



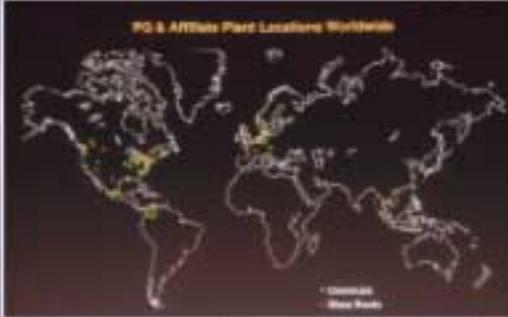
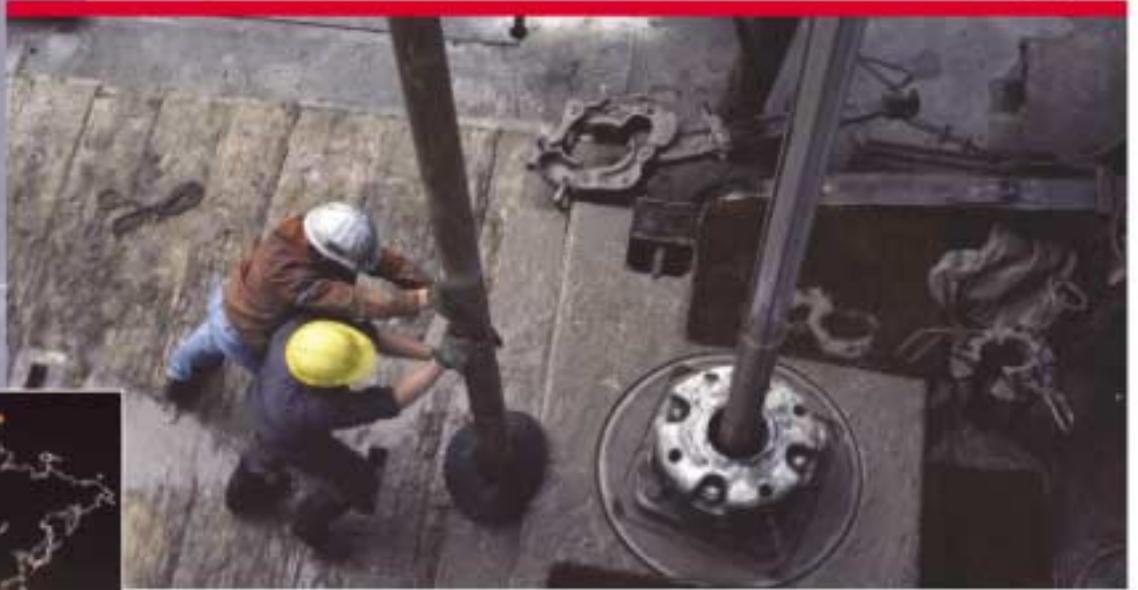
**EcoDrill**

SILICATE DRILLING FLUID  
TECHNOLOGIES



**PQ Corporation**

# The EcoDrill® Advantage



**In the mid-1990's**, there was increasing pressure to find a high performance water-based drilling fluid that would be an environmentally acceptable alternative to oil-based drilling fluids. Since the 1930's, it has been known that silicate-based drilling fluids provide oil-like shale stability. Aside from containing sodium or potassium silicate, current silicate-based drilling fluids would have little in common with these early fluids. Advances in formulating chemistry have made silicate-based drilling fluids an effective, versatile and low cost alternative to oil-based drilling fluids. Since their re-introduction in the North Sea, silicate-based drilling fluids have steadily gained in popularity with service and oil companies.

EcoDrill®, PQ's family of sodium and potassium silicates, offers the flexibility and versatility to design a mud system for almost any drilling environment. A drilling fluid, using the EcoDrill® products, provides:

- superior well bore stability
- superior environmental performance
- excellent ROP's
- low depletion rates
- corrosion control
- improved cementing

Whether an inexpensive drilling fluid is required for drilling through moderately-reactive shales or a technically superior mud system for the most challenging hole conditions, EcoDrill® offers a cost-effective solution with optimal performance characteristics.

## Experience: A Proven Advantage

PQ Corporation was involved with the development, introduction and support of the first silicate-based drilling fluids in the 1930's. This commitment continues with a dedicated global team of chemists and engineers to help

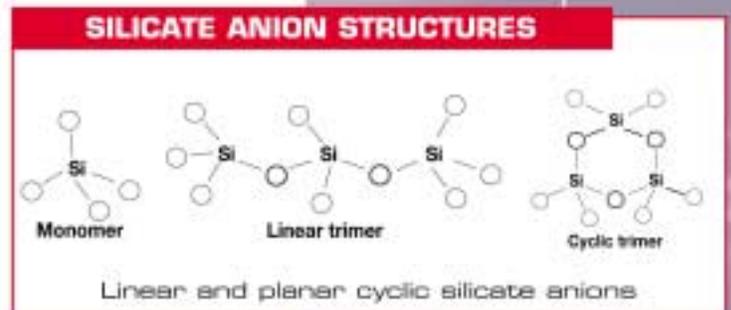
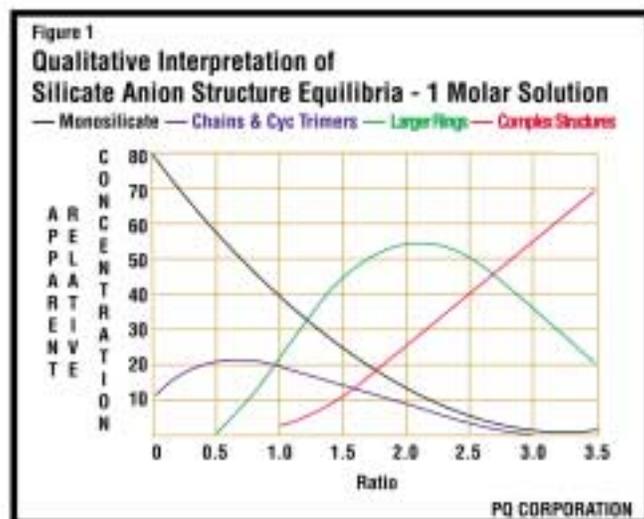
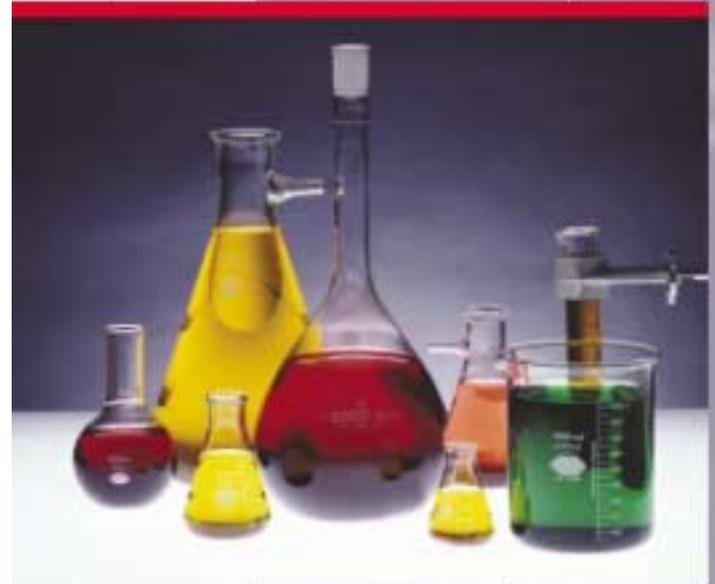


optimize the use of EcoDrill® in drilling fluid formulations. PQ Corporation is the leading producer of sodium and potassium silicates worldwide. Founded in 1831 in Philadelphia Pennsylvania, PQ has grown into one of the largest chemical companies in the world with manufacturing facilities in 19 countries on five continents. In partnership with our worldwide affiliates, extensive technical resources and global reach allows our company to provide support anywhere in the world. PQ has built its reputation as the recognized world leader in silicate application technology. Utilizing a global team of dedicated chemists and engineers, PQ specializes in product/application development and R&D related to silica based technology. Whether it is producing expert advice about silicate drilling fluids, on-site trials or troubleshooting, we have the team in place to optimize the use of EcoDrill® in drilling fluid formulations.

## What Are Soluble Silicates?

Soluble silicates are manufactured by fusing sand ( $\text{SiO}_2$ ) with sodium or potassium carbonate ( $\text{K}_2\text{CO}_3$  or  $\text{Na}_2\text{CO}_3$ ) in an open hearth furnace at 1100-1200°C and then dissolving the glass using high pressure steam forming a clear, slightly viscous liquid known as “waterglass.” Liquid silicate is the most popular commercial form of soluble silicates used in drilling fluids. However, liquid silicates can be spray-dried to form quick-dissolving hydrous powders. When conditions warrant, such as limited storage on off-shore rigs, long hauling distances or extended exposure to sub-zero temperatures, hydrous powders can offer a cost effective alternative to liquid silicates.

One of the key parameters that determines the properties of soluble silicate solutions is the weight ratio of  $\text{SiO}_2:\text{Na}_2\text{O}$ . For example, a “2.0” ratio silicate has 2kgs of  $\text{SiO}_2$  for every 1kg of  $\text{Na}_2\text{O}$ . The molecular weight of  $\text{SiO}_2$  and



Na<sub>2</sub>O are so close that the molar and weight ratios are said to be the same for all sodium silicate products. However, it should be noted that the molar and weight ratios for potassium silicates differ significantly. In terms of silicate anion structure and relative concentration, liquid silicates with higher ratios will contain proportionately greater levels of condensed, complex species with higher molecular weights. Similarly, as seen in Figure 1 on the previous page, the low and mid ratio liquids will contain significant levels

of low molecular weight chains and cyclics as well as free monosilicate. These changes in silicate speciation can have a measurable impact on drilling fluid rheology, shale inhibition and overall mud stability. Ratio selection is therefore an important consideration in formulating silicate drilling fluids.

## Chemistry: Advantage EcoDrill®

Drilling fluids using EcoDrill® products are known for providing superior well bore stability. In-gauge holes are achieved through a unique combination of versatile chemical reactions; most notably gelation and/or precipitation on shale surfaces.

**Gelation** is the self-polymerization or condensation of soluble silicate structures to form a hydrous, amorphous gel structure of silicate. Gelation is brought on by a drop in pH with polymerization beginning to rapidly occur at pH below 10.5.

**Precipitation** of silicate is the cross-linking of silicate molecules by multivalent cations (i.e. Ca<sup>+2</sup>, Mg<sup>+2</sup>, Al<sup>+3</sup>, Fe<sup>+3</sup>, etc).

It is generally believed that as the silicate in the mud comes into contact with the slightly acidic (pH 6-8) and multivalent-rich pore water, a localized gelation reaction, coupled with a minor amount of precipitation, takes place to block both the influx of mud and pressure into the formation. These reactions also lead to the sealing of microfractures, cracks and rubble giving EcoDrill® a decided advantage over any oil mud, significantly reducing potential mud losses and costs.

These unique gelation and/or precipitation mechanisms also make EcoDrill® a natural fluid loss agent so there is little transfer of fluids and pressure into the formation, keeping the integrity of the wellbore intact. In addition to this unique chemistry, silicate drilling fluids provide a thin, tough, ultra low permeable filter cake significantly reducing drilling problems such as differential sticking or torque & drag, while providing improved cementing.

EcoDrill® formulations are proven performers in all parts of the world in a variety of drilling environments. Whether drilling in the North Sea, the Middle East, the North American Rockies, Mexico or South America, EcoDrill® helps deliver an in-gauge hole.



## ROP's: Advantage EcoDrill®

Field results from around the world demonstrate that silicate based drilling fluids have ROP's that favorably compare to any drilling fluid, including oil based muds. The high penetration rates observed using EcoDrill® are attributed to its excellent inhibitive properties. The EcoDrill® inhibition mechanisms prevent drill solids from being easily dispersed into the drilling fluid. It is not uncommon for a silicate mud to maintain its initial density throughout drilling. A silicate drilling fluid's ability to inhibit also means very little reaming, leading to little or no downtime.



## Runnability: Advantage EcoDrill®

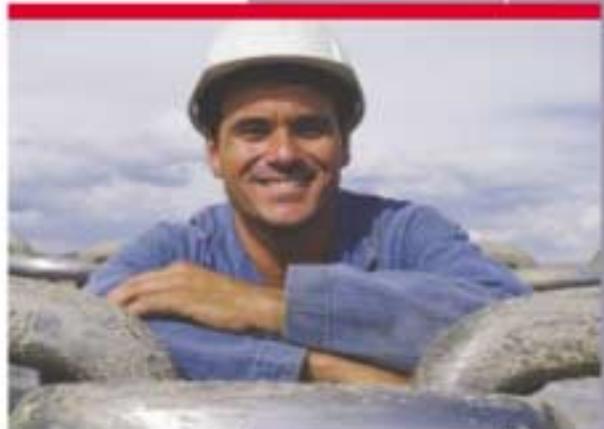
A drilling fluid using EcoDrill®, is an extremely easy system to run. EcoDrill® muds are easy to maintain with very slow and predictable depletion rates. Drilling fluids formulated with EcoDrill® typically contain fewer components making handling and logistics easier. Rheology tends to be unaffected by changing mud conditions. Monitoring the fluid condition is easy—a simple check every 24 hours will ensure optimum down hole performance.

## Safety: Advantage EcoDrill®

Worker Safety is paramount to every business, and with EcoDrill®, the advantage is clear. Our EcoDrill® products are extremely safe to handle. Sodium and potassium silicates are considered one of the most benign industrial chemicals in use today. In fact, the pH of silicates is very similar to liquid dishwashing detergent. The silicate HMIS rating is:

- Health rating - 1 (slight)
- Flammability rating - 0 (none)
- Reactive rating - 0 (none)

Silicates are generally recognized as safe (GRAS) by the USDA and FDA are **not** classified under the toxic and dangerous chemical group categories.

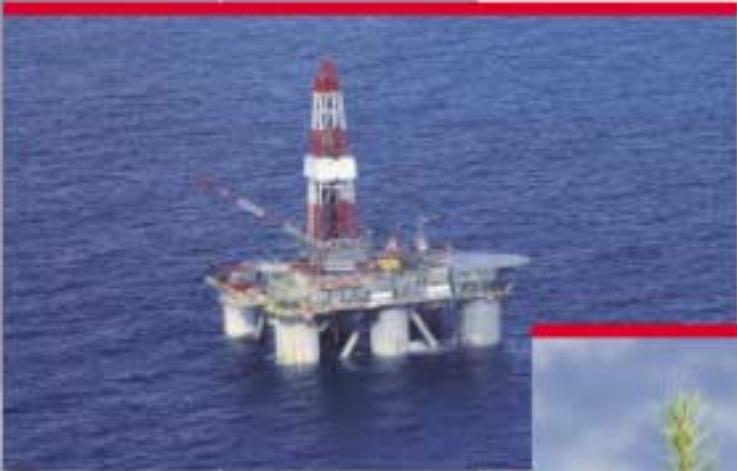


## Cost: Advantage EcoDrill®

With exceptional performance in the field, EcoDrill® muds are proving to be a cost effective alternative to oil-based drilling fluids as well as other high performance water-based drilling fluids. From the inhibition characteristics, to favorable ROP's, to the unbeatable environmental, health and safety benefits, EcoDrill® provides cost advantages delivered to the bottom line.



## Environment: Advantage EcoDrill®



Silicates are one of the few oil field chemicals that can be beneficial to the environment. Soluble silicates are derived from, and ultimately return to nature, as silica ( $\text{SiO}_2$ ) and soluble sodium and potassium compounds. Since these are among the earth's most common chemical components, they offer little potential for harmful environmental effects.



The addition of sodium or potassium silicate to seawater leads to their rapid precipitation to form calcium and magnesium silicates. These precipitates are relatively inert and non-toxic products.

It has been shown that marine life benefits from the presence of sodium silicate. In some parts of the world, sodium silicates are actually used as a nutrient for salmon, scallops and mussel farming.

Potassium silicate is approved in the USA as a potassium fertilizer and source of soluble silica. Potassium is a major plant nutrient while soluble silica has been shown to be beneficial to plant growth. Rice, cereal and grasses have been shown to benefit from the supply of soluble silica.



## Versatility: Advantage EcoDrill®

The EcoDrill® product line is gaining strong favor from both operators and drilling fluid companies alike. As silicate-based drilling fluids gain in popularity, EcoDrill® has proven to be a versatile drilling component. There is now a wide range of silicate-based drilling fluid formulations that have been developed to suit almost any drilling condition. The EcoDrill® line allows for better customization and ultimately lower costs.

PQ and its affiliates offer the widest range of sodium and potassium silicates worldwide. The EcoDrill® product line is available in both liquid and powder form in a wide variety of ratios.

### Liquids

Liquids are the preferred choice by most drilling fluid companies primarily for their convenience and ease of handling when formulating mud systems. The most commonly used EcoDrill® products are listed in the tables below.

PRODUCT NAME	DESCRIPTION	TYPICAL PROPERTIES				
		Density @ 68° F(20°C) Baumé	lbs/gal	Specific Gravity @ 68° F(20°C) g/cm <sup>3</sup>	Viscosity @ 20° C (Centipoise)	Solids %
EcoDrill® 203	A 2.6 ratio liquid sodium silicate	44.7	12.1	1.45	N/A	40
EcoDrill® 203-T1	A 2.6 ratio modified liquid sodium silicate with a lubricant additive	44.7	12.1	1.45	N/A	40
EcoDrill® 246	A 2.0 ratio liquid sodium silicate	50.5	12.8	1.53	400	44.1
EcoDrill® 246-T1	A 2.0 ratio modified liquid sodium silicate with a lubricant additive	50.5	12.8	1.53	400	44.1
EcoDrill® 154	A 3.22 ratio liquid sodium silicate suited for sweeps or ratio adjustment	41	11.6	1.38	180	37.6
EcoDrill® 317	A 2.5 ratio liquid potassium silicate	29.8	10.5	1.26	40	29.1

### Hydrous Powders

Hydrous powders are ideally suited for drilling in remote locations with limited bulk storage facilities or exposure to sub-zero temperatures for extended periods of time.

PRODUCT NAME	DESCRIPTION	TYPICAL PROPERTIES			PACKAGING
		Density @ 68° F lb/ft <sup>3</sup>	% Solids	Particle Size, (Tyler Screen)	
EcoDrill® 104	A 3.22 ratio spray dried sodium silicate ideally suited for ratio adjustment	44	81	89% thru 100 mesh	50 lb bags
EcoDrill® 115	A 2.0 ratio spray dried sodium silicate	46	81	80% thru 100 mesh	50 lb bags
EcoDrill® 310	A 1.6 ratio spray dried potassium silicate free flowing whitish powder	43	85	99% thru 40 mesh	50 lb bags
EcoDrill® 743	A 2.5 ratio spray dried potassium silicate free flowing whitish powder	42	85	99% thru 40 mesh	50 lb bags





# EcoDrill

## **PQ CORPORATION**

**Industrial Chemicals Division**

P.O. Box 840

Valley Forge, PA 19482-0840, U.S.A.

Tel: 800-944-7411 (Inside U.S.A.)

610-651-4200 (Outside U.S.A.)

Fax: 610-651-4504

[www.pqcorp.com](http://www.pqcorp.com)

## **IN CANADA**

**National Silicates**

Phone: 416-255-7771

## **IN MEXICO**

**Silicates y Derivados, S.A.**

Phone: 52-555-227-6801

## **IN EUROPE**

**PQ Europe**

Phone: 31-33-450-9030

## **IN AUSTRALIA**

**PQ Australia Pty. Ltd.**

Phone: 61-3-9708-9200

## **IN TAIWAN**

**PQ Silicates Ltd.**

Phone: 886-2-2383-0515

PQ Corporation, recently acquired by JPMorgan Partners, is a leading producer of silicate, zeolite, and other performance materials serving the detergent, pulp and paper, chemical, petroleum, catalyst, water treatment, construction, and beverage markets. It is a global enterprise, operating in 19 countries on five continents, and along with its chemical businesses, includes Potters Industries, a wholly owned subsidiary, which is a leading producer of engineered glass materials serving the highway safety, polymer additive, metal finishing, and conductive particle markets.



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