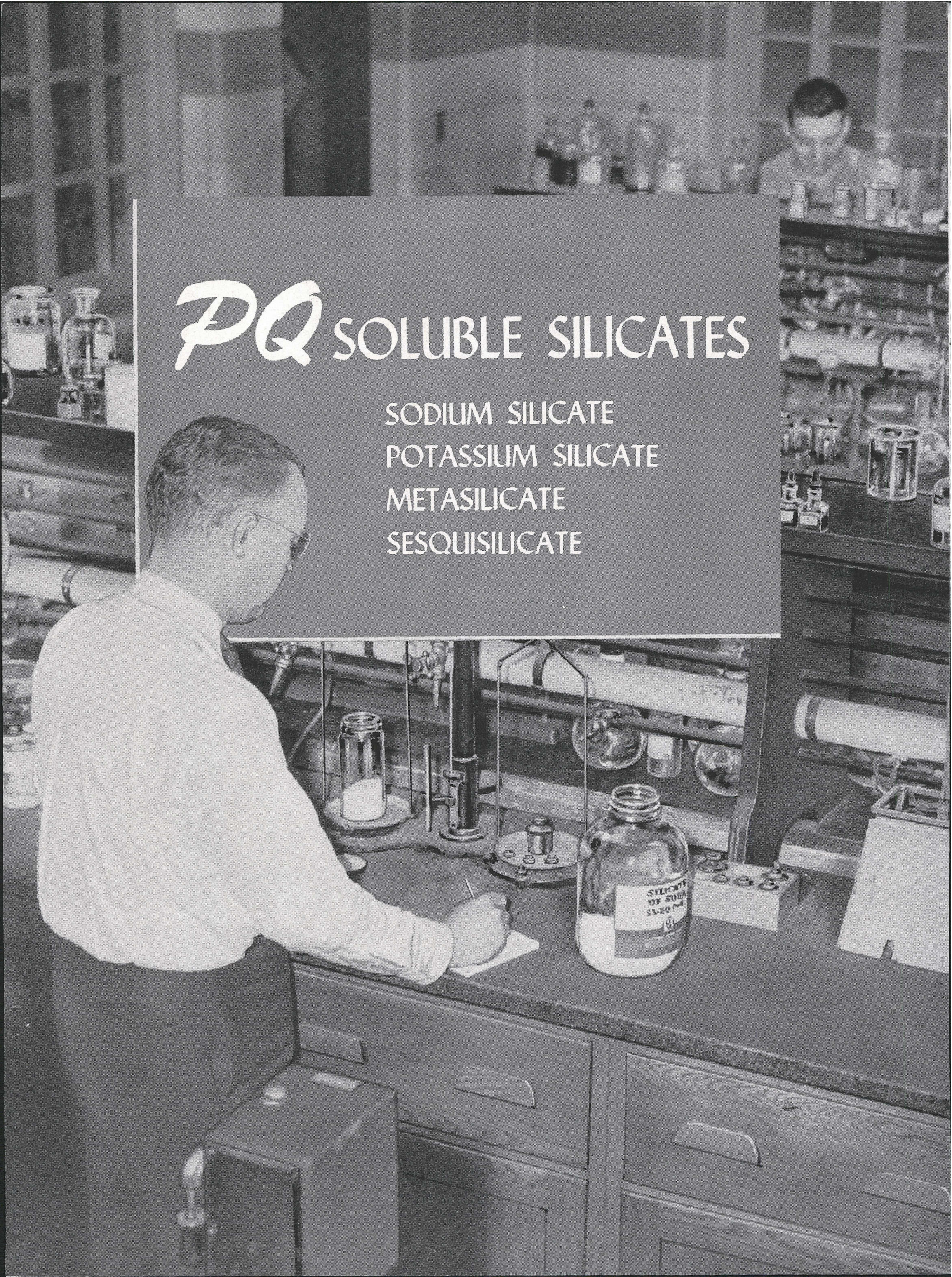
H. J. Hall

PQ soluble silicates | properties, applications

BULLETIN 17-1

Philadelphia Quartz Company | *Philadelphia 6, Pa.*


PQ SOLUBLE SILICATES
SODIUM SILICATE
POTASSIUM SILICATE
METASILICATE
SESQUISILICATE

PQ SOLUBLE SILICATES as a group of chemicals are useful to various industries because of the wide range of their physical and chemical properties. Among the industries using soluble silicates are soap, paper, paperboard, oil, rubber, textile, mining, ceramics, glass, enamelware, construction, foods, metals, cooperage, zeolite. Also developed with the aid of our research staff are other uses not related to a specific industry, such as, the coating of granules used on asphalt shingles, the commercial washing of apples, the solidification of unstable earth, the prevention of corrosion in hot and cold water lines, coagulating aids for treating raw water supplies and waste waters. The research chemist and the development engineer find the study of PQ Soluble Silicates rewarding, for here are properties which efficiently and economically can solve many of the problems that arise in chemical processes, old or new.

PQ SODIUM SILICATES

Silicates are manufactured by melting together at high temperatures, alkali (Na_2O) and a specially selected silica (SiO_2). The resultant product is a glass, clear, transparent and green in color.

Theoretically, alkali and silica may be combined in all proportions but present commercial products do not exceed a silica to alkali ratio of about four to one by weight because of the very low solubility of fused silicates above this ratio. By varying proportions of the ingredients—alkali, silica and water, by regulating the concentration and by special processes, some 50 products are available in the PQ catalog of soluble silicates. They range from readily and highly soluble crystals to white powders which are sparingly soluble even in boiling water; from slightly sticky fluids of the consistency of maple syrup, to heavy viscous materials which barely flow; soft plastic masses which bounce like rubber, sticky plastics which behave like old-fashioned taffy, and lumps of transparent glass.

Before describing the PQ products, it must be pointed out that silicates are for the most part loosely joined combinations of alkali and silica and the formula must be written to show this, i.e., a silicate having a ratio of 1 part alkali and 3 parts silica would carry the formula $Na_2O{\cdot}3SiO_2$. In a few cases, however, the silicates are definite chemical solids. Metasilicate, for instance, is properly designated as Na_2SiO_3.

RATIO

Since a molecule of Na_2O weighs very nearly the same as a molecule of SiO_2 the molecular ratio and percentage ratio are very nearly equal. Consequently it has become standard practice to use percentage ratio for all sodium silicates more siliceous than the metasilicate (1:1). In the case of potassium silicate the molecular weights of alkali and silica are so unlike that it is necessary to calculate the molecular ratio. PQ Silicates in ratio of alkali (Na_2O) to silica (SiO_2) include products from $3Na_2O{\cdot}2SiO_2$, to $Na_2O{\cdot}3.75SiO_2$. The commercial solutions are obtainable in concentration from 35° Baumé (specific gravity 1.318) to 67.5° Baumé (specific gravity 1.871).

PROPERTIES

The commercial sodium silicate solutions are colloidal. As adhesives or binders they set by removal of comparatively small amounts of water. The solutions of low soda ratio are relatively "short." As the amount of alkali increases, the solutions become increasingly tacky. The colloidal nature is indicated by the fact that the boiling point of the silicate solution is little higher than that of water; even in the 67° Baumé solution which contains 62% of solids, much colloidal matter is present. The freezing point is very slightly less than that of water. The 40° Baumé silicate freezes at about 28° F. and becomes opaque and white. In freezing there is a rapid growth of long crystalline masses which contain more water than the 40° Baumé solution. When such a solution is slightly warmed, the crystals tend to float, and it often happens that drums or tank cars of sodium silicate (40° Baumé) when frozen and then thawed will contain highly concentrated silicate at the bottom and a relatively dilute solution on the top. These are readily mixed together so that the solution is identical in proportions to the original. Solutions above 60° Baumé do not lose their transparency on freezing but become harder, and finally brittle. Likewise, when warmed to ordinary temperature they do not separate into concentrated and dilute portions.

Water is the solvent for silicate of soda. The anhydrous lump and powdered silicates of low soda ratio are difficult to dissolve. Those of high alkalinity dissolve a little more readily and the hydrated powders are easily soluble. Anhydrous glass (our "SS"), in the specially designed PQ

stationary vertical dissolver, produces 41° and 42° Baumé silicates.

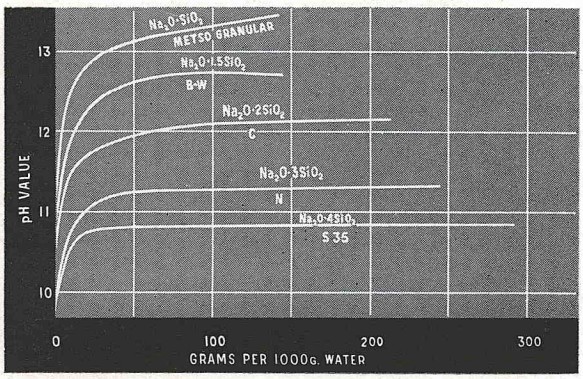
The specific gravity of silicate solutions increases regularly when concentrated. For a given concentration, the solution of a more alkaline salt has a higher specific gravity. Conversely the specific gravity of silicate solutions decreases with increasing temperature. The more concentrated the solution, the smaller is the coefficient of expansion.

The pH (alkali activity) of silicate solutions of compositions corresponding to metasilicate and several of our liquid products at various concentrations is shown in the chart below. The effect of lower pH with increasing silica, and change of pH with concentration is indicated. Electrometric titrations with acids show that the high pHs of silicate solutions are maintained until almost completely neutralized and that soluble silica increases their buffer capacity, i.e., the ability of the solution to resist changes in pH. Hence, within limits the silicate solution will maintain a fairly constant pH despite the addition of acid.

All silicate of soda is alkaline in reaction. Dilute acid may be added to diluted silicate to neutralize a large part of the alkali without forming a gel. Where a concentrated solution is desired, attempts to neutralize the alkali result in the precipitation of the silica as silicic acid which yields an entirely different product.

The ability to form sols and gels is one of the most interesting characteristics of sodium silicates. When a silicate solution is mixed with a solution of an acidic material, the mixture gradually becomes opalescent, and if the silica concentration is above one to two percent, it sets to a gel. Solutions with a lower concentration of silica form silica

pH values for various P.Q. Silicates



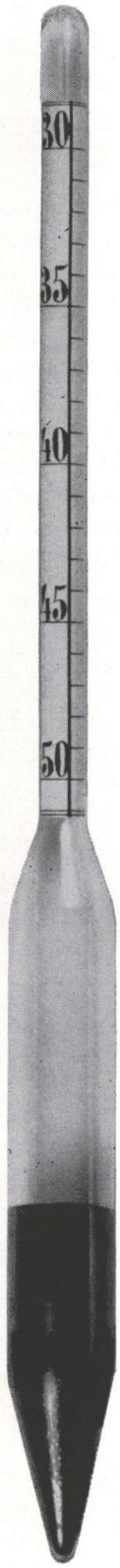
sols whose highly hydrated colloidal particles are negatively charged except in moderately concentrated acid solutions. All acids or acid-forming materials, such as chlorine, sulfur dioxide, ammonium salts, bi-sulfates, and bicarbonates, form sols or gels under these conditions. Sodium aluminate, zincate, and plumbate solutions also form gels with soluble silicate solutions. Precipitation likewise may be effected by various liquids which tend to dehydrate the silicate solution. For instance, alcohol, glycerin, salt brine, and strong ammonia solutions will precipitate concentrated solutions of sodium silicate. Such precipitates may be re-dissolved, but the second solution has somewhat different characteristics from the original silicate solution, notably viscosity. Silicate of soda is precipitated by most salts of the heavy metals, and the precipitates are believed to contain free silicic acid along with metallic silicate.

PQ POTASSIUM SILICATES

Solutions of potassium silicate with silica to potassium oxide ratios of 2.5 and 2.1 by weight corresponding to molecular ratios of 3.9 and 3.3, are available. The potassium silicates are used where the presence of sodium is objectionable. In the manufacture of television tubes, potassium silicate rather than sodium is used for holding the phosphors to the glass. Potassium silicate does not fluoresce and therefore does not affect the color of the emission. High solubility and small tendency to salt out soap together with marked detergency recommend the use of potassium silicate in liquid and rapid sudsing soaps. The comparative freedom from the tendency to effloresce makes potassium silicate preferable for paints, coatings and binders.

ANALYSIS OF SILICATES

The most common check used for silicate of soda in the trade is for density. For this the hydrometer is used. The depth to which it sinks is controlled by the weight of the instrument and the buoyancy of the liquid and is read down on the graduated stem of the instrument. There are numerous sources of error which must be considered. Silicate solutions expand when heated. Thus, a quart of silicate at 68° F. will measure more than a quart when heated, i.e., a quart at a high temperature will weigh less than another quart at a low temperature. Therefore, when silicate is warm the hydrometer will show a low reading. Occasionally



Hydrometer used for soluble silicate solutions.

Temperature (Fahr.) vs. Viscosity (Centipoise)

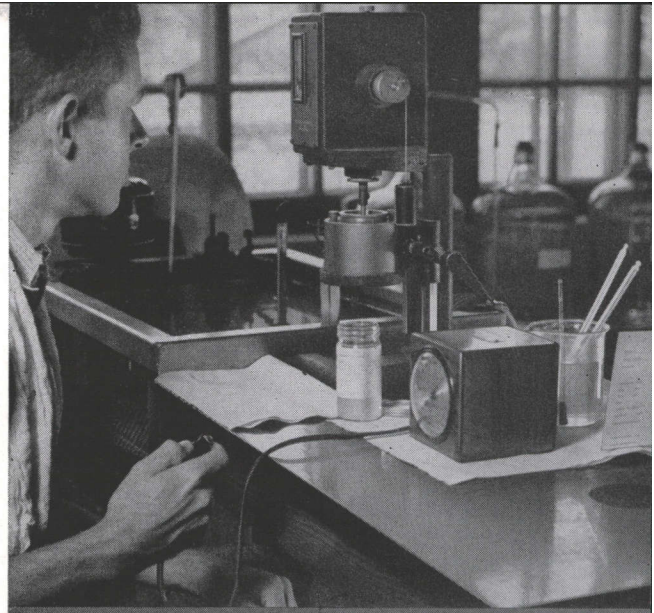
°F	S 35	N	O	K	RU	D
50	400	340	680	1680	...	800 cp
70	190	170	375	750	1700	280
90	80	90	200	360	795	120
100	55	65	155	275	520	90
120	30	35	95	170	260	40
140	20	20	60	110	145	25

Temperature (Fahr.) vs. °Baume

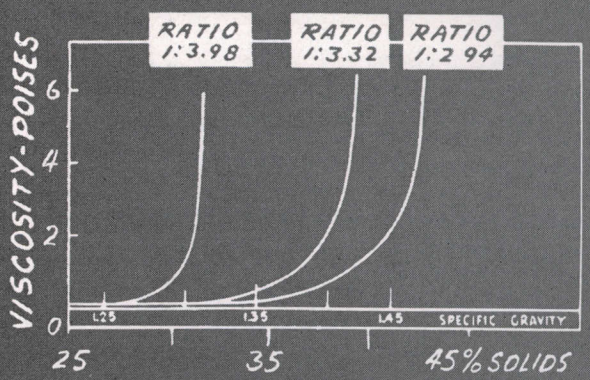
°F	N	O	Star	C
50	41.5	42.6	42.4	59.6° Bé
70	41.0	42.2	42.0	59.3
90	40.6	41.7	41.5	58.9
100	40.3	41.4	41.3	58.7
120	39.9	41.0	39.8	58.4
140	39.4	40.5	40.4	58.1

the paper scale becomes loose inside the tube and shifts enough to give a wrong reading. Dirt or dried silicate accumulated on the stem increases the weight and creates errors. Hydrometers which have been kept for a long time under water or in weak alkaline solutions lose enough weight to affect their accuracy. For best results hydrometers should be thoroughly washed and dried immediately after use. It must be kept in mind that the hydrometer is accurate only to about 0.2° Baumé. Where extreme accuracy is required, a pycnometer or specific gravity bulb is recommended.

In controlling the quality of PQ Silicates many tests are made in the PQ laboratories. In addition to checking on the alkali and silica content, for instance, the measurement of viscosity of solutions is important. A device which we use for measuring this value is the Stormer Viscometer. Flow-out type viscometers are not satisfactory for silicates. To assure dependability, viscometers must be calibrated frequently. Certain silicates for special uses require other controls such as stability, clarity, color, and for some of the powders, moisture and solubility. "Quartz Quality" in soluble silicates means uniform standards, plus experience. Constant control of quality is maintained by analysis in our laboratories of all raw materials used, by careful inspection of equipment and by subsequent testing of the finished silicates. The assurance of such uniformity enables the user in turn to maintain close control of his processes. Every delivery must be capable of performing in the same manner as the previous delivery; otherwise, losses much greater than the value of the silicate may result. Each of the PQ Silicates has been carefully formulated for the specific uses for which it is recommended, and alkali-silica ratio, water content and other characteristics are worked out to produce the quality needed. The specification for each product is rigidly followed to insure dependable service.

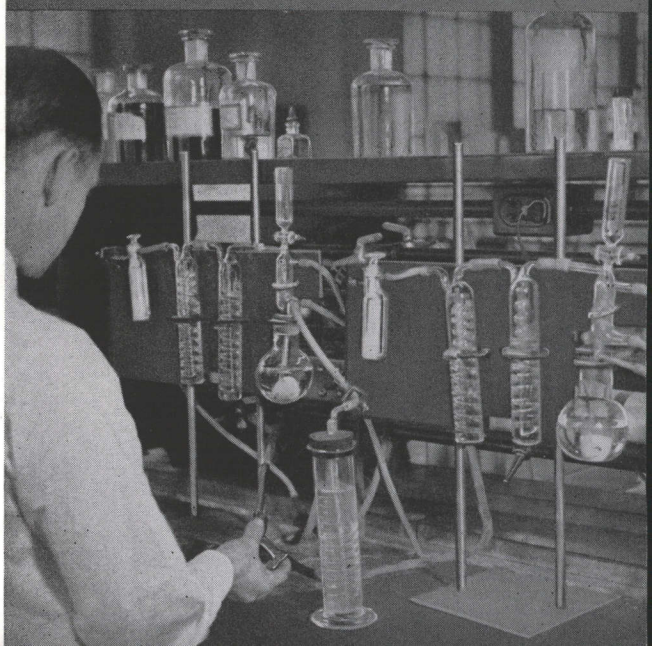


Quality closely guarded in PQ Control Laboratories. Above, measuring viscosity.



Relation of viscosity of sodium silicate adhesives to their specific gravity and solids content. Molecular ratios.

Measuring CO_2 for PQ quality metasilicate.



The most popular of the PQ Silicates are listed below. As new uses are discovered or changes in processes may call for other combinations, PQ headquarters is alert to serve special requirements. *Indicates trade mark registered U. S. Pat. Off.

The Baumé and viscosity values shown are average values, as each product requires a practical although narrow tolerance. Sodium silicate ratios are percentage ratios. Potassium silicates are quoted on the molecular basis.

P.Q. LIQUID SILICATES

All values determined at 68° F.

Product Name	*Approx. Ratio Alkali-Silica*	*Baumé Degrees*	*Viscosity Poises*	*Characteristics*
S*35	1:3.75	35.0	2.2	Consistency of thin syrup. Least alkaline
Stixso* DD	1:3.40	39.7	3.3	Special ratio adhesive for corrugated board manufacture
R*	1:3.25	42.5	7.5	Opalescent
N*	1:3.22	41.0	1.8	Opalescent, syrupy liquid
N* 38	1:3.22	38.0	0.6	Very fluid solution
E*	1:3.22	40.0	1.0	Specially clarified
O*	1:3.22	42.2	4.0	Somewhat more concentrated than N
K*	1:2.90	47.0	9.6	Sticky heavy silicate
Seal*	1:2.90	47.0	9.6	Colored green for quick identification in shipping room
M*	1:2.54	50.5	11.2	Opalescent, viscous
Star*	1:2.50	42.0	0.5	Brilliantly clear, stable solution
RU*	1:2.40	52.0	17.0	Heavy syrup
D*	1:2.00	50.0	2.8	Syrupy alkaline solution
C*	1:2.00	59.3	700	Heavy alkaline solution
J*	1:2.00	59.3	700	Viscosity controlled within narrow limits
J*A*	1:2.00	59.3	700	Prepared for use with silicon carbide abrasives
Starso*	1:1.80	44.6	0.6	Specially clarified solution
B*	1:1.60	67.5	587,000	Highly alkaline; very viscous
B-W*	1:1.60	58.5	70	Same ratio as B but more fluid

POTASSIUM SILICATES

	$K_2O:SiO_2$			
Kasil* #1	1:3.9	28.0	0.4	Clear, thin, syrupy solution
Kasil* #6	1:3.3	40.75	17.5	Heavy, viscous. Opalescent

PQ SILICATES IN LUMP AND POWDER FORMS

The following show approximate composition of the important dry PQ Silicates. More details on their properties are available in Bulletin No. 17-2.

In the case of metasilicate and sesquisilicate, as true crystals, the formulae given are on the molecular basis including water of crystallization.

	Na_2O	SiO_2	H_2O	*% Ratio*	*Description*
SS*	23.5	75.7	0	1:3.22	Anhydrous glass. Cast in plates.
G*	19.4	62.5	17.5	1:3.22	Hydrated powder; quickly soluble.
GD*	27.5	55.0	17.5	1:2.00	Hydrated powder; highly alkaline; rapidly soluble.
SS*-20-Pwd	23.3	75.0	0	1:3.22	Anhydrous; passes 20 mesh; very slowly soluble.
Noheev*	30.8	61.6	0	1:2.00	White alkaline powder.
SS*-65-Pwd	23.1	74.1	0	1:3.22	Nearly anhydrous; very slowly soluble.
SS-C*-Pwd	32.7	65.4	0	1:2.00	Anhydrous alkaline powder. Slowly soluble.
Metso* Granular	29.4	28.7	41.7	1:1:5	Hydrous crystalline powder; very easily soluble.
Metso 99*	36.7	24.2	38.1	3:2:11	Hydrous powder; very easily soluble; high pH.

USES OF PQ SILICATES

Soluble silicates have many useful properties which are not shared by other alkaline salts. This together with the fact that they are low in cost has led to wide utilization in various industries. The Philadelphia Quartz Company started about 1858 to manufacture silicate of soda for its own use in soaps. The virtue of silicated soaps soon induced other soap producers to buy the new chemical. Silicates were tried for other things and new uses developed slowly. At the beginning of the present century, the introduction of the corrugated paper shipping box brought silicate to the fore as an adhesive and PQ research has extended the knowledge of product qualities and usefulness to include a wide range of applications. For convenience we are classifying the uses under important chemical and physical properties, indicating the PQ products prepared for these purposes. However, new uses continually are being studied. If you have a problem that silicate might help to solve, we invite you to consult with us.

DETERGENTS

PQ Soluble Silicates possess high efficient cleaning qualities. The essential advantage of silicates over other alkaline salts is that they contain soluble silica which protects the material being cleaned from too drastic alkalinity. At the same time the detergent power is increased by the soluble silica, part of which is in true solution and part is present as a colloid.

Some of the important detergent actions in which soluble silica plays a part are: 1. Wetting. 2. Emulsification, or the breaking of oily dirt into fine suspended globules. 3. Deflocculation, or the breaking of solid insoluble dirt into its finest natural particles and bringing these into permanent suspension. 4. Prevention of re-deposition of dirt.

As a consequence of this activity, the silica content of PQ Silicates together with their alkaline characteristics is of value in manufacturing soaps and cleaners. Mixtures of soap and silicates are usually better than either alone. Silicate additions to soap result in greatly increased volumes of suds as well as in increased life of the suds.

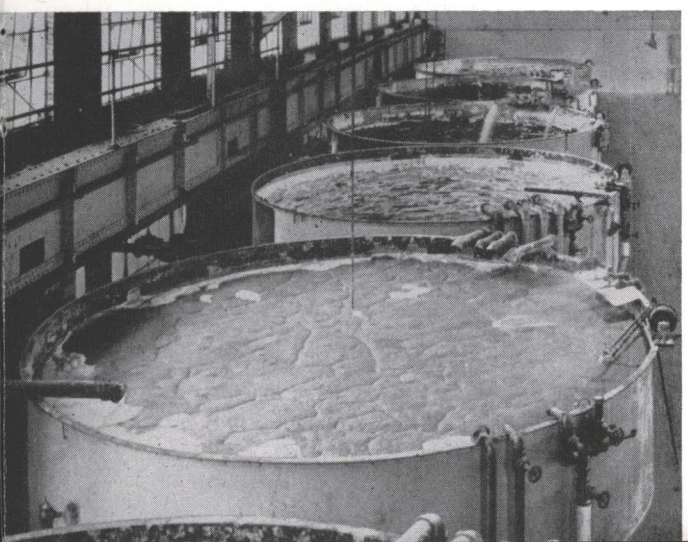
The alkaline Metso Detergents are widely used alone or in combination with soaps, synthetics, or other alkalis in diversified operations such as cleaning bottles, clothes, metals, textiles, floors, locomotives, etc. The alkalinity of the silicates enables them to neutralize acidic soil, to saponify or emulsify fats, oils, paints, and some proteins which then become water soluble or dispersible. The strong buffering capacity of the silicates maintains the pH at a high level in the presence of acidic soils or on dilution.

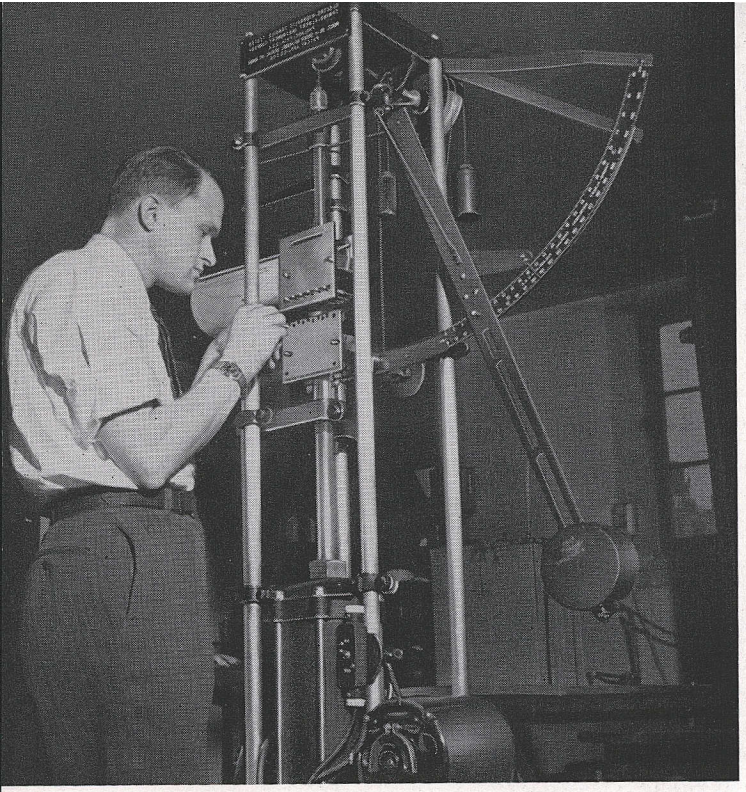
Back Gray Washing	Metso Granular, Metso 55
Boiling Off Cotton Goods	Star, Metso Granular
Bottle Washing	Metso Granular
Clarifying Dry Cleaning Solvent	Metso 99
Cleaning Aluminum	Metso 55, Metso 88, Metso Granular
Cleaning Concrete	Metso Granular, Metso 66
Compounding Special Cleaners	G, GD, Metso 99, Metso 88, Metso Granular, SS-C-Pwd, N
Metal Cleaning	Metso Granular, Metso 66, Metso 99, Metso 55
Rag Cooking	Metso Granular
Rug Washing	Metso 88, Metso 55
Scouring Rayon	Metso Granular
Soap	N, D, K, C, Kasil No. 1 & No. 6
Washing Clothes	Metso Granular, Metso 99, Metso 55

DEFLOCCULATING AGENTS

Deflocculation is not a phenomenon that is limited to detergency. It is an important factor in many industrial operations—for example, the preparation of stable suspensions of clay in pottery work. If clay and water are mixed to form a stiff, plastic mass, the addition of a very small amount of sodium silicate will result in a thin fluid which can be pumped through a pipe line. This is an example of the deflocculating power of silicate. Similar, although less spectacular, actions occur in the flotation of ores, in the refining and reclaiming of oils. Suggested uses involving deflocculation and detergent properties follow.

Kettle room of soap factory. PQ Silicates are ingredients of various soaps and detergents.





Electro-hydraulic tensile tester. Examining broken adhesive bond after test.

Crank Case Oil Reclaiming	B-W, O
Deflocculating Clays	S 35, N, Star
Deinking Paper	Metso Granular, B-W
Ore Flotation	N
Stabilizing Drilling Muds	Noheev

ADHESIVES

The loss of water from the adhesive silicates converts them from a liquid to a solid. The advantages of sodium silicate adhesives include good spreading and contact, a rate of set controllable over wide limits, and formation of a permanent, strong, rigid bond that is resistant to water, vermin and heat. The silicates for adhesives are generally shipped ready for use, but for special applications they may be modified by certain additives such as clay and casein. Although the largest amounts of adhesive silicates are for bonding paper, they also are used for wood, metals and other materials.

Asbestos Aircell	O
Capping Paper Rolls	Seal
Combined Fibre Board	Stixso Adhesives
Corrugated Paper Board	Stixso Adhesives
Fibre Trunks and Drums	N, O
Labeling and Miscellaneous Pasting	N, O, Seal
Spiral Paper Tubes	N
Parquetry Flooring	N, K
Plywood	N, O
Sealing Shipping Containers	Seal
Wall Board	Stixso Adhesives
Insulating Products	N, O

CEMENTS

When silicates are combined with cement ingredients they react chemically to form masses having strong bonding properties. A variety of cements is made with soluble silicates in powder and solution form. Silicates are important ingredients in quick-setting, acid-proof mixtures. Maximum refractoriness is obtained with the siliceous silicates and the more alkaline types are used when fluxing action is needed. The addition of silicate to refractory cement mixes increases the tensile strengths, and decreases porosity and shrinkage. Both powdered and liquid silicates are used as indicated below.

Abrasive Wheels	J, SS-65-Pwd
Acid-proof Cements	S 35, O, N
Carborundum Wheels	JA
Digester Linings	RU, C
Furnace Cements	O, G, GD, D, RU
Glass Batch Briquetting	K
Rubber Cements	S 35
Sagger Cements	N, RU
Stove Cements	B-W, B
Polishing Wheel Cements	O, K, RU
Spark Plug Cements	N, O, K, RU
Television Tubes	Kasil No. 1

FILMS AND COATINGS

Dried films of PQ Silicates are unaffected by oils, fats and greases. When applied to wooden and paper products, they are fire and vermin-resistant as well as grease-proof. Water resistance may be increased by adding heavy metal oxides. Protective films are obtained on metals used for corrosion control in water lines, in the sealing of eggs from contact with air. Some popular film or coating applications are:

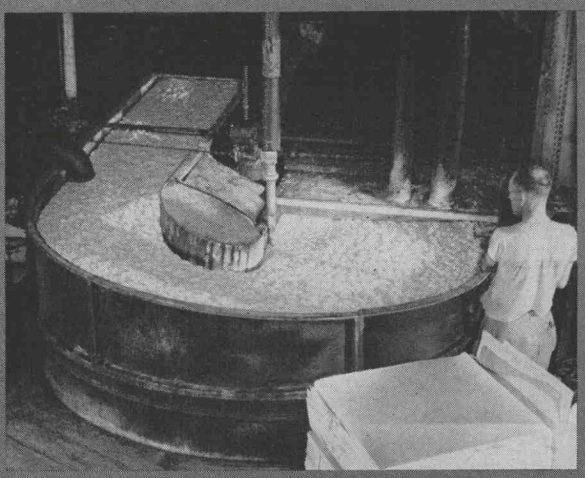
Fire-proofing Wood and Textiles	N
Grease-proofing paper	N, S 35
Testing and Lining Cooperage	N
Roofing Granules	N, S 35
Asbestos Cement Board	Kasil No. 1
Hardening and Dust-proofing Concrete	O
Curing Concrete	O
Egg Preserving	E, N
Casein Coating for Paper	O, Metso 99
Clay Coating for Paper	N, S 35

SOLS AND GELS

Although silica sols have been known for years it is only recently the chemical engineer has put them to use. Activated silica sol is used widely in coagulating processes. Its use is also of interest to paper mills for increasing fibre and filler retention on the wire.

Silicate of soda is the most convenient source of gels of silicic acid. Such gels are made by acid and a silicate solution. The resultant product is used as a gel for absorption purposes. A gel made

Continuous textile bleaching system, using peroxide and silicate. Exit end of range shown.



Beater for paper pulp where silicate, color and other chemicals are added. (Photo courtesy Champion Paper & Fibre Co.)

by combining sodium silicate and sodium aluminate serves as a base exchange mineral, particularly for softening water.

Raw Water Treatment	N
Waste Water Treatment	N
Improving Fibre Retention—Paper Mfg.	N
Gel and Catalyst Manufacture	S 35, N, E Kasil No. 1,

MISCELLANEOUS CHEMICAL USES

Applications of PQ Silicates that are not definitely identified under the previous classifications, either because they may involve several properties of the silicates or may rely on a different chemical reaction, are grouped below:

Peroxide Bleaching Textiles	Star, Starso
Peroxide Bleaching Ground Wood Pulp	N
Hypochlorite Bleaching Pulps	B-W
Sealing Water Bearing Flows	N
Rubber Cements	S 35
Sizing Paper in Beater	S 35, O
Vehicles for Cold Water Paint	N
Corrosion Control in Water Lines	N, D, C

PQ QUALITY SILICATE SERVICE

Users and prospective users find valuable data in the PQ special bulletins issued on individual uses. A listing of these is found in Bulletin 17-4, available on request. Our Chemical Laboratories, of course, are busy guarding the standards we have fixed for various PQ products, and in developing new products. They also can offer suggestions that save investigators and users valuable time. PQ technical knowledge is based on almost a century's experience in silicate manufacture and use.

The history of Soluble Silicates in the U.S.A. began in 1861 when silicate of soda was introduced by the Philadelphia Quartz Company. Thirty years prior to that the founder, Joseph Elkinton, had established a soap factory in Philadelphia. First, silicate of soda was used in the manufacture of the Elkinton soaps and then offered to other soap manufacturers. Soaps and silicates were produced until 1904 when soluble silicates became the exclusive products of the company.

Silicate plants are now located for efficient, dependable service in Anderson, Indiana; Baltimore, Maryland; Chester, Pennsylvania; Gardenville, New York; Jeffersonville, Indiana; Kansas City, Kansas; Rahway, New Jersey; St. Louis, Missouri, and Utica, Illinois.

For the convenience of silicate users of less than carload quantities, PQ Soluble Silicates also are carried in stock by leading chemical distributors in over sixty-five cities. Please ask for the PQ distributor nearest you.

When you need information on silicates, or samples for experiment, or delivery of commercial quantities, consult PQ. The headquarter offices of the company are located in the Public Ledger Building, Independence Square, Philadelphia 6, Pa.

Some Leading Industries Using PQ Silicates

Industry	*Product Recommended*	*Chief Advantage*	*Silicate Property*
Ceramics			
Abrasive Wheels	J, SS-65-Pwd	Powdered, economical binder.	Binder
Deflocculating Clays	S 35, N, Star	Improves fluidity. Removes impurities.	Dispersion
Glass Batch Briquetting	K	Avoids loss of alkali through dusting.	Binder
Shipping Case Glue	Seal	Economical adhesive. Vermin-resistant. Pilfer-proof.	Adhesion
Polishing Wheel Cements	RU, O, K	Heat resistant. Tenacious bond.	Binder
Construction Industry			
Curing Concrete	O	Quick, effective. Reduces labor cost.	Film formation
Hardening Concrete	O	Oil-proofs; dust-proofs; acid resistant.	Chemical reaction, film formation
Acid-proof Cements	N 38, S 35	Ease of use. Economical.	Chemical
Refractory Cements	G, N, O, RU	Strong bond. Excellent thermal action.	Binder
Thermal Insulation	O	Fire-proof bond.	Adhesion, film formation
Plywood	N	Economical, water-resistant.	Adhesive
Soil Solidification	N	Economical binder.	Gel reaction
Metals			
Porous Castings	N	Seals leaks. Avoids loss.	Film formation
Coating Welding Rods	K, N, R, Kasil No. 1, Kasil No. 6	Good bond and fluxing action.	Binder
Metal Cleaning	Metso 66, Metso Granular, Metso 99	Good emulsifier. Prevents dirt re-deposition.	Detergent
Oil			
Oil Clarification	B-W, O	Economical. Clear effluent.	Deflocculant
Drilling Muds	Noheev	Prevents heaving shale.	Colloidal control
Corrosion Prevention	N	Efficient. Reduces cost.	Chemical

Some Leading Industries Using PQ Silicates

Industry	*Product Recommended*	*Chief Advantage*	*Silicate Property*
Paper			
Raw Water Treatment	N	Clearer effluent; greater capacity.	Flocculation
Beater Sizing	O	Smoother printing surface.	Chemical reaction
Coating	S 35, N	Grease-proofs. Moisture resistant.	Film formation
Deinking Paper	B-W	Whiter, cleaner pulp.	Deflocculant
Rag Cooking	Metso Granular	Better color removal. Bleach saving.	Detergency
Digester Linings	S 35	Acid resistant bond.	Binder, film formation
Peroxide Bleaching of Pulp	N	Conserves peroxide. Produces whiter pulp.	Chemical
Adhesives	N, O, Seal	Economical, strong bonds.	Adhesion
Waste Water Treatment	N	Increased size of floc. Improved clarification.	Flocculation
Paper Board Industry			
Corrugated Paper Board	Stixso NN, Stixso OO, Stixso DD	Mineral, ready-to-use; strong bonds.	Adhesion
Solid Fibre Board	Stixso NN, Stixso DD, Stixso OO	Mineral, ready-to-use; strong bonds.	Adhesion
Wall Board	Stixso NN, Stixso DD, Stixso OO	Ready-to-use. Fire-proof bonds. Vermin-resistant.	Adhesion
Textile Industry			
Peroxide Bleaching	Star, Starso	Conserve peroxide. Whiter whites.	Chemical
Wool Scouring	C, Metso Granular	Cleaner wool; soap economy.	Detergency
Silk Weighting	Star	Improves strength. Resistance to abrasion.	Chemical
Kier Boiling	Star	Whiter whites. More level dyeing.	Detergency
Sealing Shipping Containers	Seal	Pilfer-proof bond. Vermin-proof. Odorless.	Adhesion
Waste Water Treatment	N	Increased size of floc. Improved clarification.	Flocculation

PHILADELPHIA QUARTZ COMPANY

General Offices: Public Ledger Bldg., Philadelphia 6, Pa.

Chicago Sales Office: 205 W. Wacker Drive

Plants: Anderson, Ind.; Baltimore, Md.; Buffalo, N. Y.; Chester, Pa.; Jeffersonville, Ind.; Kansas City, Kans.; Rahway, N. J.; St. Louis, Mo.; Utica, Ill.

Distributors in over 65 Cities

17—1—3M—5-52—AD

Printed in U. S. A.