Britesil® Silicates
A Family of Multifunctional Soluble Detergent Builders

\[ \text{MOOM} + \text{Si(OH)}_4 = \text{MOOM} \text{OH} \]
Introduction

PQ Corporation is a leading producer of specialty inorganic chemicals, catalysts and engineered glass products. The Company conducts operations through three principal businesses, the Performance Chemicals division, which develops, manufactures and sells high performance silicate-based specialty chemicals, the Catalyst division, a leading producer of catalysts and the Potters division, which manufactures and sells highly engineered solid and hollow glass spheres. PQ Corporation operates worldwide with more than 60 plants in about 20 countries and has one of the most comprehensive global manufacturing and distribution networks serving a large variety of industries with a broad range of environment friendly products.

Britesil® silicates:
- soluble builders for laundry and automatic-dishwasher powders & tablets

PQ Corporation offers a broad range of soluble silicates under the Britesil brand name. The Britesil soluble silicates are multifunctional builders, specially developed to meet the demanding requirements of modern detergents. The chemical and physical composition of Britesil silicates is carefully controlled to ensure optimum solubility and detergency. Britesil silicates are environmentally safe.

The Britesil hydrous silicates are amorphous and completely soluble in water. The Britesil silicates are available as powders and granules. The tables below show typical data of the Britesil powders and granules.

Typical properties of the BRITESIL® range of silicate powders:

<table>
<thead>
<tr>
<th>BRITESIL®</th>
<th>C 201</th>
<th>C 20</th>
<th>C 205</th>
<th>C 207</th>
<th>C 265</th>
<th>C 330</th>
<th>C 335</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molar ratio</td>
<td>2,05</td>
<td>2,05</td>
<td>2,05</td>
<td>2,05</td>
<td>2,65</td>
<td>3,35</td>
<td>3,35</td>
</tr>
<tr>
<td>LOI, 800°C, %</td>
<td>15,5</td>
<td>19,5</td>
<td>20</td>
<td>20,5</td>
<td>19,5</td>
<td>&lt;20</td>
<td>&lt;20</td>
</tr>
<tr>
<td>Bulk density, g/l</td>
<td>100</td>
<td>500</td>
<td>525</td>
<td>675</td>
<td>625</td>
<td>650</td>
<td>650</td>
</tr>
<tr>
<td>Mean particle size, µm</td>
<td>250</td>
<td>160</td>
<td>130</td>
<td>95</td>
<td>90</td>
<td>175</td>
<td>80</td>
</tr>
</tbody>
</table>

Typical properties of the BRITESIL® range of silicate granules:

<table>
<thead>
<tr>
<th>BRITESIL®</th>
<th>H 20</th>
<th>H 20 S</th>
<th>H 265 HP</th>
<th>H 265 LC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molar ratio</td>
<td>2,0</td>
<td>2,0</td>
<td>2,65</td>
<td>2,65</td>
</tr>
<tr>
<td>LOI, 800°C, %</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>19</td>
</tr>
<tr>
<td>Bulk density, g/l</td>
<td>825</td>
<td>&gt;750</td>
<td>725</td>
<td>500</td>
</tr>
<tr>
<td>Mean particle size, µm</td>
<td>700</td>
<td>700</td>
<td>700</td>
<td>700</td>
</tr>
<tr>
<td>Porosity, ml/kg</td>
<td>125</td>
<td>95</td>
<td>200</td>
<td>300</td>
</tr>
</tbody>
</table>

(Has a very high purity)
The properties of Britesil® silicates in detergents

Britesil soluble silicates contribute to detergency by acting as builders and processing aids in detergent formulations. The Britesil range of silicates is suitable for both powder and tablet formulations. Britesil silicates exhibit a high degree of compatibility with other detergent ingredients making them extremely versatile and easy to process in many formulations.

The contribution of BRITESIL® soluble silicates in detergents.

■ Buffering and alkalinity: BRITESIL silicates exhibit excellent buffering capacity, which is important for optimum detergency. The active alkalinity of silicates neutralizes and saponifies fatty acid soil and aids in the emulsification of oily soil.

■ Sequestration: BRITESIL silicates soften the water by sequestering the calcium and magnesium ions in the wash solution and thereby ensure optimal performance of the surfactant system.

■ Wetting: The ability of BRITESIL silicates to lower the interfacial tension between water and oil better than simple alkali enhances the performance of the surfactant system even further.

■ Prevention of soil redeposition: BRITESIL silicates aid in preventing redeposition of particulate soil by keeping the soil suspended in the wash solution.

■ Liquid carrying capacity (LCC): The ability of BRITESIL silicates to absorb liquid ingredients provides detergent manufacturers with a major processing advantage. The high porosity of BRITESIL H 265 HP and BRITESIL H 265 LC enables them to absorb large amounts of liquid ingredients. The newly developed product BRITESIL H 265 LC has a nonionic absorption capacity equal that of Zeolite 4A.

■ Stabilization of the bleach system: In addition to their builder properties BRITESIL silicates stabilize the bleach system, not only during the wash process but also during storage. This is especially important when percarbonate is used.

■ Corrosion inhibition: BRITESIL silicates act as corrosion inhibitors, forming a protective barrier on metal, glass and ceramic surfaces.

■ Binding properties: BRITESIL silicates have excellent binding properties, which are important in the manufacturing of detergent tablets.

■ Processing: BRITESIL silicate builders are suitable for post addition to a spray tower process and for dry mix processes.

■ Labeling: As BRITESIL H 265 HP and BRITESIL H 265 LC are mildly alkaline and labeled with R 36/37/38 they can be used at any concentration without the need to label the formulation with R 41 (risk of serious damage to eyes). This is important, for instance, in relation to applications for the Nordic Swan environmental label.
Absorption of nonionic surfactants on BRITESIL® Silicates

Liquid carrying capacity (LCC)
The ability of BRITESIL silicates to absorb liquid ingredients provides detergent manufacturers a major processing advantage. The high porosity of BRITESIL H 265 HP and BRITESIL H 265 LC enables them to absorb high amounts of liquid ingredients. The new developed product BRITESIL H 265 LC has a nonionic absorption capacity equal to that of Zeolite 4A, (see figure 1).

Bulk density regulation with BRITESIL® C 201

Concentration of Britesil C 201
The total volume of the detergent is 50g.

Processing aid
Britesil silicate builders are suitable for post addition to a spray tower process and for dry mix processes. Detergents produced in a dry mix process normally have a high bulk density. Britesil C 201 is a silicate powder with a bulk density of only 100g/l, which makes Britesil C 201 suitable for adjusting the densities of detergent powders to the desired lower level.

fig. 1

* Nonionic surfactant C12-C15EO
Buffering action
It is of vital importance for optimum detergency to keep the pH correct and constant throughout the washing process. Britesil silicates provide both alkalinity and good buffering properties (see figure 2). As a result, a fall in pH due to acid soil or dilution is prevented.

Bleach stabilization
It is well known that silicates stabilize bleaching agents in solutions by complexing metal ions. Perborate and percarbonate, which both form hydrogen peroxide and - in conjunction with TAED - form peracetic acid, are stabilized during the washing process by silicate. Unfortunate reactions with metal ions from the soil or water, which might otherwise damage textiles, are thus avoided.

Silicates also act as stabilizers during storage of detergent formulations. Figure 3 shows the stabilization effect of Britesil silicates compared to zeolite when stored together with an unstabilized percarbonate. The figure also shows that the water in the Britesil silicates is tightly bound and therefore does not have a negative effect on the percarbonate. This effect is also achieved in a fully formulated detergent. Not only is the bleaching performance improved, but attacks on other raw materials such as enzymes are also prevented.

Corrosion inhibition
By forming a protective barrier, the soluble silica content of Britesil silicates acts as a corrosion inhibitor, protecting metal, glassy and ceramic surfaces against attack from other detergent ingredients such as complexing agents like phosphate or MGDA, synthetic detergents and other alkalis. In general, higher mole ratio silicas enhance corrosion protection.

The mechanism for inhibiting corrosion of metal surfaces is shown in figure 4. The monomeric species of silica, which are negatively charged, adhere to metal surfaces, forming a thin monomolecular film that inhibits corrosion. As the film does not build up further, there is no risk of excessive scale forming.
Laundry detergents

The builder system is an essential part of a laundry detergent. It has to create an environment in which the other ingredients like surfactants, bleach agents and enzymes can work at their best. The builder system takes up 40-60 % of the total detergent formulation. A builder system

- softens the water by sequestering calcium and magnesium ions
- provides alkalinity and buffers the wash liquor
- prevents redeposition of dirt on the textiles
- has a high liquid carrying capacity, especially important in non-tower routes

As wash temperature and water consumption are reduced and washing cycles are getting shorter, there is a trend towards soluble non-phosphate builder systems. These soluble builder systems usually consist of silicate, carbonate and a polymer, with the possible addition of phosphonate and/or citrate.

Britesil soluble silicate builders are especially developed to meet the new requirements from the detergent industry. The Britesil range of hydrous silicates is amorphous and completely soluble in water. The optimum proportions of alkali, soluble silica and rate of hydration enhance the detergency of a laundry formulation without causing damage on textiles and colors.

The detergency test shows the advantage of Britesil silicate based formulation compared to a carbonate formulation. The silicate based detergent shows a much lower ash content after 10 washing cycles than the carbonate based formulation. The primary cleaning efficiency is equal for both formulations.
**TEST CONDITIONS**

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Miele washing machine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method</td>
<td>DIN 44 983</td>
</tr>
</tbody>
</table>
| Swatches        | EMPA 101: Soot, olive oil  
                 | WFK AS9: Pigment, oil, milk  
                 | WFK PC9: Pigment, oil  
                 | EMPA 114: Red wine  
                 | Cotton and terry towel (ash content) |
| Temperature     | 30°C                   |
| Water hardness  | 20°dH, Ca:Mg 3:1       |
| Cycles          | Primary cleaning – 1 cycle  
                 | Secondary cleaning – 10 cycles |
| Load            | 4.5 kg                 |

**TEST FORMULATIONS**

<table>
<thead>
<tr>
<th>Formulation, g/wash</th>
<th>Britesil based</th>
<th>Soda ash based</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anionic surfactant (LAS)</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Nonionic surfactant</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Soap</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Britesil H 265 LC</td>
<td>24</td>
<td>4</td>
</tr>
<tr>
<td>Soda ash</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>Polymer</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Perborate Monohydrate</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>TAED</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Dosage</td>
<td>75 g/wash</td>
<td>75 g/wash</td>
</tr>
</tbody>
</table>

**Graphs**

- **Primary cleaning**
  - Britesil based detergent
  - Soda ash based detergent

- **Secondary cleaning**
  - Cotton
  - Terry towel
  - Ash content, %
Automatic dishwasher detergents

Soluble silicates have long been used in automatic dishwasher detergents, where they provide alkalinity, stabilize the bleaching system, enhance cleansing, and prevent corrosion of glass, ceramics and metal surfaces. Britesil silicates are especially suitable in low alkaline automatic dishwashing detergents.

Soluble silica absorbs onto glass surfaces and thus prevents corrosion. The monolayer barrier that is formed protects the glass against attack from alkaline raw materials as well as other detergent ingredients. The figure shows the glass protection of Britesil H 265 HP in a phosphate based formulation after 300 cycles at 65°C, 0-1°dH and a dosage of 20g.

Co-granules for phosphate free automatic dishwasher detergents

Although phosphate is an excellent builder, it has some shortcomings. One major shortcoming is the negative impact on the environment, which has lead to bans or restrictions in various parts of the world. Phosphate causes eutrophication, which means that it works as a nutrient causing excessive growth of algae. In countries where phosphates are still used, detergent manufacturers are looking for alternatives.

PQ Corporation has developed a co-granule, Britesil CG 900, which is suitable for dry-mixing with other ADD ingredients. Table shows the typical properties of Britesil CG 900. Britesil CG 900 is particular suitable for ADD tablets. Sodium citrate is crystalline and difficult to process. Britesil CG 900 combines silicate, citrate and polymer in...
an amorphous state enabling tabletting machines to run more efficiently. The figure shows the increase in tablet strength achieved by the use of Britesil CG 900.

PQ Corporation has the capability to make different types of co-granules and we are continuously working on new developments.

**Typical properties of Britesil CG 900**

<table>
<thead>
<tr>
<th>Property</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium Disilicate, %</td>
<td>25 - 29</td>
</tr>
<tr>
<td>Sodium citrate, %</td>
<td>50 - 56</td>
</tr>
<tr>
<td>Copolymer, %</td>
<td>5.5 - 6.5</td>
</tr>
<tr>
<td>Water, %</td>
<td>to 100</td>
</tr>
<tr>
<td>Bulk density, g/l</td>
<td>820 - 920</td>
</tr>
<tr>
<td>Particle size</td>
<td></td>
</tr>
<tr>
<td>Average, µm</td>
<td>750</td>
</tr>
<tr>
<td>&lt; 180 µm, %</td>
<td>&lt; 5</td>
</tr>
<tr>
<td>&gt; 1250 µm, %</td>
<td>&lt; 25</td>
</tr>
<tr>
<td>Solubility, 20°c, s</td>
<td>&lt; 2</td>
</tr>
</tbody>
</table>
Other uses

In addition to their use in laundry and dishwasher powders, Britesil silicates are also recommended for use in a range of industrial applications.

Bonding and coating properties:

Soluble silicates have physical and chemical properties that are useful in bonding and coating applications. When applied as a thin layer on the surfaces of other materials, the soluble silicate forms a tough, tightly adhesive inorganic bond with the following characteristics:

- resistant to temperatures of up to 1600° C.
- non-toxic
- non-flammable
- moisture-resistant
- bonds to metals, particles, ceramics, glasses and fibers
- strong and rigid.

Thanks to these properties, soluble silicates are useful in a broad range of bonding applications including corrugated board, tube winding, insulating materials, ceramics, acid-proof cement, refractory and dust binders for coal, and mineral wool. Britesil granules and powders are particularly suitable for use in dry-mix products and where less water is desired.

Other properties:

The ability of Britesil silicates to form complex metal ions is used in water treatment, bleaching processes, and dry-mix cement.

Britesil silicates act as flotation agents in ore beneficication.
Environmental compatibility

Britesil silicates are totally inorganic. Therefore the question of biodegradability, that is associated with organic compounds, does not arise; their alkalinity dissipates once they are dissolved in effluents. The soluble silica (SiO₂) component either remains in the dissolved silica found in most natural waters, or becomes part of precipitates such as silica, calcium or magnesium silicates, thus joining the insoluble silicates of mineral origin which make up most of the earth’s crust.

Product Safety

Britesil silicates are highly alkaline and should therefore be handled with care to prevent discomfort or injury. Users should observe the precautionary information on the label. Soluble silicates are inorganic and there is no danger of low flash point or flammability. PQ Europe can provide information on the precautionary labeling of household detergents sold as consumer products, as well as Material Safety Data Sheets.

Packaging

The Britesil silicates are available in bulk, semi-bulk bags, or 25 kg bags fitted with a PE inner layer. These bags ensure that the products are delivered in a fresh, free-flowing state.

Storage

Dry sodium silicates are hygroscopic. The tendency to absorb moisture is enhanced at higher temperatures and humidities. Britesil silicates should therefore be stored in a cool, dry warehouse in their original packaging, which protects them against moisture. In the case of bulk deliveries, Britesil silicates must be protected against moisture.

Since dry sodium silicates have a natural tendency to absorb water from the air, partially used containers should be tightly closed. The packaging material provides protection for storage at moderate humidity for reasonable periods of time. Storage temperatures should be below 60°C. To avoid caking, additional protection should be provided if high humidity is expected or if the products are to be stored for a long period of time. Under such conditions, the use of additional plastic bags is recommended.
PQ Corporation

Head office in Europe
PQ Corporation
De Brand 24
P.O.Box 664
3800 AR Amersfoort
The Netherlands
tel.+31 33 450 90 30
fax.+31 33 450 90 31

Customer Service Center
PQ Silicas B.V.
Ir. Rocourstraat 28
P.O. Box 1
6245 ZG Eijsden
The Netherlands
Tel: +31 43 409 93 33
Fax: +31 43 409 41 65

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