core binder foundry
- arts & decoration
How Wöllner can support you

- we create customized products (blends, modified products)
- development of additives stable at high pH-values (rheological additives, water repellents)
- door-to-door logistics solution for many countries
- individual technical support for customers
Thank you for your attention!