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**PQ Corporation is a privately held global enterprise operating in 20 countries, with annual revenues in excess of $500 million. PQ 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.**

**Potters Industries, PQ's wholly owned subsidiary, is a leading producer of engineered glass materials serving the highway safety, polymer additive, fine abrasive, and conductive product markets.**

**Bulletin 17-70**

# PQ® Liquid Sodium and Potassium Silicates - Storage and Handling

Liquid sodium and potassium silicates constitute two families of products, which range from moderately to strongly alkaline. Specific products within these families are usually defined by their silica-to-alkali "ratios" (i.e., $SiO_2$:$Na_2O$ or $SiO_2$:$K_2O$ weight ratios), in addition to other characteristics such as concentration, density, and viscosity.

PQ® liquid sodium silicates are aqueous solutions that range from pH 11.3 for 3.22 ratio products to pH 13.4 for 1.6 ratio solutions. PQ's potassium silicates range in pH from 11.3 for 2.5 ratio to 11.9 for 1.6 ratio.

## HANDLING PRECAUTIONS

Because of their alkalinity, care should be exercised in working with sodium and potassium silicates. In addition, silicate that has dried will become glass-like, thereby presenting a cut hazard. A thorough knowledge regarding the proper handling procedures and safety precautions of the silicate products should be employed by all users. All persons involved in handling the products should familiarize themselves with the first-aid procedures in the event of skin and eye contact or ingestion.

This information, along with procedures for handling spills, is provided in Material Safety Data Sheets (MSDS) supplied by PQ Corporation. The user should keep copies of the MSDS on file. For additional MSDS, contact the PQ Customer Assistance Center at 800-944-7411 or visit www.pqcorp.com. For chemical emergencies, call Chemtrec at 800-424-9300.

**Personal Protection.** Personnel involved in unloading and/or handling liquid sodium and potassium silicates should utilize protective clothing and equipment to prevent accidental contact. This equipment generally consists of: hard hat, chemical goggles or face shield, alkali-resistant rubber gloves, safety footwear, and coveralls.

## STORAGE ISSUES FOR LIQUID SILICATES

**Storage Temperature.** It is good practice to store liquid silicates at the lowest temperature needed to maintain a pumpable viscosity (i.e., 150-200 cP). Storage temperature will vary with each different product (see Figure 1). Higher temperatures may promote dehydration of the silicate, thus causing a surface skin to form. Tank agitation is necessary to prevent this gelatinous silicate skin from sinking to the bottom of the tank, building up on tank walls, plugging lines, or interfering with processes downstream. ***Liquid silicates should always be stored at a temperature below 140°F (60°C).*** For guidance on storage temperature for a particular product, contact PQ Technical Service at 610-651-4507.


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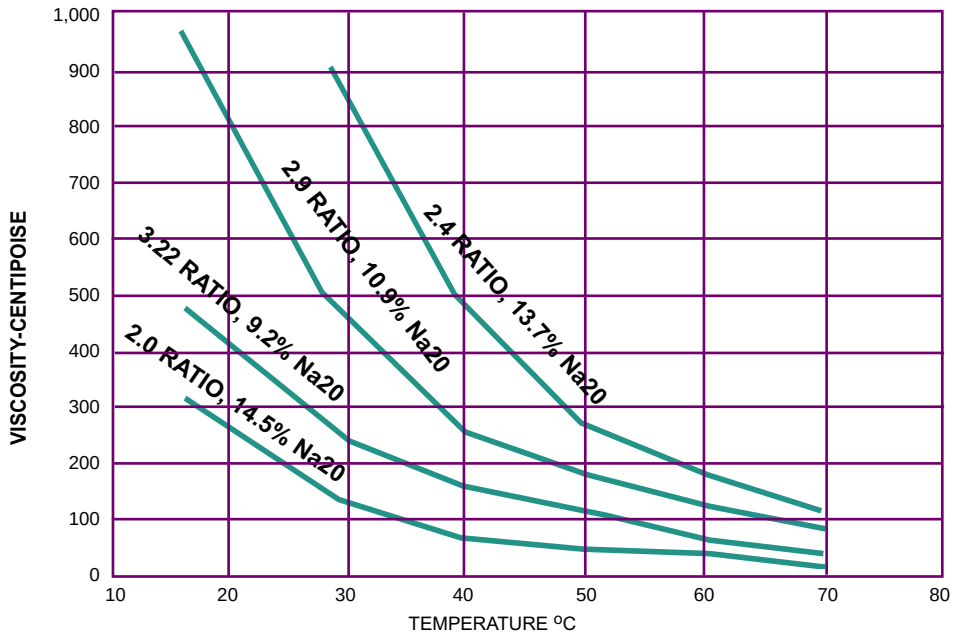
**FIGURE 1—VISCOSITY OF SODIUM SILICATE AS A FUNCTION OF TEMPERATURE**




**Freezing.** The freezing point of sodium and potassium silicate solutions is nearly the same as water, 32°F (0°C). If silicate cools to the freezing point, the water component of the solution begins to crystallize into ice, and this leaves the remaining portion of liquid over-saturated with respect to silica ($SiO_2$). As a result, the silica polymerizes into a gel. It may be possible to reconstitute frozen sodium silicate if it is thawed carefully and then mixed vigorously. It is significantly more difficult, however, to reconstitute frozen potassium silicate, and in most cases the product cannot be recovered.

The performance of a recovered product may not equal that of the original material. For more information on recovering frozen silicate, contact PQ Technical Service at 610-651-4507.

**Minimizing the Accumulation of Storage Tank Sediment.** It is the nature of sodium and potassium silicate liquid, regardless of the manufacturing method, to contain a small amount of suspended particles that can accumulate over time at the bottom of the storage tank. To minimize this accumulation of sediment, PQ recommends sloped-bottom or cone-bottom tanks. Recirculation of the liquid in the tank and prevention of silicate dehydration will also help. In addition, a maintenance schedule of inspection and tank cleaning is strongly recommended. If sediment is not controlled, tank capacity may be reduced, lines may become plugged, and soft gelatinous sediment may transform into a hard, persistent mass that can be costly to remove. If a routine maintenance program has not been implemented and removal of accumulated sediment becomes necessary, PQ can help identify the type of sediment that has collected and provide a list of professionals who can remove it. Although not hazardous, storage tank sediment is a regulated waste and should be disposed of in accordance with federal, state, and local regulations.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# TANK RECOMMENDATIONS FOR BULK STORAGE OF LIQUID SILICATES

Liquid silicates can be stored in either horizontal or vertical tanks constructed of carbon steel, stainless steel, fiberglass-reinforced plastic, or other suitable materials.

*NOTE: Aluminum and brass tanks and fittings are not suitable for liquid silicate storage since they can be attacked by alkaline solutions.*

Storage tanks and their supporting structures should be designed to contain liquid silicates with densities ranging from 1.31 to 1.68 g/cm$^3$ (82 to 105 lb/ft$^3$). Also, the tanks should meet all local code requirements and regulations. To reduce the accumulation of tank sediment, PQ recommends implementing one of the following:

- Use a tank with a cone bottom, and pipe the outlet line to come directly off the bottom.
- Use a tank with the bottom sloped to the outlet line.
- Install an agitator or tank recirculation system.

Commercial recirculation systems consist of a pump and piping installed several inches above the tank bottom. The pipe assembly may be circular with eductors at intervals around the circumference of the circle. Compressed air can be used as the motive force.

**Tank Location.** It is desirable to locate liquid silicate storage tanks in a heated building to minimize the possibility of the silicate freezing and to avoid pumping problems associated with increasing product viscosities due to cold weather.

For tanks located outside or in unheated buildings, provisions should be made for insulating the tank and/or for heating the contents with an external coil and low-pressure steam. This will prevent the liquid silicate from freezing and maintain a suitable viscosity for pumping (see Figure 1 for guidelines).

**Heating Methods.** When heating of the silicate becomes necessary, external heating is preferred. This may be provided by electrical heating tapes and/or blankets, or external steam plates (15 psig maximum steam pressure is recommended). Continuous agitation of the silicate is suggested to prevent localized over-heating and possible dehydration. Agitation can be accomplished by providing a recirculation loop between the storage tank and the day tank or the process equipment via a return bypass.

Internal heating is generally not advisable. It can cause localized dehydration of the silicate, resulting in a buildup of solid silicates on the heating surfaces. If internal heating is used, the silicate temperature should not exceed 140°F and continuous mixing of the contents is recommended. Internal surfaces should be inspected regularly for solids buildup. If buildup occurs, the tank should be emptied and the silicate buildup should be removed by dissolving it with steam and/or a dilute solution of caustic soda (NaOH).

*NOTE: Do not heat fiberglass or plastic tanks. If heat is applied and there is no mixing, dehydration occurs and the resultant hard, dehydrated product cannot be cleaned by the usual methods without damaging the tanks.*


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**Tank Fittings.** To ensure proper performance and facilitate maintenance, liquid silicate storage tanks should be fitted with the following:

- A 48-inch diameter manhole, with a hinged or bolted cover to permit access for inspection and cleaning.
- An appropriate liquid-level indicator. This can be a measuring stick calibrated to the tank's capacity per unit of liquid level, a sight glass, or a more complex liquid-level measuring instrument.
- A vent, properly sized for the tank volume and pumping rate.
- A silicate filling inlet line at the top of the tank.
- A silicate removal line at the bottom of the tank.
- An overflow line for spill control, to protect paint and insulation, and to ensure maximum liquid head space in the tank.
- A 20- to 24-inch bolted side port, with an alkaline-resistant gasket, near the bottom of the tank for cleaning and inspection.
- Ladders and platforms necessary to provide access to the top of the tank, valves, fittings, etc., which comply with OSHA requirements.
- It is good practice to use an overflow alarm system to prevent spills of the product.

**Spill Containment.** Provisions should be made to provide secondary containment of storage tanks and loading areas, if not required by local environmental regulations. This will avoid loss of product and/or environmental contamination due to spills or leakage.

Generally, the secondary containment should be sized to hold the contents of the largest storage tank plus 10% excess. All valves that penetrate the dike walls of the secondary containment should be closed and locked down when not in use.

**Annual Inspection.** New tanks should be washed and rinsed before filling to remove scale, grease, and dirt. Metal tanks should then be "painted" inside with a dilute silicate solution to prevent rust. Thereafter, they should be inspected periodically for structural defects, corrosion, and other potential hazards or contamination.

Tanks should be inspected externally for any signs of leaks. The tank vent and overflow lines should be inspected, and any blockage or buildup of material or debris removed. Insulated tanks should be inspected for rain intrusion. Check capping and flashing at the top of the tank, and make sure the rainwater drain line is clear. The insulation at the bottom of the tank should be checked for wicking or other signs of water intrusion that cause rust. External steam coils should be pressure tested annually.

The tank should be inspected internally for the accumulation of sediment and, if necessary, emptied and cleaned to remove the sediment.

## PUMPS & PIPING

Pumps for handling liquid silicates are selected on the basis of the viscosity of the product(s) to be used, temperature conditions, required flow rates, and piping system characteristics.

Pumps should be equipped with casing drains to permit draining and washing when the need arises.


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Ordinary iron-pump bushings are satisfactory. Carbon-graphite bushings should not be used.

**Positive Displacement Pumps.** For flows less than 10 gpm, and for higher viscosity liquid silicates (above 400 cP), positive displacement pumps are preferred. They are self-priming and operate against a suction lift. (For higher flow rates, either positive displacement or centrifugal pumps are typically used).

A relief loop arrangement should be provided to relieve pressure if there is a blockage on the pump's delivery side, thus avoiding pump or piping damage and a possible unsafe condition. The stuffing box should be deeper than normal to allow maximum absorption of any silicate that might seep past the ring seal.

**Centrifugal Pumps.** These pumps can be used with low viscosity silicates (less than 400 cP). Higher viscosity products can cause slippage and cavitation of the material, resulting in elevated temperatures due to friction. This in turn may cause dehydration of the silicate and excessive wear of the pump. Centrifugal pumps of 1750 rpm are recommended, rather than 3500 rpm pumps.

**Diaphragm Pumps.** This type of pump has been used successfully to move silicate products. They are efficient when pressurized air lines are available.

**Pump Relief Valve.** A 2-inch Cash Standard Class D relief valve set at 15 psi should be installed in the pump discharge line to allow liquid to return to storage when it is not being pumped to a batching tank or to process. All piping suction discharge lines should be a 1/2 inch larger in diameter than the pump ports.

*NOTE: It is suggested that you consult your pump supplier for additional information and assistance needed to select the proper type and size of pump for the silicate product(s) you process.*

**Piping.** Liquid silicates can be handled in carbon-steel (black iron) or stainless-steel pipes. Brass, copper, or aluminum pipes should NOT be used.

The size of piping is determined based on the distance the silicate is pumped, the pumping rate, and its viscosity.

Tees should be installed in place of elbows at key locations to permit easy cleaning.

In order to minimize viscosity changes due to wide temperature variations, it may be desirable to insulate the piping.

**Valves.** Cast-iron or carbon-steel valves are suitable. "Teflon® "-coated plug valves, butterfly valves, and gate valves are preferred. Globe valves, which may stick more easily, are less desirable.

If lines are not kept completely full, steam or a warm alkaline solution should be used to purge valves when not in use.


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**Meters.** In-line meters are useful in maintaining accurate process control. Mass flow meters offer accurate readings, which are independent of changes in viscosity, temperature, or density.

**Strainers.** These are often employed to prevent contamination of mixtures or downstream equipment with large particles. Screens of 1/8 - to 1/4 -inch size are usually used, but actual selection will depend on pump clearances and/or tolerance of the process to particle size variation and amount of solids.

As a general rule, the screen area should be four times the cross-sectional area of the pipe. Basket or Y strainers are suggested. The following basket sizes are recommended, based on the flow rate:

| Flow, gpm | Basket Size |
|---|---|
| 18 | 1 ” |
| 50 | 2 ” |
| 140 | 3 ” |
| 250 | 4 ” |
| 550 | 6 ” |

## UNLOADING BULK SHIPMENTS

Bulk shipments of PQ liquid sodium and potassium silicates are generally shipped in tank trucks or railroad tank cars. The following suggestions are provided to facilitate safe and efficient unloading operations.

**Personal Safety Precautions.** Refer to “Handling Precautions” on page 1.

**Pre-Shipment Planning.** PQ customers, especially new customers, can expedite deliveries by providing the following information when placing their orders:

- Diameter of the inlet pipe and the type of fitting provided (i.e., threaded, quick-connect, etc.). Its diameter should be at least 3 inches.

- Distance from the inlet pipe to the location at which the tank or truck car will be unloaded. Normally, a tank truck is equipped with 40 feet of hose. The carrier may be notified if additional hose is required, and the customer will be charged for this service.

It is recommended that bulk liquid silicate storage tanks be located near the delivery point and, preferably, not far from the process point where it will be used.

The equipment and facilities that come in contact with the silicate when it is delivered should be clean and free of any contaminants to ensure the product’s integrity. Also, the customer should check storage tank levels prior to delivery to be certain there is sufficient tank capacity available to accept the quantity received.


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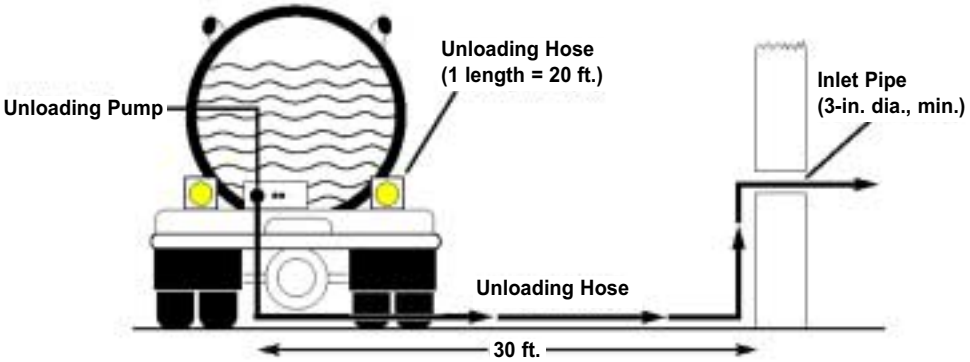
FIGURE 2—TYPICAL ARRANGEMENT FOR UNLOADING OF LIQUID SODIUM AND POTASSIUM SILICATES FROM A TANK TRUCK




## TANK TRUCK UNLOADING

It is recommended that quality checks of the product be made before it is unloaded. Tank trucks should be positioned for unloading on a containment pad that provides sufficient capacity to contain the contents of the trailer in the event of an accidental spill.

Usually, 3-inch flexible hoses are used for unloading liquid silicates to minimize delivery time. These are supplied by the carrier and are provided with various sizes and types of fittings, including a quick-connect coupling.

Transfer from tank trucks is usually accomplished in one of the following ways:

**Gravity** – The material flows by gravity directly to storage or to a customer-supplied pumping station.

**Truck-Mounted Pump** – The pump transfers the silicate to the customer's storage tank.

**Compressed Air** – Pressurized air is supplied by the customer from a truck-mounted unit. Generally, when compressed air unloading is going to be used, the customer should advise the PQ sales or customer service representative at the time the order is placed. The fill line connection should be no more than 3 feet above ground level, and it should be threaded and capped to prevent entry of foreign material.

A typical arrangement for unloading tank trucks is shown in Figure 2.

## TANK CAR UNLOADING

In addition to the precautions for handling liquid silicates as described on previous pages, the following DOT-required safety precautions should be followed with railroad tank cars:

- Be sure handbrake is set and wheels are blocked after the car is spotted.
- Place appropriate Federal Railway Administration (FRA) caution signs at each end of car warning that it is being unloaded or connected.
- Be sure derail attachments are in place at the ends of the siding.
- Goggles or face shields should be worn. Transfer of liquid silicate from tank cars to storage can be accomplished by the following means: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**Gravity or Pumping** – These are the preferred methods.

When using either of these methods, it is important that the tank car shell be vented by opening the car's dome cover; or with domeless tank cars by opening the vacuum relief valve. Once vented, the car's outlet valve is opened and the contents are transferred.

The car interior should be inspected once unloading has been completed.

**Compressed Air** – This is the least desirable method for use with tank cars.

If this method is employed, however, an air-control assembly must be applied carefully, and the air pressure should never exceed 25 psi during unloading.

The sound of clear air through the discharge line signals the completion of the unloading process. After the air pressure has been released, the car interior should be inspected to ensure it is empty.

Figure 3 shows a typical arrangement for unloading a rail tank car.

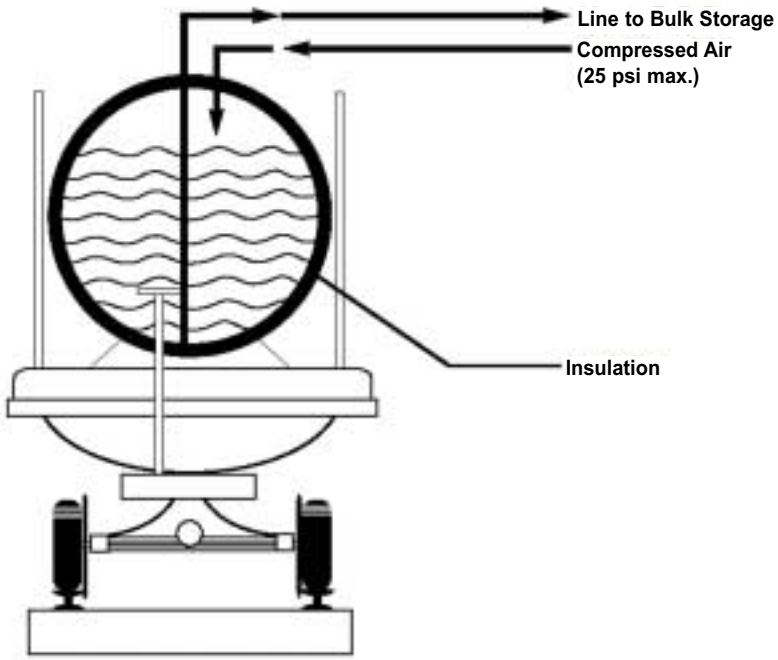
## PERIODIC MAINTENANCE OF SILICATE STORAGE SYSTEMS

It is good practice to examine the equipment and facilities employed for unloading, storing, and distributing liquid silicates on a regular basis. This will ensure consistent product quality and trouble-free equipment operation.

## PUMPS

- Check pumps, renew packing, and clean as required – including drive motors.
- Check water supply and drainage at packing gland (where water is used in the lantern ring) or over the gland.

**FIGURE 3—TYPICAL ARRANGEMENT FOR UNLOADING LIQUID SODIUM OR POTASSIUM SILICATES FROM A TANK CAR WITH COMPRESSED AIR**

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- Check operation of pressure relief valve on rotary positive displacement pumps.
- Check manual suction and discharge shut-off valves for good operation, including packing around stems. Renew as required.
- Check strainers.

## CARE AND MAINTENANCE OF STUFFING BOX AND PUMP SHAFT

The stuffing box should be deeper than normal to allow for the maximum absorption of any silicates that might seep past the ring seal. Care should be used when installing the packing. This includes tightening the follower itself after the packing has been properly installed. Tightening the follower with either water or grease will promote good performance. The adjusting nuts on the follower should be taken up uniformly and finger-tight. Excessive tightening will squeeze the packing, increase the friction at the shaft contact surfaces, and accelerate wear with attendant leakage around the shaft. Progressive tightening will tend to aggravate wear on these surfaces.

It is good practice to drip water onto the motor shaft at the seal to dissolve any silicate which might seep through the seal and otherwise dry on the shaft, damaging the seal. Water can also be piped through the lantern ring with a 1/4 -inch copper tubing to a 1/4 -inch hole drilled in the gland just behind the gland flange, or to the outside in front of the flange. This should not be done under pressure because the water could then work its way back past the seal, into the silicate, and dilute it. A Teflon-type stuffing material should be used in the stuffing box.

## VALVES

- Check all valves in the distribution system for good operation and proper closure.
- Check valve-stem packing and renew as required. Remove faulty valves and replace them.
- Check foot valve in tank on pump suction line, where used, in conjunction with cleaning.

## STORAGE TANKS

- Check liquid-level indicators for performance.
- Check top manhole cover. Be sure it is properly in place at all times.
- Check air vent to determine that it is open to the atmosphere.
- Check the heating system where used. If submerged coils are used, clean them at the same time as the tank. Neglecting this operation contributes to buildup of silicate solids on the coils, resulting in poor heat transfer.
- Check thermostatic controls.
- Check for accumulation of sediment by surrounding the tank with a steel rod or a weighted tape measure.
- Schedule tank cleaning if needed. Remove sediment manually or by high-pressure water jet. Disposal of waste should be in compliance with federal, state, and local environmental requirements.