OxyChem

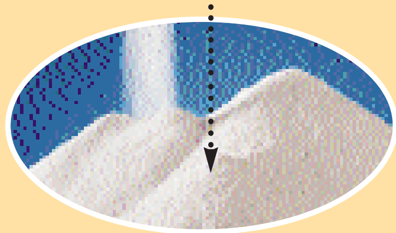
We've got A Lot To Offer Our Silicates Customers.

Foreword

Users of Sodium Silicates will recognize the value and utility of a practical handbook, covering the proper methods of handling, storing and using this important chemical. This information has been prepared to meet the needs of technical and plant personnel who require operating data in their work, with minimum effort required for its interpretation.

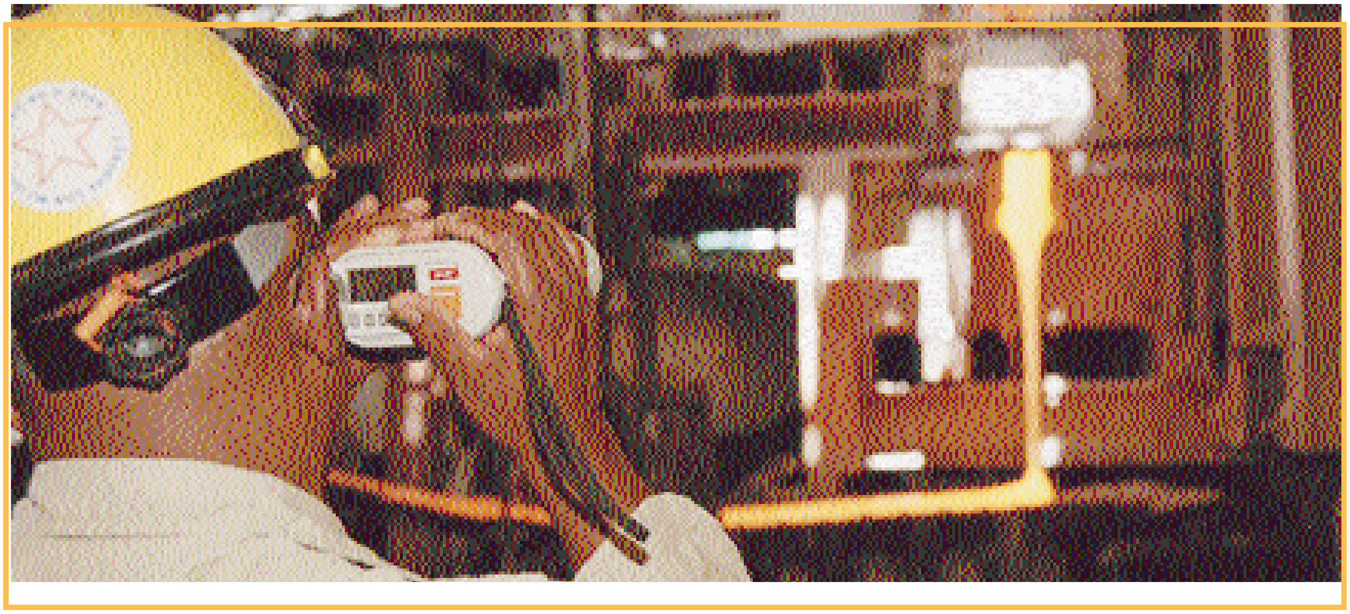
Buyers and other interested individuals desiring information on Sodium Silicate Liquids, Sodium Silicate Glass Briquettes, or Sodium Metasilicates will find most of their questions answered in this handbook. For the laboratory person, basic information has been included on analytical procedures. If further assistance is needed pertaining to Sodium Silicates, OxyChem's sales, technical service and traffic departments are available by contacting your nearest OxyChem location as listed on the inside back cover of this handbook.

OxyChem Silicate Plants



★ ***OSHA Star Plant:*** The highest honor for excellence in safety performance awarded by the Occupational Safety and Health Administration.

The OxyChem Sodium Silicates Handbook



Contents

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Introduction

Sodium Silicates

Sodium silicate is the generic name for a series of compounds derived from soluble sodium silicate glasses. They are water solutions of sodium oxide (Na_2O) and silicon dioxide (SiO_2) combined in various ratios. Varying the proportions of SiO_2 to Na_2O and the solids content results in solutions with differing properties that have many diversified industrial applications.

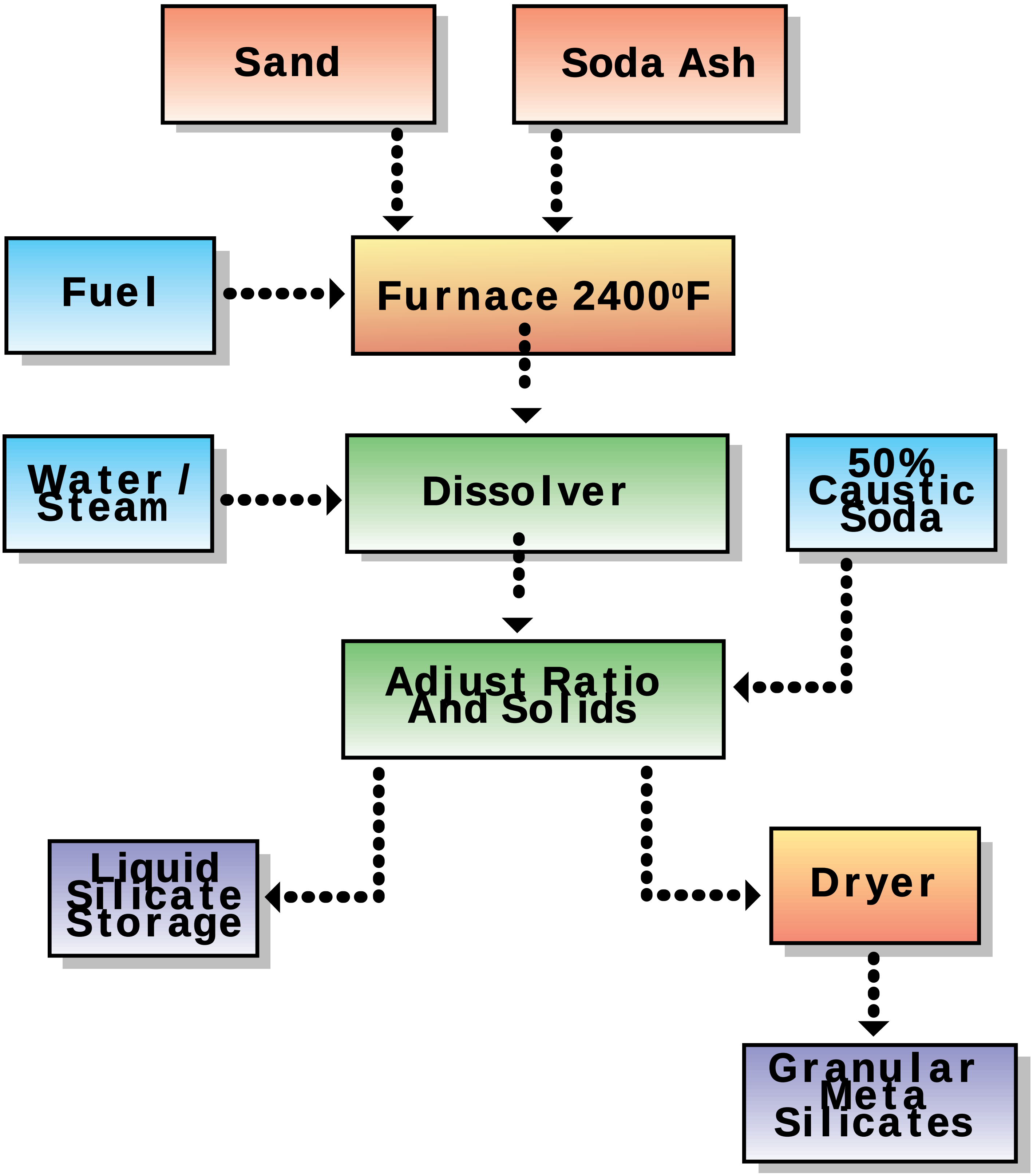
Occidental Chemical Corporation's standard commercial grades of liquid sodium silicates range in weight ratio of SiO_2 to Na_2O from 1.6 to 3.3.

In addition to liquid sodium silicates, OxyChem produces sodium silicate glass briquettes, as well as metasilicates in granular anhydrous (S-25®) and pentahydrate forms (Uniflo®26). Glass briquettes are dissolved on-site by some large volume consumers when freight savings can justify the equipment and labor costs involved. The sodium metasilicates are primarily used in cleaning compounds. Special technical bulletins for these compounds are available on request.

Sodium silicate glass is made by fusing high purity silica sand and soda ash in open hearth furnaces at 1300°C/2400°F. The molten glass is cooled, fractured, and charged into vessels where it is dissolved under pressure by hot water and steam. The various grades of liquid sodium silicate are produced by varying the alkali/silica ratio and the solids content.

OxyChem's silicate plants are located throughout the United States and are within convenient shipping distances of all major industrial areas.

Sodium Silicate Manufacturing



General Applications

This list includes both major and minor uses for silicates. The uses noted illustrate the wide range of applications for sodium silicates.

Abrasive Wheels
Absorbents
Adhesives
Asbestos Products

Bar Soaps
Beater Sizing of Paper
Bleaching Textiles & Paper
Boiler Compounds
Brick-Making
Briquetting
- Coal
- Glass
- Ores

Buffering Agent
Building Materials
- Acoustical Insulation
- Building Blocks
- Thermal Insulation
- Wallboard

Cements
- Acid-Proof
- Chimney
- Furnace
- Refractory
- Spark Plug
- Stove

Ceramics
Cement Grouts
Chemical Grouting
Cleaning Compounds
Coagulant
Coatings
- Enamels
- Roofing Granules
- Welding Rods

Concrete Cleaners
Concrete Treatment
Corrosion Control
Corrugated Board

Dairy Cleaners
Deflocculation of Clays
Dehumidifiers
De-inking Paper
Detergent Formulations
Dishwashing
Drilling Fluids
- Mud Additive
- Silicate Base Muds
- Synthetic Muds

Drum Washing

Earthwork Construction
Egg Washing

Fiber Drums
Fire-Resistant Paint
Floor Cleaners
Fly Ash Structural Materials
Foil Laminating
Foundry
- Cores
- Hot Tops
- Molds

Frits
Fruit & Vegetable Peeling

Ground Water Control
- Canals, Ponds, Waste Lagoons
- Sewer Sealing
- Shaft Tunnel & Mine Sealing
- Wells, Caissons, Irrigation

Heavy-Duty Cleaning
Hog Scalding

Laminating Metal Foil
Laundry Operations
Leather Processing
Liquid Detergents
Lithographic Printing

Magnesium Trisilicate
Metal Cleaning
Molded Articles
Molecular Sieves

Oil Reclaiming
Oil Wells
- Cementing Casing for Later Recovery
- Corrosion Control
- Formation Cleaning
- Fracture Fluids
- Heavy Shale
- Water Exclusion
- Workover Fluids

Ore Flotation

Paint & Rubber Fillers
Paint Removers
Paints
Paper Coating
Paper Tube Winding
Pelletizing Minerals
Pigments
Polishing Wheel Cement
Portland Cement
Poultry Processing

Radiator Compounds
Release Agent
Rust Removers

Sealing Containers
Sealing Metal Castings
Secondary Oil Recovery
Silica Gel
- Aerogel
- Hydrogel
- Xerogel

Soap Conditioners
Soap-Making
Soil Solidification
Solid Fiberboard
Source for Silica Sols
Space Vehicle Paint
Steam Cleaning
Synthetic Catalysts
Synthetic Detergents

Textile Processing
Timed Fertilizers
Tire Cleaners
Titanium Dioxide

Ultramarine

Vegetable Oil Refining

Washing Locomotives
Water Clarification
Water Treatment
Wire Drawing

Zeolite (Synthetic)

Principle Uses of Sodium Silicates

Adhesives and Cements

Liquid sodium silicates of suitable concentration, usually in the weight ratio range of 2.8 to 3.3 are widely used as adhesives in making fiber drums, paper tubes, and miscellaneous materials. Sodium silicate is an excellent adhesive for sealing fiberboard boxes because it sets quickly and firmly holds the flaps together. The advantages of soluble silicate adhesive include the easy wetting of the surfaces to be joined, controlled penetration, suitable viscosity, good setting characteristics, and high strength.

Sodium silicates are especially valuable as adhesives because they can change from a liquid to a semi-solid condition upon the loss of a small amount of water. This property results in the adhesive taking a quick, initial set - so important in the modern, high-speed machine manufacture of paper products.

Sodium silicate solutions of widely varying ratios are used for making many kinds of cement, including types for acid-proof construction, refractory uses, and binding thermal insulating materials. Cements made with sodium silicates are used for lining and laying refractory units, preparing foundry molds and cores, laying brick in sulfite digesters for chemical wood pulps, and construction of acid-proof masonry. Cements for stoves, chimneys, furnaces, coke ovens, spark plugs, and for binding metal to glass and porcelain are often made using sodium silicates.

There are a number of outstanding advantages of sodium silicates as binders in the cement mixtures. These include resistance of the set cements to acid, to high temperature, and to water. Silicate cements may be set by the reaction of an added substance, causing the formation of a silica gel or heavy metal silicate.

Other advantages of sodium silicates as binders in cements are ease of application, low costs, and a strong bonding action for many types of surfaces.

Pulp & Paper

Sodium silicates are used for de-inking, sizing, coating, and bleaching of recycled paper products in the pulp and paper industry.

Sodium silicates have long been the stabilizer of choice for hydrogen peroxide bleaching of cellulose. Hydrogen peroxide is an efficient and economical bleaching agent when properly stabilized against heavy metal ions, enzymes and other process impurities. Optimal efficiency is achieved when the solution is correctly buffered in the alkaline pH range. Sodium silicates are effective and economical stabilizers and buffering agents.

Sodium silicates and hydrogen peroxide are used together for the bleaching of cellulose, in the following industries:

The Pulp & Paper Industry, where they brighten both soft and hardwood pulps. They are used mainly with mechanical ground-wood pulps to upgrade newsprint stock, and with whiter goods such as toweling, napkins, magazine stock and better quality printing papers.

The Waste Paper or Paper Recycling Industry, where sodium silicates aid in repulping and de-inking operations. Silicates stabilize and buffer peroxide bleaching steps to provide a whiter recycled pulp.

OxyChem's Grade 40 liquid sodium silicate is the preferred silicate for wood pulp bleaching operations. Grade 50 is also used in pulp bleach liquor and can achieve cost savings in some situations.

As efforts to recycle paper increase, waste paper has become a key raw material. Approximately 25% of the fiber used by paper and board mills now comes from waste paper, and this amount continues to increase. Ten to fifteen percent of waste paper is de-inked and bleached to make whiter grades of paper. The balance is used in paper board products where brightness and cleanliness are not as important.

The de-inking process solubilizes and removes nonfibrous materials, such as inks, from the fiber stock. This is usually accomplished by:

- Mechanical pulping of paper to be recycled.
- Alkaline cook solution to suspend nonfibrous materials (primarily inks).
- Washing and/or flotation to separate de-inked fibers from impurities.

Sodium silicates perform many of the roles in the waste paper reclaiming process. They act as buffering agents, regulating the intensity of alkaline conditions. They also prevent unnecessary degradation of the fiber stock during the alkaline cook Silicates also act as dispersing agents, suspending inks and other undesirable materials, preventing their redeposition onto the fiber.

Detergents & Soaps

Many detergent operations are performed using both the liquid and dry granular forms of sodium silicates. Such operations range from metal cleaning, textile processing, laundering and de-inking paper, to washing dishes, dairy equipment, bottles, floors, and locomotives. For instance, in the textile industry, sodium silicates are used with bleaches, soaps, wetting agents, synthetic detergents and other alkalies in operations such as cleaning and finishing, kier boiling, wool scouring, bleaching and degumming.

A large amount of research has been done on the principles of cleaning and detergent processes, helping to establish the value of sodium silicates as detergents.

Sodium silicates possess such fundamental properties as low interfacial tension of solutions against various components of dirt, good emulsifying and suspending powers, reserve alkalinity for neutralizing or saponifying soil materials, and high buffering power. Buffering enables detergent solutions to maintain approximately the same pH value on dilution, or until most of the alkalinity has been neutralized by acidic materials.

Cleaning with alkaline solutions is the oldest form of commercial metal cleaning and still the most widely used. The alkaline, crystalline metasilicates, such as UNIFLO 26 and S-25, are widely used for metal cleaning either separately or as components in cleaning formulas. The granular, free-flowing

property of UNIFLO makes it especially suitable for dry mixing with other cleaning agents such as various phosphates, soda ash, caustic soda, and wetting agents. Soak-tank, spray, and electrolytic types of cleaning are carried out using alkaline solutions. Generally, sodium silicates in the meta to ortho ratio range are important ingredients in these solutions. Temperatures in alkaline cleaning baths usually vary from around 160^0 F for the spray-type process to just under the boiling point for the soak-type and electrolytic processes.

For well over a century, both liquid silicates and metasilicates have been added to soaps as builders. Liquid silicate of a weight ratio around 3.3 is used in the order of 1% (anhydrous basis) in bar and toilet soaps to prevent rancidity.

In the commercial and the self-service types of laundries, metasilicates are used as soap builders. The silicate is used either alone or in combination with other alkalies, and the detergent action is considerably enhanced over that of soap alone.

The use of synthetic detergents has grown very rapidly. These detergents were first used alone and later, in combination with phosphates and other builders as the detergent properties were greatly improved. However, a serious weakness developed with the introduction of these detergents for household washing tasks. It was found that the synthetic detergent compositions were corrosive to aluminum, zinc, and certain metal alloys used in domestic washers. There was also attack on porcelain enamel and overglaze fine china decorations. The incorporation of sodium silicate in the compositions brought these corrosion and alkali attack problems under control.

While many new detergent products have since been introduced, sodium silicates still perform the same functions in these new products.

Gels, Catalysts and Zeolites

Silica gels may be prepared by treating sodium silicate solutions with acids, washing the precipitated silicic acid to remove soluble salts, drying, and reducing the resultant product to suitable particle size range. Siliceous ratio silicates are generally used for making silica gels. The end product, a granular glassy material, has an immense internal pore area, giving it the capacity to absorb large quantities of moisture as well as other substances. This property makes gels useful as dehumidifying agents for air and other gases, and as filtering agents to clarify juices and beers. Specially prepared silica gels are used for making thermal insulation materials.

Principle Uses of Sodium Silicates

Closely related to silica gels are the amorphous silica powders which are used as additives to rubber products to provide abrasion and wear resistance. Other uses for these silica products are for thickening agents in inks, plastics and varnishes, suspending agents in paints, as well as anti-caking additives in various compounds, such as dusting powders and insecticides.

Sodium silicate solutions react with solutions of many soluble salts to form complex gelatinous precipitates. For instance, aluminum salts react with sodium silicate solutions to form sodium-aluminum silicate gels which can be processed to make base-exchange materials particularly suitable for water softening.

Many combinations of silica gel with other substances are used in making catalyst materials. One of the most widely used of these is the silica-alumina type of catalyst, which contains alumina intimately associated with the silica gel. With careful and precise processing, the dried silica-alumina catalyst is used in various operations in the petroleum industry, such as the production of high octane gasoline. Silica gels, with quantities of various compounds co-precipitated or deposited after the siliceous material has solidified, have been used to increase catalytic activity in a wide range of reactions such as oxidation of organic compounds, cracking petroleum hydrocarbons, and oxidation of sulfur dioxide to sulfur trioxide.

Similar in some aspects to silica gel catalysts are the molecular sieve compounds formed by the reaction of sodium silicate with various salts, such as sodium aluminate.

The molecular sieve compounds are crystalline in structure and have controlled internal pore sizes. This gives the sieve compounds the remarkable property of being able to separate mixtures of different sized molecules. Upon passage through a molecular sieve, a particular sized molecule in a mixture is retained in and on the pores, thus effecting a separation or screening action.

Foundry

Another application of the gel-forming properties of sodium silicate is in the foundry industry. Mixtures of sand and silicate for making both molds and cores in the foundry are given an initial set by forcing CO_2 gas under pressure through compacted forms. The initial hardening of the silicate-sand mix in the CO_2 process is caused by a chemical reaction between the carbon dioxide gas and sodium silicate. The alkali of the latter is partially neutralized, forming an gelatinous silicic acid which binds the sand particles together in a stiff mass. Later, as the mix loses moisture, further bond strength is provided. Molds and cores made by this process can be used immediately and need not be dried or baked, as required in the case of oil or resin bonded forms. Sodium silicate solutions in the weight ratio range from 3.22 to 2.00 are generally recommended for foundry use. Often certain organic materials, such as sugars, are first mixed in the silicate to impart special properties.

Soil Stabilization

The gel-forming property of sodium silicate is used to advantage in soil stabilization. Sodium silicate solutions, along with reacting chemicals, have been used for the consolidation of porous soil structures for many years. Soils are solidified and stabilized to increase their load-bearing capacity, to arrest settlement and lateral movement of foundations, and to control the flow of water in earthwork engineering projects such as dams, mines, tunnels, and excavations.

The stabilization of porous soils by sodium silicate is brought about by an induced gel formation of a silicate solution after introduction into the soil. Gelling of the silicate solution results in a modified soil structure of increased strength and reduced permeability. The gelling may be brought about by either immediate or slow reaction.

In the first case, or immediate reaction, separate solutions of untreated sodium silicate and of a reacting material are alternately introduced into the same soil formation. Upon contact of the two solutions in the subsurface soil, immediate gelling occurs.

In the second case, which is the preferred method, reacting chemicals are mixed with the silicate solution, causing a delayed self-hardening action. The delayed gelling solution, or chemical grout, solidifies at a pre-determined time after being pumped into a pervious soil formation. This grout solution may be varied as to concentration, viscosity, and gel time to meet various mixing and injection requirements. Hardening of the grout solution in the soil is uniform and complete. This method of single injection has the additional advantage of using only one final solution.

Silica Sols and Water Treatment

Silica sols of colloidal silica may be prepared in several different ways. Methods of preparation include dialysis, electrodialysis, neutralization of a sodium silicate solution by an acid or acid substance, peptizing a silica hydrogel, and passage of a sodium silicate solution through an ion exchanger for sodium removal.

The theory of formation of colloidal silica in the activated form as used in water treatment is generally regarded to be the growth of silica particles from low molecular weight silicic acid. Freshly liberated from the sodium silicate solution by neutralization, these acids polymerize, increasing in molecular size, and form micelles of polymerized silicic acid with a strong negative charge. After a controlled aging period, the silica sol is diluted to prevent further polymerization and to stabilize for a relatively short time the activated silica.

Activated silica sols are used in water purification as coagulant aids, flocculating impurities with aluminum and iron salts. In lime softening of water, activated silica acts as a primary coagulant. Activated silica is used in the treatment of both raw and waste waters.

Corrosion of iron in water systems may be controlled by the addition of small amounts of sodium silicate, usually of siliceous ratio, which deposits a thin protective film of silica on the metal. In alkaline cleaning operations, the presence of sodium silicate in the detergent solution inhibits attack by the alkali on aluminum and will greatly retard the attack on zinc. Again, a protective film on the metals derived from the sodium silicate inhibits the action of the alkaline solution.

Coatings

Sodium silicate solutions, either unaltered or suitably modified, are used in making various paints and coatings. Upon losing small amounts of water, thin layers of liquid silicates first became tacky and then change to hard films.

Considerable loss of water occurs at ordinary room temperatures, but to render the film more water-resistant, elevated temperatures are necessary for drying.

If heat is to be used in the drying operation, it is important that silicate films and coatings not be exposed to an initial temperature that is too high.

The temperature should first be slowly raised to around 210°F and held there until the majority of the water is removed. Then, the temperature may be increased to the final level desired, such as in a 300-700°F range. Sudden heating of the wet film to a high temperature is not desirable. Such treatment in many instances would cause steam formation, resulting in blistering and loss of integrity in the dried film. Infra-red heat is suitable for drying silicate films.

Sodium silicates used in coating and paint formulations vary in ratio from about 2.0 to 3.3. The alkaline ratio silicates dry somewhat more slowly than the siliceous liquids. The alkaline ratio solutions dry to form films that are slightly more flexible than those of siliceous ratios.

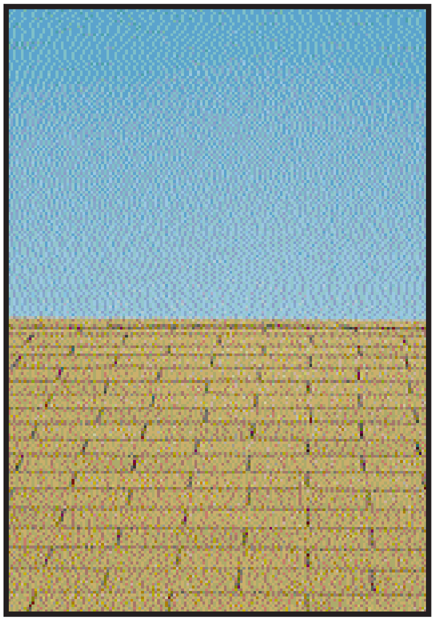
If high temperatures are not practical, the water resistance of a sodium silicate film may be enhanced by reaction with an acid or certain salts, such as boric acid, phosphoric acid, sodium silicofluoride, and aluminum phosphate. Such materials may be incorporated in the paint formula or applied as a solution in the form of a second coating or curing treatment.

Two other well-established applications of sodium silicate coatings are for welding rods and roofing granules.

Specific Applications for OxyChem Silicates

Use - Application	Grade Silicate	Properties	Advantages
Abrasive wheels	40	Binding	Economical binder
Acid-proof cement	40, 42	Acid resistance	Economical - High performance
Adhesive formulations	40, 42, 47	Binder	Strong bonds Economical
Briquetting glass batch and coal	40, 42, 47	Binding	Reduce dusting
Coating formulations	40, 47	Film formation	Low cost - Fire resistant
Coating roofing granules	40, 42, 47, 50	Film formation	Fireproof - Water resistance Pigment binder
Corrosion control in water lines	40, 42, 50	Film formation	Reduces rust and lead
Deflocculating clays	40, 42, 47, 50, 52	Dispersing action	More fluid - Power reduction in brickmaking
De-inking paper	All grades	Deflocculating action	Whiter pulp
Drilling muds	40, 42, 50, 52	Colloidal	Stabilizing well bore
Engine coolants	40, 40 Clear	Corrosion inhibition	Protects radiators and water pumps
Fiber drums	42	Adhesive - Fast set	High strength
Foundry molds and cores	49 FG, 47, 50, 52	Binding	Fast set
Furnace and stove cements	50, 52	Binding	Plastic - Heat resistance
Hardening concrete	40, 42	Chemical	Dust-proofs – Longer life
Hot tops for steel ingot molds	40, 49 FG, 52	Binder	Economical binder
Kier boiling textiles	JW-25, 40, 42, JW Clear, 30 Clear	Detergent	Whiter cloth – Better dyeing

Specific Applications for OxyChem Silicates



Use - Application	Grade Silicate	Properties	Advantages
Laminating paper and metal foil	40, 45, 47, 49 FG	Adhesive-Fast set	High speed operation – Thin film application
Leak sealing compounds	42, 47, 50	Film forming	Economical – Rust inhibitor
Manufacture of gels, catalysts, and molecular sieves	40, 42,	Chemical	Convenient silica source
Manufacture of soaps, detergents and industrial cleaners	40, 42, 49 FG, 50, 52, Anhydrous Metasilicate UNIFLO®	Wetting and emulsifying action	Metal protection – Increased detergency
Manufacture of titanium dioxide	40, 42	Coats particles	Acid resistance Reduces chalking
Manufacture of ultramarine	40, 42,	Coats particles	Increased acid resistance of pigment
Metal cleaning	Anhydrous Metasilicate UNIFLO®	Wetting and emulsifying action	Increased detergency
Ore flotation	40, 42, 47, 50, 52 UNIFLO®	Deflocculating action	Improved separation
Paper beater sizing	40, 42	Formation of precipitates	Smooth, hard paper surface
Paper products	40, 42	Adhesive-Fast set	High strength board-Ready to use adhesive Imparts some fire resistance
Pelletizing minerals	40, 42	Binding	Fast set-Strong bond
Pulp bleaching	40, 40 Clear, 50	Buffering and sequestering agent	Conserves oxygen
Slurry thinner	40	Transport and handling	Improved transportation economics
Soil stabilization	40	Chemical	Increased load bearing-prevents foundation settling- prevents cave-in during construction

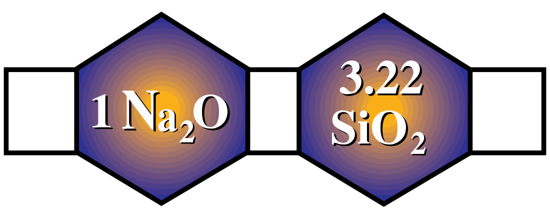
Principle Grades of OxyChem Sodium Silicates

Grade	% Na_2O	% SiO_2	% H_2O	Weight Ratio SiO_2/Na_2O	Gravity °Be	Viscosity CPS
40	9.1	29.3	61.6	3.22	41.5	200
40 Clear	9.1	29.3	61.6	3.22	41.5	200
42	9.3	30.0	60.7	3.22	42.5	400
JW Clear	10.6	26.9	62.5	2.54	42.0	65
JW-25	10.6	26.9	62.5	2.54	42.0	65
47	11.2	31.8	57.0	2.84	47.0	650
49 FG	12.4	32.0	55.6	2.58	49.0	600
52	13.9	33.4	52.7	2.40	52.0	1800
50	14.7	29.4	55.9	2.00	50.0	340
WD-43	13.3	23.9	62.8	1.80	43.8	60
30 Clear	10.6	27.0	62.4	2.55	42.3	65
20 Clear	8.9	28.9	62.8	3.25	41.00.4	175

Gravity and Viscosity Values at 20°C

In addition to the above regular grades, OxyChem makes special sodium silicates of different compositions to meet customer specifications.

OxyChem Solid Sodium Silicate Glass Briquettes



Anhydrous Glass

Physical Form – A clear glass in briquette or crushed form

3.22 ratio

Weight ratio – typical: Na_2O : 3.22 SiO_2

Weight per cu. ft.– briquettes–approx.: 85 - 90 pounds

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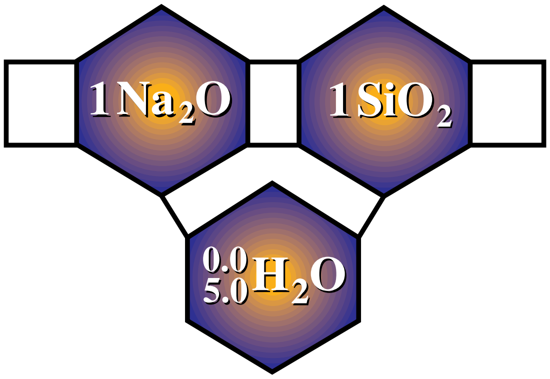
OxyChem Sodium Metasilicates



UNIFLO® Sodium Metasilicate Pentahydrate

Physical Form	A white, free-flowing granular product
Molecular ratio and hydrate- approx.	Na_2O-SiO_2-$5H_2O$

pH values (3) at room temperatures

0.1% solution	11.5
1.0% solution	12.4
5.0% solution	13.0

Total Na_2O - typical	29.2%
Solids content - typical	58.2%
Melting point	72.2°C

Containers	NetWeight (Approx.)
Multiwall bags	50 lb.
	100 lb.
	25 Kg bags

Bulk bags (Super sacks)
Bulk Rail Cars
Bulk Trucks

Uses
- Dairy cleaning
- Laundry operations
- Detergent formulations
- Metal cleaning
- Dishwashing compounds
- Paper mill operations
- Car wash
- Industrial cleaners
- Concrete cleaning

S-25 Anhydrous Sodium Metasilicate

Physical Form	A white, free-flowing granular product
Molecular ratio - approx.	Na_2O - SiO_2

pH values (3) at room temperatures

0.1% solution	11.8
1.0% solution	12.7
5.0% solution	13.2

Total Na_2O - typical	51.0%
Solids content - typical	99.5%
Melting point	1089°C

Containers	Net Weight (Approx.)
Multiwall bags	50 lbs.
	100 lbs.
	25 Kg. bags

Bulk bags (Super sacks)
Bulk Rail Cars
Bulk Trucks

Uses
- Dairy cleaning
- Floor cleaning
- Detergent formulations
- Laundry operations
- Dishwashing compounds
- Metal cleaning
- Industrial cleaners
- Soil stabilization

Safety Procedures in Handling Sodium Silicates

Liquid Silicates

Sodium silicates are non-flammable, non-explosive, and non-toxic. They are, however, alkaline materials and pose hazards to the skin and eyes. The physiological effects of contact vary with the alkalinity of the silicate involved, and range from causing irritation to causing chemical burns.

While the liquid grades of sodium silicate of greater than 1.6 weight ratio are not strongly alkaline, they should be handled with care. If there is any risk of silicate solution splashing in the eyes, goggles should be worn. It is also recommended that appropriate protective clothing and gloves be worn to prevent silicate solutions from coming into contact with the skin. Additionally, the use of oil-based cold cream or petroleum jelly on skin areas that could possibly come in contact with the silicate would also be beneficial. Under no circumstances should liquid sodium silicates be taken internally.

Prior to using any liquid silicate, carefully read and comprehend the material safety data sheet specific for the grade of silicate being used.

Metasilicates

The granular metasilicates are also non-flammable and non-explosive but are highly alkaline. The compounds themselves, as well as water solutions of the metasilicates, may cause chemical burns to the skin and eyes. Appropriate eye protection, as well as protective clothing and gloves, must be worn when handling sodium metasilicates.

Consult the specific material safety data sheet for detailed handling instructions and recommended first-aid procedures prior to use.

Storage and Handling

The various grades of liquid sodium silicates are supplied in quantities varying up to 16,000 gallon lots.
The smallest quantity normally shipped is in 55 gallon steel drums. Larger shipments are made in tank trucks and railroad tank cars, by pipelines, and in large, synthetic rubber, collapsible containers.

Tank truck shipments of silicates in order of 3,000 - 4,000 gallon quantities are usually made for deliveries to customers requiring less than tank car quantities. Larger shipments are ordinarily made in 16,000 gallon and 10,000 gallon railroad tank cars.

In those instances where a customer's plant is located near a sodium silicate plant and the silicate requirements are large, it is sometimes economical to construct a pipeline between the two plants and make silicate deliveries through the line.

Unloading Tank Cars

Sodium silicate tank cars may be unloaded by gravity flow (if the top of the receiving tank is lower in level than the outlet of the tank car), by pumping, or by air pressure. Arrangement of the unloading mechanism varies somewhat with different tank cars.

Figure 1 gives a sectional sketch of a tank car showing one arrangement of the unloading mechanism. The outlet (9) on the tank car is a special 4 inch fitting which is usually reduced to a 2 or 3 inch size for capping or plugging. In any case, the outlet line of the tank car should be connected to a 3 inch line leading to the storage tank. Some cars are equipped with a gate valve and plug, instead of a valve cap assembly with plug as shown in the illustration. The cars are usually equipped with steam coils for warming or thawing the sodium silicate in cold weather.

Referring to Figure 1, instructions are noted below for unloading sodium silicate from tank cars.

1. Set handbrake and block wheels after car is properly spotted. Caution signs should be placed at both ends of the car being unloaded to warn persons, as well as switching crews, that the tank car is connected. Derail attachments are sometimes advised for the open end of the siding. Goggles or face masks should be worn to guard against eye injury.

2. Remove the dome cover (1), and try out the foot valve (6) to make certain it is in the closed position.

3. Remove valve cap assembly (10) at the bottom of the outlet (9), and attach tank car angle connection and hose or pipe to storage tank. If it is convenient to use the 2 inch opening, remove the 2 inch plug and bush to 3 inch for connection to the rubber hose or pipe.

4. Return to the dome and open the foot valve (6) by turning the valve rod handle (3). Leave dome cover off unless unloading with air pressure. If unloading with a pump, start the pump after the foot valve is opened. With gravity flow unloading, the silicate will start to flow when the foot valve is opened.

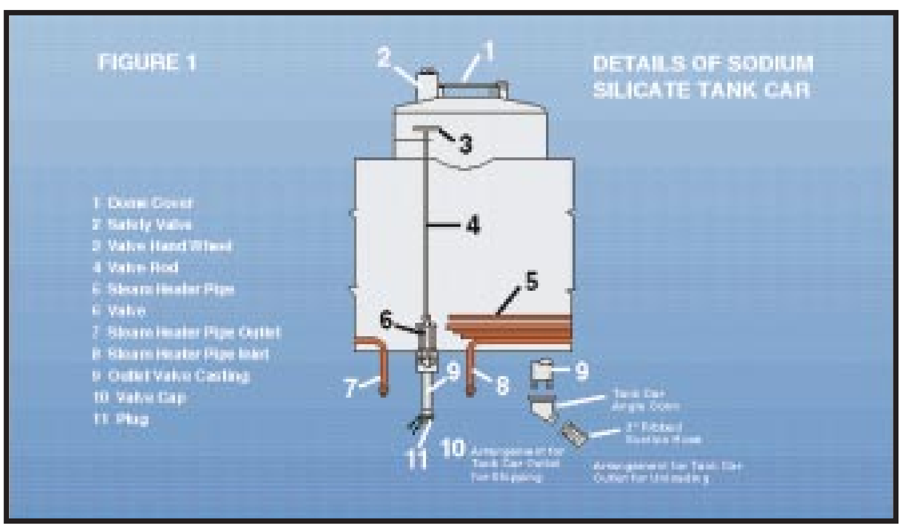
5. If air is employed for unloading, use the following procedure. After opening the foot valve, replace the dome cover using a gasket and tighten. Then attach an air pressure line at the connection provided on the dome cover. When air is turned on the silicate will start to flow from the car. Care should be taken not to use air pressures greater than about 25 psig since the safety valve (2) is set to release at 25 to 30 psig. For safety, there should be installed in the air line to the dome a gauge and a safety valve set to release at 25 psig.

6. If necessary to heat the silicate with steam, first loosen dome cover. Then remove the caps or plugs from the steam coil inlet (8) and outlet (7) connections, and attach a steam line to the inlet connection (8). Introduce steam slowly into the line until the pipes are heated, and steam and condensate emerge from the coil outlet (7). Steam may then be somewhat increased, but care should be exercised to prevent rupture of the steam heater pipes. Since prolonged use of steam is not desirable, turn off the steam and unload as soon as the silicate is warm enough to flow readily. Low pressure steam at 5-15 psig should preferably be used to prevent possible deposits on the coils.

In any case, turn the steam off before the silicate has dropped below the level of the heating coils inside the car. After the car is unloaded, any condensate remaining in the coils should be blown out using compressed air. This is to prevent possible freezing and bursting of the pipes. The caps or plugs should then be replaced on the steam inlet and outlet connections.

7. After all the silicate has been unloaded from the tank car, close the foot valve (6) by turning the valve rod handle (3), and remove the connecting ribbed rubber hose and angled fittings. Screw on the pipe plug or cap to the car outlet connection. Then, add about 50 gallons of water to the car to prevent hardening of the silicate around the foot valve, and replace the dome cover (1). Any other connections that have been made should be disconnected.

8. After the car is empty, precautions should be taken to insure that the unloading line is drained or thoroughly flushed. Otherwise, the silicate may harden or freeze in the line. It is good practice to make the flexible connection on the unloading line removable so it can be disconnected and soaked in water to prevent hardening of silicate in the threads or joints. If unloading is by gravity, the unloading line may be cleared by blowing with air or steam from the tank car end of the line. If a pump is used, the line should be pumped dry and the valve closed on the pump inlet. Then, the line should be blown back from this point. The pump is usually left full of silicate. The tank car end of the line should then be capped to minimize drying of any remaining silicate.



Tank Trucks

Tank truck shipments of liquid sodium silicate are made in quantities of approximately 3,500 gallons.

The unloading of a tank truck is handled by the truck driver using a pump or air compressor mounted on the truck. Normally, 10 and 20 foot lengths of heavy rubber hose are carried on the truck for connecting to the line provided by the customer and leading to the storage facility, or tank.

The unloading line to the storage tank should be 3 inch steel pipe and located inside to the extent possible to prevent freezing. The connecting end should be threaded and capped to prevent the setting up and hardening of liquid silicate. A plug type valve should be in this line close to the capped end.

Steel Drums

Drum shipments of liquid sodium silicate are made in 55 gallon non-returnable steel drums.

Air pressure should never be used on silicate drums in emptying them. The drums are not built as pressure vessels, and could rupture under pressure causing a serious accident.

Shipments of sodium silicate in drums require an unloading dock for moving the drums in and out of the motor truck or railroad boxcar. For moving, handling, and emptying drums of silicate in the plant, use is ordinarily made of such equipment as drum hand trucks, fork lift trucks, hoists, and drum cradles. Drum cradles are useful in handling and holding drums for dispensing small quantities of silicate.

In using a drum cradle for partial withdrawals of silicate, the drum should first be upended with the end having a 3/4 inch plug on top. The plug is removed, and replaced with a 3/4 inch gate valve drum spigot. The drum is then placed in a horizontal position on the drum cradle with the 2 inch plug on top. As silicate is withdrawn, the 2 inch plug should be slightly opened to allow air to enter the drum. After finishing a withdrawal of silicate, this plug should be screwed down to close the opening.

Drums should be stored in a dry, and in winter a reasonably warm, warehouse. If allowed to become cold enough to freeze, which occurs a little below 32°F, liquid grades of sodium silicate, upon thawing, separate into layers of different composition. To restore to the original uniform composition, a thorough mixing is required which is difficult to accomplish in drums. Therefore, to avoid a mixing operation, it is recommended that the silicate not be allowed to freeze. Furthermore, if the silicate is kept at ordinary room temperatures emptying from the drum is more easily accomplished by avoiding the higher viscosities due to lower temperatures. On the other hand, drums of silicates should not be stored in places where the temperature is extremely high such as next to a furnace or heater. In general, temperatures under 90°F are desirable since prolonged storage at higher temperatures may cause gradual thermal decomposition.

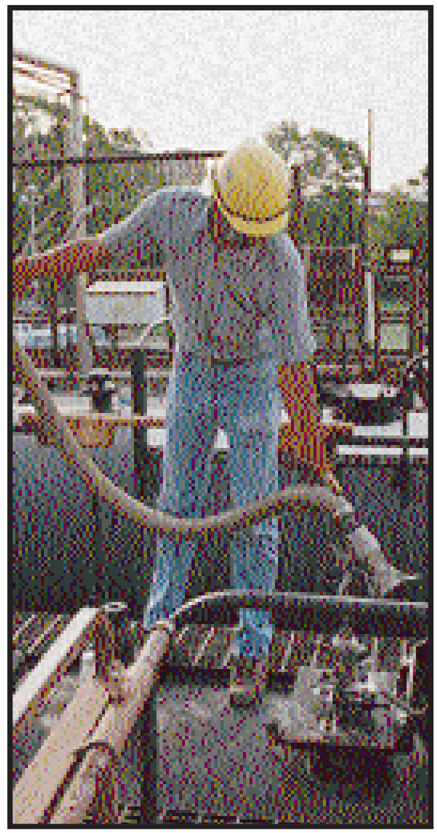
Storage

The general rule for storage capacity is 1.5 times the normal shipment volume. Tanks may be constructed of 1/4" mild steel but 3/8" gauge is preferred. Plastic tanks made from alkali resistant polyethylene or polypropylene may also be used. Silicate storage tanks should be covered and provided with a manhole for inspection. Storage tanks should also be provided with a vent and inlet and outlet lines. If tank car shipments are to be received, the storage tank should preferably have a capacity of not less than about 20,000 gallons.

Location of storage tanks inside a heated building is desirable to minimize cold weather troubles. Outside storage tanks should be insulated (1 1/2" thick insulation is usually adequate) and provided with heating coils in most areas. External heating coils are recommended, since internal heating, except of the mildest type, probably will result in "baking" the silicate on the heating unit. Furthermore, internal heating may cause undue concentration of the silicate solution, and the formation of an excessive quantity of sludge or "bottoms" in the tank.

Long storage or storage at elevated temperatures should be avoided.

Foreign materials of all types should be kept out of silicate storage tanks, and inspection made at regular intervals to note any accumulation of sediment on the bottom of the tanks. Formation of sediment, or "bottoms," should be cleaned from tanks as necessary.



Pumps, Valves and Piping

For handling the various grades of liquid sodium silicate, rotary or centrifugal type pumps have been found satisfactory depending upon the job to be performed. Flooded suction is required for centrifugal pumps, but such pumps normally require less maintenance since the packing gland is not subjected to full discharge pressure. Rotary pumps are used for services requiring positive action, and are self-priming. All iron construction is satisfactory for silicate pumps, and standard steel pipe meets the usual piping requirements.

For most silicate installations, rubber diaphragm or plug type valves are satisfactory. Gate valves are often used, but globe valves are generally to be avoided. The use of brass, bronze, copper, or aluminum on wetted parts should be avoided.

A special OxyChem Technical Bulletin on storing and handling liquid sodium silicates is available for those desiring more detailed information.

Handling Sodium Metasilicates

Bulk truck shipments have been found practical for UNIFLO® sodium metasilicate pentahydrate, and anhydrous sodium metasilicate. In particular, this is true where the distances involved are not great and the consumption is not large enough to justify rail delivery. Through bulk handling sodium metasilicates, a savings can be realized in raw material costs and intra-plant handling.

A tank-type trailer is available for this service and is equipped with a build-on unloading system which pneumatically unloads the metasilicate into the storage bin. The unloading operation is carried out by the truck driver, thus making a complete delivery.

In the bulk storage and handling of sodium metasilicates, the following precautions should be observed:

1. Avoid moisture pickup in the storage bin with a desiccator breather.

2. Schedule shipments of material to avoid prolonged periods of storage.

3. The discharge opening of the storage bin should have a slope of at least 60 degrees.

Equipment

There is shown in Figures 2 and 3 a drawing illustrating a typical storage facility for UNIFLO® sodium metasilicate pentahydrate. A description of the equipment required follows:

1. Unloading line

For receiving material from the self-unloading truck, a transmission line made with 4" standard pipe is required.

An adapter, OPW Kamlok No. 633A, is required on the 4" line to make the flexible hose connection to the trailer. A cap is needed on the open pipe to keep the bin airtight and free of moisture.

To allow for a 5' radius bend in the flexible hose, the fixed transmission line inlet should be 5' above ground level.

2. Storage bin

A 9' diameter cylindrical, 60° cone bottom bin with a capacity of about 1200 cubic feet is suggested. This size bin will hold approximately 30 tons of UNIFLO® sodium metasilicate pentahydrate. Prefabricated bins, suitable for metasilicate storage, are manufactured by several companies. Generally, these bins afford considerable savings over the custom-built installations.

An unloading auger can be purchased with the bin. The standard 6" auger will give a discharge rate of about 750 cubic feet per hour.

3. Vent piping

An 8" vent pipe connection from the dust filter and desiccator is required. Slide gates should be provided to insure having the vent open to the bag filter during unloading.

4. Bag filter

Since less volume of air is used in this system than in a conventional pneumatic system, the air separation is relatively simple. A bag filter over the 8" air outlet is all that will be required. We suggest using a resin-treated Dacron* cloth for the bag. The cloth style #702-50 is used successfully in self-unloading truck installations. This cloth has a permeability rating of 20 CFM per square foot at the 15 psi operating pressure. The bag is 4' in diameter and 6' long, or a total cloth area of 75 sq. ft. This allows for more than three times the volume of air to be vented from the tank.

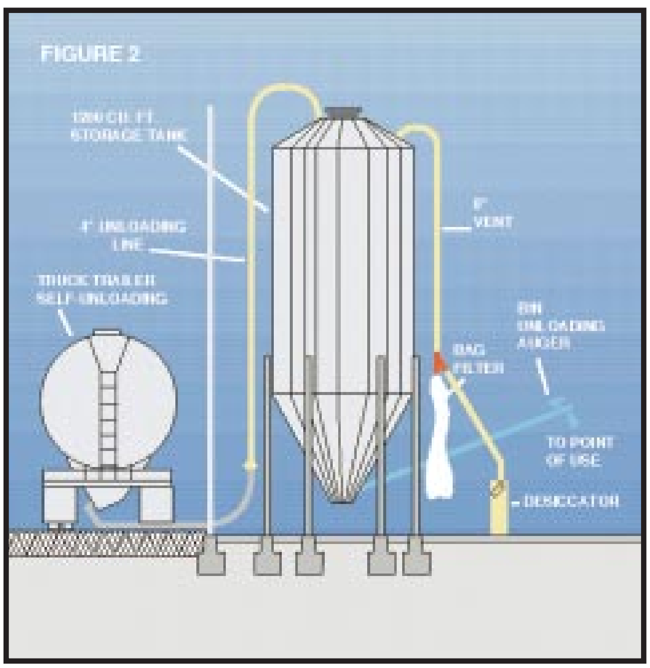
75 sq. ft. x 20 CFM/sq. ft. = 1500 CFM capacity 1500 CFM capacity - 450 CFM (truck compressor rating) = 3.3

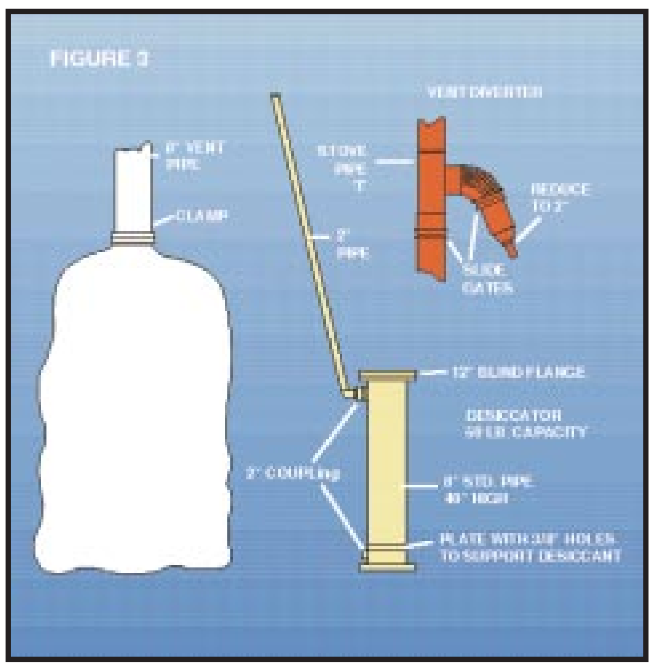
** Reg. T.M. of E.I. du Pont de Nemours*

5. Desiccator

To avoid moisture laden air entering the storage bin, a desiccator is recommended for the bin vent. The desiccator will contain a desiccant such as calcium sulfate, calcium chloride, silica gel, or a prepared mixture.

Changes in atmospheric temperature and pressure will cause some passage of air in and out of the bin. However, most air will enter as material is being evacuated. The desiccator size is determined then by the flow rate from the bin auger. A 6" auger, for example, will have a flow rate of 750 cubic feet per hour. The desiccator should be sized to handle that volume of air.





Technical Data

This section presents tables and charts giving chemical and physical data on sodium silicates.

Viscosity Change with Temperature - There is a rather large change in viscosity values with change in temperature for the relatively viscous sodium silicate solutions. Chart 1, gives curves showing the change in viscosity with temperature change for the most common grades of OxyChem sodium silicate.

Table 1 gives pH values of commercial concentrations of selected OxyChem grades of liquid sodium silicate.

Gravity Correction for Temperature is shown in Table 2. The standard temperature used for measuring gravity and viscosity values of sodium silicate solutions is 20°C. However, it is sometimes desired to convert gravity figures obtained at temperatures other than 20°C to approximate values at 20°C.

Table 3 shows the relationship between Specific Gravity and Degrees Baumé, as well as the lbs. per gallon equivalents.

Solids Content - Chart 2, gives the solids content for different Baumé values at 20°C of sodium silicate solutions of the principal weight ratios that are made by OxyChem.

Gravity Viscosity Relationships - Chart 3, gives the gravity-viscosity relationship for the principal ratios of OxyChem liquid sodium silicates. Viscosity values were obtained using a Stormer viscometer, an instrument commonly employed in the soluble silicate industry. The unit of Stormer seconds used in Chart 3 has a conversion factor to absolute viscosity units over an approximate range of 80 to 950 centipoises (equivalent to 29 to 345 Stormer seconds) as follows:

Stormer seconds x 2.75 = centipoises

The Stormer seconds unit as defined, while an arbitrary one, is standard in OxyChem sodium silicate plants and for this reason is included along with centipoise values in this chart. In using Chart 3, viscosity values outside the range noted should be considered only approximate. The composition of a liquid sodium silicate may be estimated from the gravity and viscosity values.

***Example**: A sodium silicate solution has a gravity of 41.2° Baumé and viscosity of 65 Stormer seconds, both at 20°C. Estimate the composition.*

***Solution**: Using Chart 3, it is seen that the gravity and viscosity values correspond to a 3.2 ratio. From Chart 2, a solids content of 38.0% is given for a 3.22 ratio sodium silicate of 41.2° Baumé. Then,*

$$\frac{\%\ \text{Solids content}}{\text{wt. ratio} + 1} = \%\ Na_2O$$

$$\text{Or, } \frac{38.0}{4.22} = 9.0\%\ Na_2O, \text{ and}$$

$$38.0 - 9.0 = 29.0\%\ SiO_2$$

Thus, the estimated composition of the sodium silicate is:

9.0% Na_2O
29.0% SiO_2
62.0% H_2O

TABLE 1

pH Values of OxyChem Liquid Sodium Silicates *

Grade	pH Value
40	11.3
40 Clear	11.3
42	11.3
JW Clear	11.7
JW-25	11.7
47	11.5
49 FG	11.6
50	12.3
52	11.8
WD-43	12.5

*Commercial concentration at room temperatures

TABLE 2

Gravity Correction for Temperature Changes to Convert Baumé to approximate Values at 20°C for grades 40 and 42 Sodium Silicate

Temperature °C	Temperature °F		Correction Baumé
4.4	40	Subtract	0.7
10.0	50	Subtract	0.5
15.6	60	Subtract	0.2
20.0	68	No Correction	0.0
26.7	80	Add	0.2
32.2	90	Add	0.4
37.8	100	Add	0.6
43.3	110	Add	0.9
48.9	120	Add	1.1
54.4	130	Add	1.3
60.0	140	Add	1.6
65.6	150	Add	1.8
71.1	160	Add	2.0
76.7	170	Add	2.3
82.2	180	Add	2.5
87.8	190	Add	2.7
93.3	200	Add	3.0
100.0	212	Add	3.2

Example: A 3.22 weight ratio sodium silicate giving a reading of 41.0 Baumé at 37.8°C is estimated to have a gravity of 41.6° Baumé at 20°C.

TABLE 3
Density - Pounds per Gallon Equivalents

Degrees Baumé	Specific Gravity	Pounds per Gal.	Degrees Baumé	Specific Gravity	Pounds per Gal.
10.0	1.0741	8.95	36.0	1.3303	11.08
11.0	1.0821	9.01	37.0	1.3426	11.18
12.0	1.0902	9.08	38.0	1.3551	11.29
13.0	1.0985	9.15	39.0	1.3679	11.39
14.0	1.1069	9.22	40.0	1.3810	11.50
15.0	1.1154	9.29	41.0	1.3942	11.61
16.0	1.1240	9.36	42.0	1.4078	11.73
17.0	1.1328	9.44	43.0	1.4216	11.84
18.0	1.1417	9.51	44.0	1.4356	11.96
19.0	1.1508	9.59	45.0	1.4500	12.08
20.0	1.1600	9.66	46.0	1.4646	12.20
21.0	1.1694	9.74	47.0	1.4796	12.32
22.0	1.1789	9.82	48.0	1.4948	12.45
23.0	1.1885	9.90	49.0	1.5104	12.58
24.0	1.1983	9.98	50.0	1.5263	12.71
25.0	1.2083	10.06	51.0	1.5426	12.85
26.0	1.2185	10.15	52.0	1.5591	12.99
27.0	1.2288	10.24	53.0	1.5761	13.13
28.0	1.2393	10.32	54.0	1.5934	13.27
29.0	1.2500	10.41	55.0	1.6111	13.42
30.0	1.2609	10.50	56.0	1.6292	13.57
31.0	1.2719	10.59	57.0	1.6477	13.72
32.0	1.2832	10.69	58.0	1.6667	13.88
33.0	1.2946	10.78	59.0	1.6860	14.04
34.0	1.3063	10.88	60.0	1.7059	14.21
35.0	1.3182	10.98			

The weight figures are for 20°C (68°F).
1 Gallon water weighs 8.3298 lbs. at 20°C.

TABLE 4
Capacities of Vertical Cylindrical Tanks

Dia. in inches	Gals. per in. height	Dia. in inches	Gals. per in. height	Dia. in inches	Gals. per in. height
12	0.49	54	9.91	96	31.33
15	0.77	57	11.05	99	33.32
18	1.10	60	12.24	102	35.37
21	1.50	63	13.50	105	37.49
24	1.96	66	14.81	108	39.66
27	2.48	69	16.19	111	41.89
30	3.06	72	17.63	114	44.19
33	3.70	75	19.13	117	46.54
36	4.41	78	20.69	120	48.96
39	5.17	81	22.31	123	51.44
42	6.00	84	23.99	126	53.98
45	6.89	87	25.15	129	56.58
48	7.83	90	27.54	132	59.24
51	8.84	93	29.41	135	61.97

FORMULA U.S. Gallons = $d^2 \times h \times .0034$
where d = tank diameter in inches
h = tank height in inches

CHART 1
Viscosity Change with Temperature of Certain OxyChem Grades of Sodium Silicate

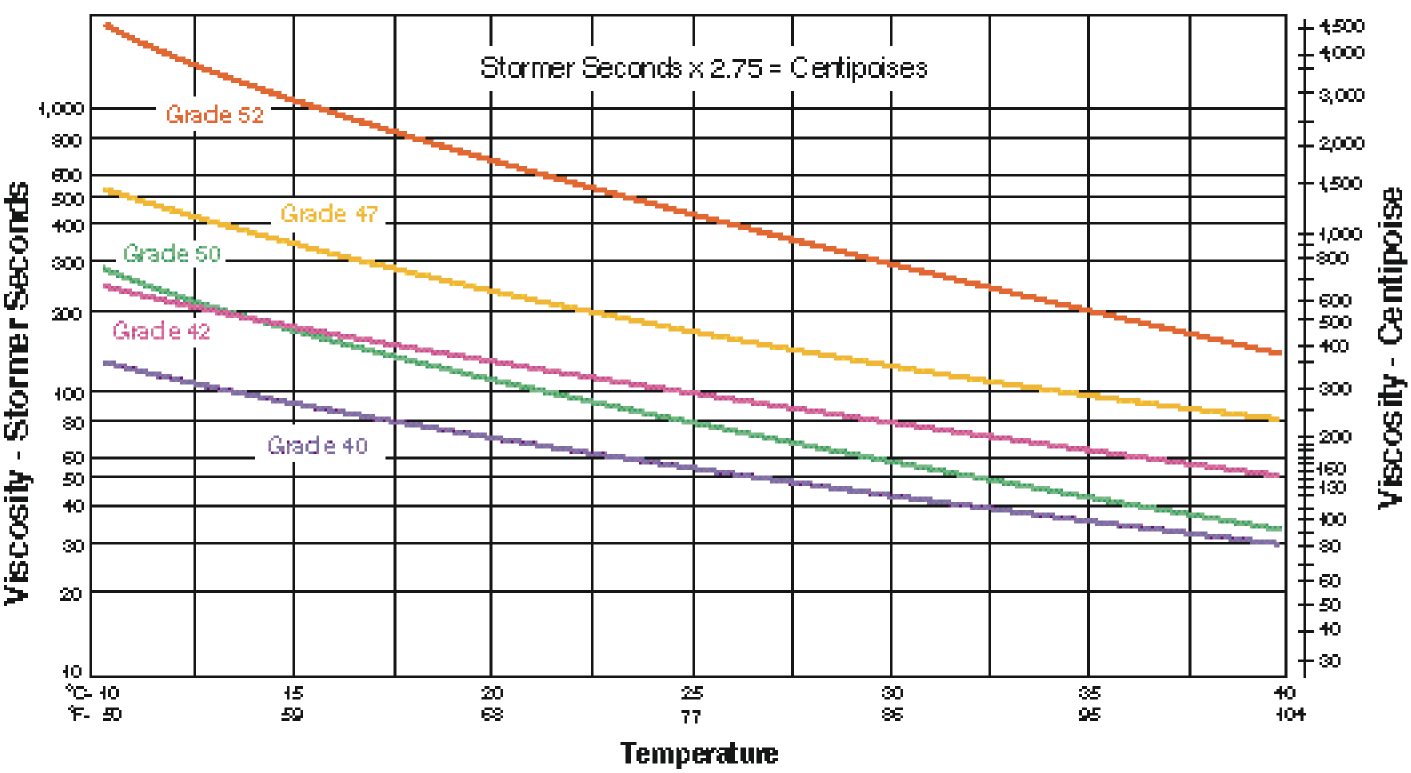


CHART 2

Solids Content of Various Weight Ratio Sodium Silicate Solutions

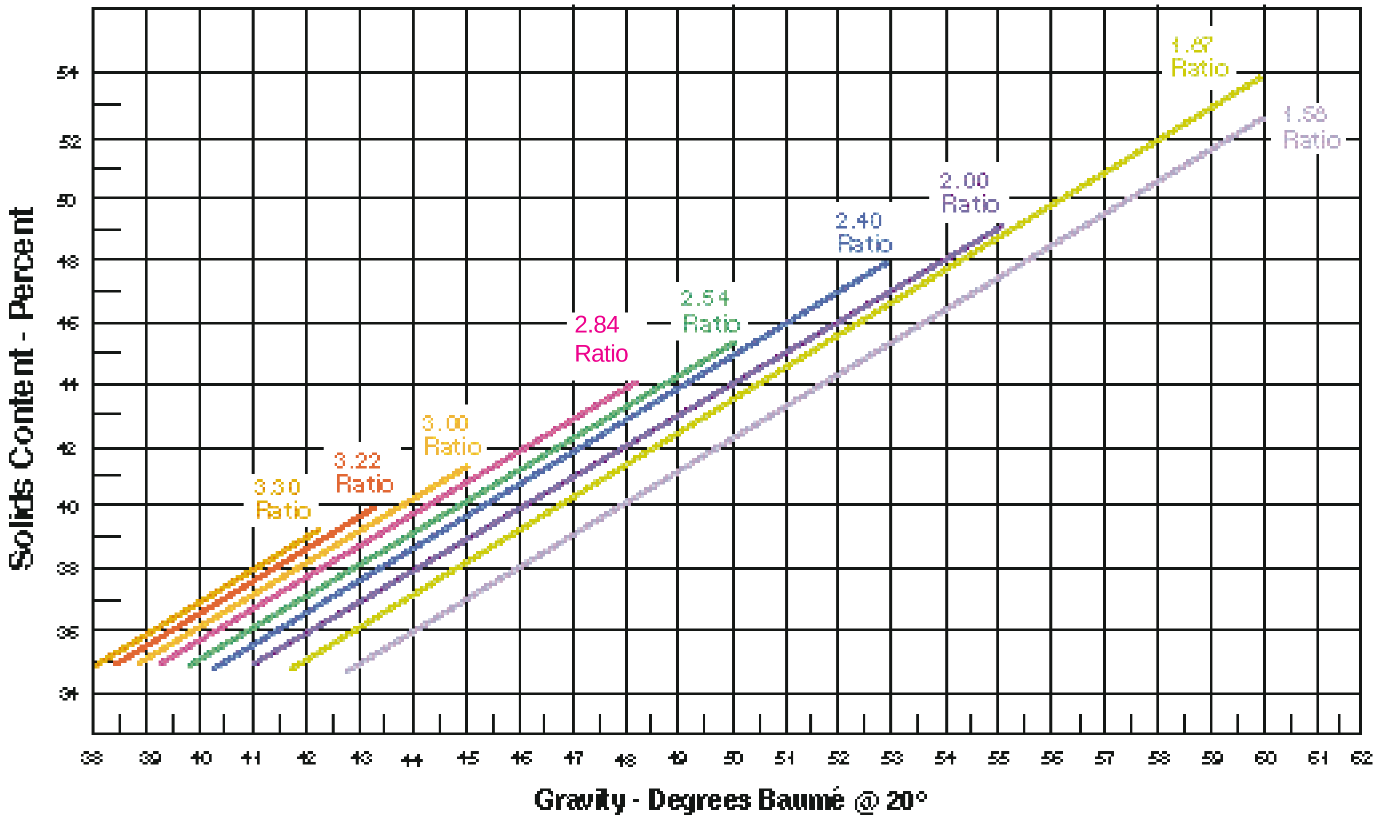
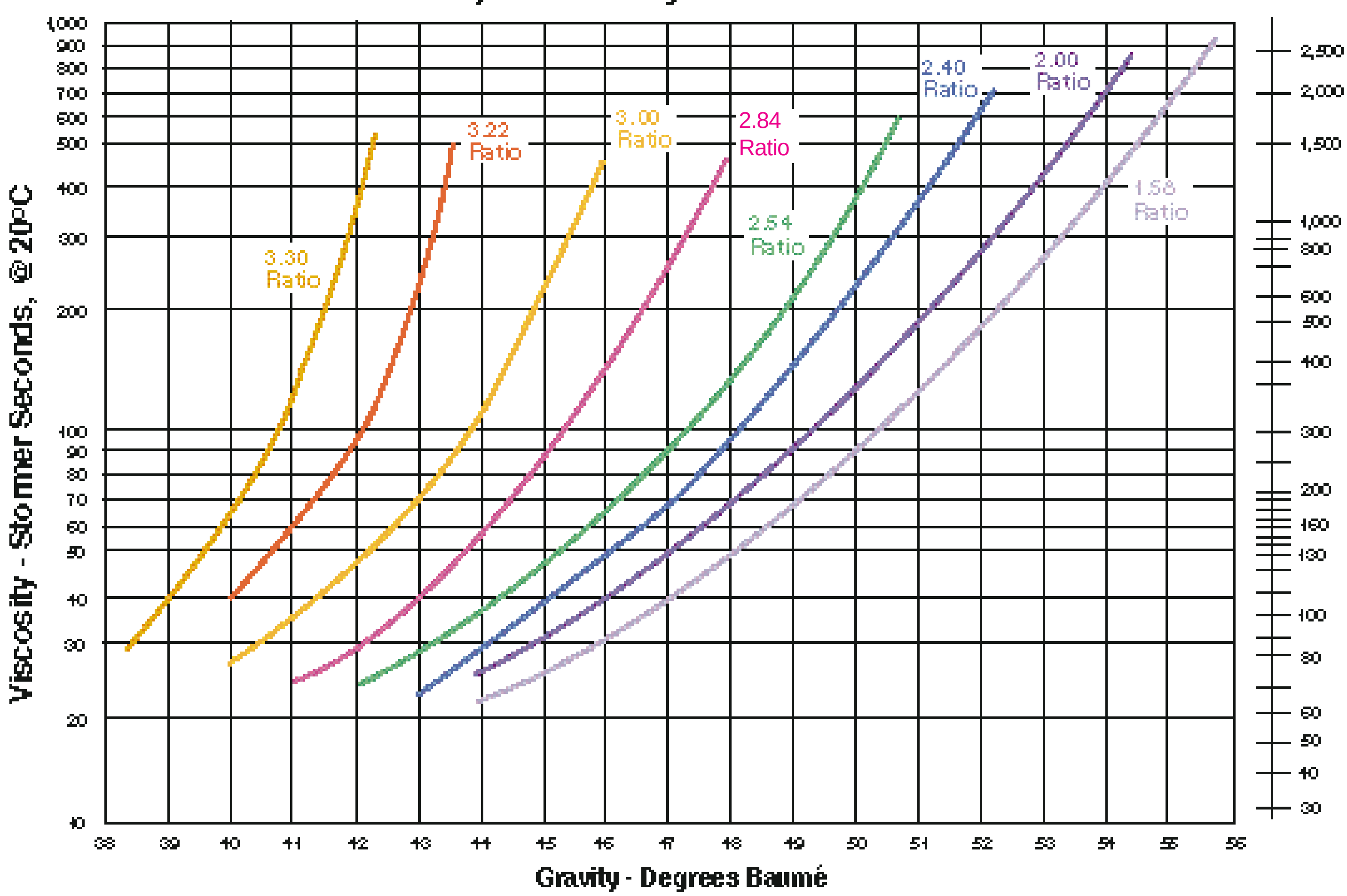


CHART 3

Viscosity of Various Weight Ratio Sodium Silicate Solutions



Methods of Analysis

The information that follows is intended to describe the various analytical procedures used for sodium silicates in general terms. If more specific details are needed, please contact your nearest sales office.

A. The sodium oxide content of sodium silicate is determined by a chemical titration of a sample with standard hydrochloric acid to pH 4.3 using either a pH meter or a suitable indicator such as methyl orange. The usual procedure is to accurately weigh a 25 gram sample of the silicate and dilute to 500 ml with deionized water. A 50 ml aliquot is then titrated with 0.2 N HCI. For highly alkaline grades, a 15 gram sample is suggested.

Calculations:

$$\% \, Na_2O = \frac{\text{ml HCIxNormality x 3.1}}{\text{sample weight}}$$

B. Viscosity

The viscosity of liquid sodium silicate solutions may be determined by either a Stormer or a Brookfield Viscometer. The instruments must be standardized against Bureau of Standard oils in the viscosity range of the material being measured. OxyChem's standard temperature for reporting viscosity data is at 68°F. Readings may be taken at other temperatures and extrapolated to 68°F by referring to Chart 1. Data may be reported as either Stormer Seconds or Centipoises.

The conversion factor we use for converting Stormer Seconds to Centipoises is 2.75 (Stormer Seconds x 2.75 = Centipoises.) The single most important factor in obtaining satisfactory results, besides careful instrument calibration, is a precise determination of the temperature of the silicate solution. The accuracy of the thermometer should be within 0.3°F. Digital thermometers have proven to be more accurate than glass-stem mercury thermometers.

Gravity Determination

The gravity of liquid sodium silicates is usually measured at 68°F using a Baumé hydrometer standardized against a Bureau of Standards certified hydrometer. Measurements may be taken at temperatures other than 68°F and extrapolated to 68°F for reporting purposes by referring to Table 2.

The relationship between degrees Baumé and Specific Gravity is:

Degrees Baumé =
145 - 145/ Specific Gravity

Specific Gravity =
145/ (145 - degrees Baumé)

Total Solids

The total solids of liquid silicates is the residue remaining after careful ignition of a small sample in a muffle furnace. The procedure consists of accurately weighing a 1 to 2 gram sample into a tared, previously fired, porcelain crucible and igniting to 1050°C for one half hour. A few drops of 30% hydrogen peroxide should be added to prevent spattering. After cooling in a desiccator, reweigh the crucible. The weight of the residue is the % solids and is reported to the nearest 0.01%.

Silicon Dioxide

For all but the most critical situations, the SiO_2 content may be calculated by subtracting the % sodium oxide from the % total solids as determined by the previously described procedures. For more precise purposes, a weighed sample is diluted with deionized water and acidified with dilute hydrochloric acid. After evaporating to dryness on a hot plate, the resultant silica gel is rinsed free of chlorides. The residue is ignited in a muffle furnace in a carefully weighed crucible. After cooling and weighing, the residue is calculated directly as SiO_2.

Ratio

Sodium silicates are often described by the weight ratio of the silicon dioxide to the sodium oxide, with the sodium oxide as unity. It may be calculated directly by dividing the % SiO_2 (determined from either one of the above described procedures) by the % Na_2O that has been chemically determined. A more rapid, but still quite accurate, method consists of carefully measuring the gravity and viscosity at 68°F. By referring to Chart 3, the ratio of the SiO_2/Na_2O ratio can be determined.

Chart 2, shows the interrelationships of the ratio, gravity, and the solids content for the various liquid sodium silicates.

Basic Chemicals
Silicates

U.S. SALES OFFICES

EASTERN REGION
701 Lee Road, Suite 220
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Parkway East
Suite 1060
Houston, TX 77060
(281) 931-0485
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OCCIDENTAL CHEMICAL CORPORATION

Occidental Tower
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CINCINNATI PLANT
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Cincinnati, OH 45229
(513) 242-2900

DALLAS PLANT
1100 Lenway Street
Dallas, TX 75215
(214) 421-7607

MOBILE PLANT 7620
1300 Jarvis Rd.
Mobile, AL 36614
(334) 452-

Occidental Chemical Corporation
Occidental Tower, 5005 LBJ Freeway
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