SILICATE PRODUCTS FOR THE OILFIELD
From our beginnings in 1831 as a soap and candle business, PQ Corporation has evolved into a world leader in providing customer solutions through the company’s knowledge of silica-based chemistry and the needs of the oilfield industry.

PQ was founded to provide basic essentials of daily life. Today the company’s employees are partners in the same process of providing safe and useful materials for society’s benefit. PQ’s soluble silicates and their derivatives make significant contributions in a variety of oilfield applications.

Through the years, building on its constantly expanding silicate production and applications technology, PQ has developed numerous high value derivatives of our soluble silicate products. PQ Corporation, in combination with our affiliates around the world, is the largest volume producer of sodium and potassium silicates. With industrial operations in 14 countries, PQ supplies soluble silicates in a wider variety of forms than any other manufacturer on a global basis.

PQ adheres to the principle that protection of health, safety, and the environment is everyone’s business. As a member of The American Chemical Council, PQ is committed to supporting the association’s Responsible Care® program. This vital program was initiated for the purpose of improving the responsible management of chemicals.

National Silicates is a wholly-owned Canadian subsidiary of PQ Corporation, and follows the STOP Health, Safety and Environment program developed by DuPont. Our priority is the safety of employees and the communities in which we do business. As a member of the Canadian Chemical Producer’s Association (CCPA) we support Responsible Care® in Canada. Additionally, National Silicates is a member of the Petroleum Alliance Association of Canada (PTAC) and the Petroleum Services Association of Canada (PSAC). Through all of these organizations we promote education and safety awareness in the petroleum industry.
Superior Shale Inhibition Meets Superior Environmental Compliance

Shale Stabilization
It has been known since the 1920s that water-based drilling fluids formulated with potassium or sodium silicate provide superior shale stability, regardless of shale type. Eighty years later, silicates are still recognized as the most effective water-based shale inhibitor.

The unique chemistry of silicate will stabilize shales by a variety of different but complimentary mechanisms. Depending on shale conditions, the typical concentration of soluble silicate in a drilling fluid is 2-10% v/v. PQ’s complete line of silicate products allows for service companies to further customize the drilling fluid to maximize performance and reduce drilling fluid costs.

Environment
PQ silicates are non-toxic and one of the few oilfield chemicals that can be beneficial to the environment: both on-land and off-shore. Potassium silicate is a source of soluble potassium as well as soluble silica and in many countries PQ potassium silicate is registered as a fertilizer. On-land, this makes potassium silicate the natural choice for drilling. Offshore, sodium silicate is the preferred product. When discharged into the ocean the soluble silica aids in diatom growth.

Silicate-based drilling waste is easy to treat or dispose of. Offshore, sodium silicate-based drilling fluids qualify for environmental disposal options such as discharge into the ocean. On-land, postassium silicate-based drilling fluid has several disposal options including mix-bury-cover, land spreading or land spraying.

One Chemical Has Multiple Benefits
PQ silicates provide other benefits beyond shale inhibition and environmental compliance. Other established performance properties include;

- Corrosion control
- Improved cementing
- Low depletion rates
- Low disposal costs
- High ROP (low solids pick-up)

With help from PQ Corporation, service companies continue to develop new generations of silicate-based drilling fluids that allow for expanded use at lower costs.

Please read bulletins 36-01, 36-02 for more detailed information.
Inorganic Silicates Offer Versatility In A Range Of Oilfield Cementing Applications

Available in liquid and solid form, inorganic silicates offer versatility in a range of oilfield cementing applications – from lightweight cements to set accelerators. The SiO$_2$::Na$_2$O ratio range of PQ’s sodium silicate and sodium metasilicate products ensures that setting times can be controlled for maximum flexibility.

Applications

PQ’s technical group has a long history of providing assistance in the formulation of silicates for a wide variety of field applications. Today, our broad spectrum of silicate products are used in a growing number of established applications.

Sodium metasilicate is used in cements to reduce slurry density, prevent segregation of solids, promote early strength, accelerate set-times and reduce free water in normal and heavyweight cements. Because of these benefits, PQ’s sodium metasilicate is used in lightweight cements.

PQ’s liquid silicates are used as set accelerators in conventional cementing. Liquid silicates are used in waste remediation to sequester heavy metals and/or gel (set) with acids and acid salts producing reaction products than can be easily isolated by conventional cementing techniques.

PQ’s hydrous powders are used in dry cement admixtures, the high ratio G® sodium silicate for longer setting times and the lower ratio GD® for faster setting.

Combine liquid silicate grouting with cementing to control water influx and contribute strength and durability in deep locations. Advera® zeolites are used in specialty cementing applications to maintain strength at extremely high and low temperatures.

Environmental

PQ’s family of silicates and zeolites are inorganic materials exhibiting no biodegradability issues. They break down into benign, naturally-occurring products.

Please read bulletin 35-01 for more detailed information.
PQ’s Unique Family Of Silicate Products
Proven Useful In Harsh Reservoir Environments

The worldwide cost of unwanted water production in the oilfield has been estimated to be in excess of 50 billion dollars. Increasing well efficiency can help to lower costs, and as wells become more mature, reducing the flow of unwanted water can extend well life and increase profitability. PQ’s unique family of silicate products has proven to be useful in harsh reservoir environments (>150ºC) where polymers are not suited.

Applications
Take advantage of the unique chemistry and environmental benefits of PQ silicates to control unwanted water in the following applications:

- Conformance and redirection - EOR
- Water Shutoff – wells and reservoirs
- Soil and sand consolidation - formation

Environmental
Silicates are inorganic materials and there are no biodegradability issues with either the raw materials or when chemically set to plug the influx of unwanted water.

For fixing unstable formations, silicates can be set with a variety of setting aids to provide strong, permanent barriers to further erosion or water influx. When used in combination with cementing, strength and durability can be further increased.

Please read bulletin 35-01 for more detailed information.
Sodium Silicate’s Unique Chemistry Ideal For Maximizing Enhanced Oil Recovery

Similar to drilling fluids, the idea of using PQ sodium silicate to improve oil recovery first originated in the 1920s. Silicate’s unique chemistry continues to be the low cost, high performance and environmental solution to help maximize oil recovery.

Conformance

Many conformance problems can be solved using systems formulated around sodium silicate. PQ’s R&D and field experience have helped service companies and operators to formulate a wide range of conformance solutions based on sodium silicate. A variety of mechanisms are possible, depending on the choice of setting agent:

**Externally catalyzed (precipitation of sodium silicate)** – these are formulated to have quick reaction times and be used near the wellbore

**Internally catalyzed (polymerization of sodium silicate)** – these have longer reaction times and take advantage of low sodium silicate viscosity and molecular weight for deep reservoir placement

**CO$_2$ catalyzed** – Emerging as another category is the use of sodium silicate for CO$_2$-EOR. Upon contact with CO$_2$, sodium silicate reacts to give a high strength silica gel. The unique reaction between CO$_2$ and sodium silicate allows for the selective plugging on unwanted CO$_2$ pathways.

All sodium silicate formulas offer the following benefits:

- easy placement
- excellent chemical, mechanical and thermal stability
- versatility
- low cost
- environmentally friendly

**Alkali-Surfactant-Polymer Flooding (ASP)**

PQ was heavily involved with the initial development work using sodium silicate for alkaline flooding and later in alkaline-surfactant-polymer flooding. Under appropriate reservoir conditions, sodium silicate has proven to be the alkali of choice. Sodium silicate is used at a very low dosage and acts as a multi-functional chemical in the reservoir. Sodium silicate also helps to enhance the performance of the surfactant and polymer. Some of the properties provided by sodium silicate include:

- lowers interfacial tension at the crude/water interface
- reduces levels of divalent metal ions
- reduces surfactant adsorption/retention
- increases water-wetness

*Originally used in “Clean Coal Technologies” DVD, produced by the University of Kentucky Center for Applied Energy Research.*
### Liquid Sodium Silicate

<table>
<thead>
<tr>
<th>PQ Product Name</th>
<th>Wt Ratio SiO&lt;sub&gt;2&lt;/sub&gt;:Na&lt;sub&gt;2&lt;/sub&gt;O</th>
<th>Wt % Na&lt;sub&gt;2&lt;/sub&gt;O</th>
<th>Wt % SiO&lt;sub&gt;2&lt;/sub&gt;</th>
<th>Density lb/gal</th>
<th>Viscosity cPs</th>
</tr>
</thead>
<tbody>
<tr>
<td>N&lt;sup&gt;0&lt;/sup&gt;</td>
<td>3.22</td>
<td>8.9</td>
<td>28.7</td>
<td>41.0</td>
<td>11.6</td>
</tr>
<tr>
<td>N&lt;sup&gt;0&lt;/sup&gt;Clear</td>
<td>3.22</td>
<td>8.9</td>
<td>28.7</td>
<td>41.0</td>
<td>11.6</td>
</tr>
<tr>
<td>N&lt;sup&gt;38&lt;/sup&gt;</td>
<td>3.22</td>
<td>8.2</td>
<td>26.4</td>
<td>38.0</td>
<td>11.3</td>
</tr>
<tr>
<td>E&lt;sup&gt;7&lt;/sup&gt;</td>
<td>3.22</td>
<td>8.6</td>
<td>27.7</td>
<td>40.0</td>
<td>11.5</td>
</tr>
<tr>
<td>G&lt;sup&gt;7&lt;/sup&gt;</td>
<td>3.22</td>
<td>9.1</td>
<td>29.5</td>
<td>42.2</td>
<td>11.8</td>
</tr>
<tr>
<td>K&lt;sup&gt;7&lt;/sup&gt;</td>
<td>2.88</td>
<td>11.0</td>
<td>31.7</td>
<td>47.0</td>
<td>12.3</td>
</tr>
<tr>
<td>M&lt;sup&gt;7&lt;/sup&gt;</td>
<td>2.58</td>
<td>12.4</td>
<td>32.1</td>
<td>49.3</td>
<td>12.6</td>
</tr>
<tr>
<td>STAR&lt;sup&gt;10&lt;/sup&gt;</td>
<td>2.50</td>
<td>10.6</td>
<td>26.5</td>
<td>42.0</td>
<td>11.7</td>
</tr>
<tr>
<td>RO&lt;sup&gt;10&lt;/sup&gt;</td>
<td>2.40</td>
<td>13.8</td>
<td>33.2</td>
<td>52.0</td>
<td>13.0</td>
</tr>
<tr>
<td>D&lt;sup&gt;10&lt;/sup&gt;</td>
<td>2.00</td>
<td>14.7</td>
<td>29.4</td>
<td>50.5</td>
<td>12.8</td>
</tr>
</tbody>
</table>

### Hydrous and Anhydrous Silicate

<table>
<thead>
<tr>
<th>PQ Product Name</th>
<th>Wt Ratio SiO&lt;sub&gt;2&lt;/sub&gt;:Na&lt;sub&gt;2&lt;/sub&gt;O</th>
<th>Wt % Na&lt;sub&gt;2&lt;/sub&gt;O</th>
<th>Wt % SiO&lt;sub&gt;2&lt;/sub&gt;</th>
<th>Wt% H&lt;sub&gt;2&lt;/sub&gt;O</th>
<th>Density lb/gal</th>
<th>Particle Size, Tyler</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS&lt;sup&gt;0&lt;/sup&gt;</td>
<td>3.22</td>
<td>23.5</td>
<td>75.7</td>
<td>0</td>
<td>88</td>
<td>1.41</td>
</tr>
<tr>
<td>SS&lt;sup&gt;20&lt;/sup&gt;Pwd</td>
<td>3.22</td>
<td>23.5</td>
<td>75.5</td>
<td>0</td>
<td>65</td>
<td>1.04</td>
</tr>
<tr>
<td>SS&lt;sup&gt;65&lt;/sup&gt;Pwd</td>
<td>3.22</td>
<td>23.1</td>
<td>74.7</td>
<td>0</td>
<td>54</td>
<td>0.86</td>
</tr>
<tr>
<td>SS&lt;sup&gt;200&lt;/sup&gt;Pwd</td>
<td>3.22</td>
<td>23.5</td>
<td>75.7</td>
<td>0</td>
<td>88</td>
<td>1.41</td>
</tr>
<tr>
<td>G&lt;sup&gt;7&lt;/sup&gt;</td>
<td>2.40</td>
<td>23.8</td>
<td>77.2</td>
<td>17.5</td>
<td>39</td>
<td>0.61</td>
</tr>
<tr>
<td>C&lt;sup&gt;7&lt;/sup&gt;</td>
<td>3.22</td>
<td>19.2</td>
<td>61.8</td>
<td>18.5</td>
<td>44</td>
<td>0.70</td>
</tr>
<tr>
<td>SS&lt;sup&gt;C10&lt;/sup&gt;</td>
<td>2.00</td>
<td>33.0</td>
<td>66.0</td>
<td>0</td>
<td>88</td>
<td>1.41</td>
</tr>
<tr>
<td>SS&lt;sup&gt;C20&lt;/sup&gt;Pwd</td>
<td>2.00</td>
<td>32.7</td>
<td>66.5</td>
<td>0</td>
<td>45</td>
<td>0.72</td>
</tr>
<tr>
<td>SS&lt;sup&gt;C200&lt;/sup&gt;Pwd</td>
<td>2.00</td>
<td>32.7</td>
<td>66.5</td>
<td>0</td>
<td>46</td>
<td>0.73</td>
</tr>
<tr>
<td>GD&lt;sup&gt;7&lt;/sup&gt;</td>
<td>2.00</td>
<td>27.0</td>
<td>54.0</td>
<td>18.0</td>
<td>46</td>
<td>0.73</td>
</tr>
</tbody>
</table>

### Liquid KASIL® Potassium Silicates

<table>
<thead>
<tr>
<th>PQ Product Name</th>
<th>Wt Ratio SiO&lt;sub&gt;2&lt;/sub&gt;:K&lt;sub&gt;2&lt;/sub&gt;O</th>
<th>Wt % K&lt;sub&gt;2&lt;/sub&gt;O</th>
<th>Wt % SiO&lt;sub&gt;2&lt;/sub&gt;</th>
<th>Density lb/gal</th>
<th>Viscosity cPs</th>
</tr>
</thead>
<tbody>
<tr>
<td>KASIL&lt;sup&gt;1&lt;/sup&gt;</td>
<td>2.50</td>
<td>8.3</td>
<td>20.8</td>
<td>29.8</td>
<td>10.5</td>
</tr>
<tr>
<td>Ecoblend® 317</td>
<td>2.50</td>
<td>8.3</td>
<td>20.8</td>
<td>29.8</td>
<td>10.5</td>
</tr>
<tr>
<td>KASIL&lt;sup&gt;33&lt;/sup&gt;</td>
<td>2.10</td>
<td>11.6</td>
<td>24.4</td>
<td>37.3</td>
<td>11.2</td>
</tr>
<tr>
<td>KASIL&lt;sup&gt;76&lt;/sup&gt;</td>
<td>2.10</td>
<td>12.63</td>
<td>26.5</td>
<td>40.3</td>
<td>11.6</td>
</tr>
<tr>
<td>KASIL&lt;sup&gt;1624&lt;/sup&gt;</td>
<td>1.65</td>
<td>9.1</td>
<td>15.0</td>
<td>-</td>
<td>10.15</td>
</tr>
<tr>
<td>KASIL&lt;sup&gt;2130&lt;/sup&gt;</td>
<td>2.10</td>
<td>9.5</td>
<td>20.0</td>
<td>-</td>
<td>10.6</td>
</tr>
<tr>
<td>KASIL&lt;sup&gt;2135&lt;/sup&gt;</td>
<td>2.18</td>
<td>11.0</td>
<td>24.0</td>
<td>-</td>
<td>11.0</td>
</tr>
<tr>
<td>KASIL&lt;sup&gt;2529&lt;/sup&gt;</td>
<td>2.50</td>
<td>8.3</td>
<td>20.8</td>
<td>29.8</td>
<td>10.5</td>
</tr>
</tbody>
</table>

### KASOLV® Hydrous Potassium Silicate

<table>
<thead>
<tr>
<th>PQ Product Name</th>
<th>Wt Ratio SiO&lt;sub&gt;2&lt;/sub&gt;:K&lt;sub&gt;2&lt;/sub&gt;O</th>
<th>Wt % K&lt;sub&gt;2&lt;/sub&gt;O</th>
<th>Wt % SiO&lt;sub&gt;2&lt;/sub&gt;</th>
<th>Density lb/gal</th>
<th>Particle Size, Tyler</th>
</tr>
</thead>
<tbody>
<tr>
<td>KASOLV&lt;sup&gt;10&lt;/sup&gt;</td>
<td>1.60</td>
<td>32.4</td>
<td>53.0</td>
<td>14.5</td>
<td>43</td>
</tr>
</tbody>
</table>

### PQ Magnesium Sulfate Heptahydrate (Epsom Salt)

- Min 99.9% (ignited basis) MgSO<sub>4</sub> Max 52.0% (ignited basis) Loss on Ignition
- Max 140 ppm Chlorides Max 20 ppm Fe
- Max 10 ppm Heavy Metals as Lead Max 15 ppm Boron
- Max 30 ppm Selenium Bulk Density 59 (±5) lb/ft<sup>3</sup>
- Max 4% held on 10 mesh US Max 10% thru 50 mesh US

### Metasilicate

<table>
<thead>
<tr>
<th>Typical Property Data</th>
<th>METSO BREAD® 2548 Anhydrous Sodium Metasilicate</th>
<th>METSO PENTRADE® 20 Sodium Metasilicate Pentahydrate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wt % Na&lt;sub&gt;2&lt;/sub&gt;O</td>
<td>51.0</td>
<td>29.3</td>
</tr>
<tr>
<td>Wt % SiO&lt;sub&gt;2&lt;/sub&gt;</td>
<td>47.0</td>
<td>28.7</td>
</tr>
<tr>
<td>Wt % H&lt;sub&gt;2&lt;/sub&gt;O</td>
<td>0</td>
<td>41.3</td>
</tr>
<tr>
<td>Density, lb/g (g/cm&lt;sup&gt;3&lt;/sup&gt;)</td>
<td>65 (1.04)</td>
<td>55 (0.88)</td>
</tr>
<tr>
<td>Particle Size, Tyler</td>
<td>93% in 20 to 65 mesh 94% in 20 to 48 mesh</td>
<td>165 (72)</td>
</tr>
<tr>
<td>Melting Point, °C (F)</td>
<td>1990 (1888)</td>
<td>165 (72)</td>
</tr>
<tr>
<td>Rate of Solution in Water, sec (5w% 70°F)</td>
<td>50</td>
<td>35</td>
</tr>
<tr>
<td>Appearance of Solution</td>
<td>Clear</td>
<td>Clear</td>
</tr>
</tbody>
</table>

### Zeolite

<table>
<thead>
<tr>
<th>Property</th>
<th>VALOR® 100</th>
<th>ADVERTA® 01</th>
<th>ADVERTA® 01F</th>
<th>ADVERTA® 01P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical Composition</td>
<td>17% Na&lt;sub&gt;2&lt;/sub&gt;O, 28% Al&lt;sub&gt;2&lt;/sub&gt;O&lt;sub&gt;3&lt;/sub&gt;, 33% SiO&lt;sub&gt;2&lt;/sub&gt;, 22% H&lt;sub&gt;2&lt;/sub&gt;O</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>% Moisture Loss (±2%) at 80°F</td>
<td>20</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Medial Particle Size, micron</td>
<td>3-6</td>
<td>3-6</td>
<td>2-5</td>
<td>3-6</td>
</tr>
<tr>
<td>Bulk Density, lb/ft&lt;sup&gt;3&lt;/sup&gt; (g/cm&lt;sup&gt;3&lt;/sup&gt;)</td>
<td>33 (0.5)</td>
<td>28 (0.4)</td>
<td>25 (0.4)</td>
<td>28 (0.4)</td>
</tr>
<tr>
<td>pH of 1% Dispersion</td>
<td>11</td>
<td>11</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>Color</td>
<td>White (Hunter L=98)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Calcium Exchange Capacity, mg CaCO&lt;sub&gt;3&lt;/sub&gt;/g anhydrous</td>
<td>280</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>zeolite</td>
<td>Surfactant adsorption, wt%</td>
<td>35</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Although the information and suggestions in this brochure ("information") are believed to be correct, PQ Corporation makes no representations or warranties as to the completeness or accuracy of the information. The information is supplied upon the following conditions: The persons receiving the information will determine its suitability for their purposes; PQ Corporation will not be responsible for damages of any nature whatsoever resulting from the use of, or reliance upon, the information or the materials, devices or products to which the information refers; No information is to be construed as a recommendation to use any product, process, equipment or formulation in conflict with any patent; PQ Corporation makes no representation or warranty, express or implied, that the use thereof will not infringe any patent; and NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR OF ANY OTHER NATURE ARE MADE HEREBUNDER WITH RESPECT TO INFORMATION OR THE MATERIALS, DEVICES OR PRODUCTS TO WHICH THE INFORMATION REFERS.

© 2009 PQ Corporation. All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means electronic, mechanical, photocopying, recording or otherwise, without the prior permission of the publisher and copyright holder.

---

About PQ Corporation

PQ Corporation (www.pqcorp.com) is a leading producer of specialty inorganic chemicals, catalysts, and engineered glass products, with annual sales revenues in excess of US $1 billion. The company conducts operations through three principal businesses: the Performance Chemicals division, which develops, manufactures and sells high performance silicate-based specialty chemicals; the Catalysts division, a leading producer of high performance zeolite- and silica-based catalysts; and the Potters division, which manufactures and sells highly engineered solid and hollow glass spheres. The company’s products are used in a variety of applications in a diverse range of industrial, consumer and governmental end-markets. The company operates over 60 manufacturing sites in 21 countries on five continents and has one of the most comprehensive global manufacturing and distribution networks serving customers in the company’s end-markets.

---

For Customer Service Call:
01-800-944-7411

Or Contact Us At:
PQ Corporation
300 Lindenwood Drive,
Malvern, PA 19355-1740 USA
T: +1 610 651 4200
F: +1 610 251 4504

National Silicates
429 Kipling Avenue
Etobicoke, MB Z 5C7 ON
Canada
T: (416) 255-7771
F: (416) 201-4343

Silicatos y Derivados S.A. de C.V.
Fracc. Ind. San Nicolás
Río Lerma 55
Tlalnepantla, Edo. de Mexico
C.P. 54030
Mexico
T: (011) 525-55-227-6800
F: (011) 525-55-227-6835

PQ Corporation
Warrington, England, WA 5 1AB
T: +44 (0)1925 416100
F: +44 (0)1925 416116

PQ Corporation
Av. Marques de São Vicente, 121, 6º andar sala 60101159-001
São Paulo, SP Brazil
T: +55 (0)11 3638 9900
F: +55 (0)11 3638 9919

PQ Corporation
169 Tedstone Road, PO Box 14016, Wadeville 1422, Gauteng, S. Africa
T: +27 (0)11 820 7111
F: +27 (0)11 827 6922

PQ Corporation
P. Van Dijkstraat 9, 9672 AJ
Wenschoten, The Netherlands
T: +31 597 455 111
F: +31 597 423 496

PQ Corporation
11-502, Fanzuci, Huanan Country Garden
Nancun, Panyu, Guanzhou, China
T: +861 3322 806747

PQ Nederland B.V., De Brand 24
3823 LJ Amersfoort
3800 AR Amersfoort, Netherlands
T: +31 33 450 90 30
F: +31 33 450 90 31

Please Visit Our Website At:
www.pqcorp.com

PQ's technical group has a long history of providing assistance in the formulation of silicates for a wide variety of field applications.