

INDUSTRIAL
CHEMICALS
DIVISION

 The PQ Corporation

Bulletin 12-30

Sodium Silicates: Versatile Inorganic Adhesives

INTRODUCTION

Liquid sodium silicates are solutions of water soluble glasses made from varied proportions of sand (SiO_2) and soda ash (Na_2CO_3). They range in viscosity from slightly sticky fluids to thick substances that resist flow. The more siliceous silicates (2.8 to 3.2 ratio) have long been used as dependable, low cost adhesives.

Sodium silicate adhesives are used for bonding a variety of porous surfaces and materials such as paper, mineral wool (used in insulation), perlite, mica and wood.

Table 1 lists properties and typical applications of the four sodium silicates commonly used as adhesives, STIXSO[®] RR, N[®], O[®] and K[®]. As silicates lose water, their viscosities increase and strong bonds are formed (Table 2). The viscosities of the more siliceous silicates (N[®] and O[®]) rise more rapidly than the more alkaline K[®] sodium silicate (Figure 1). Hence, K[®] has a longer setting time.

ADVANTAGES

Liquid silicates are inexpensive, readily available, and convenient. Silicates are nonflammable adhesives. They are odorless and will not impart any taste to the contents of packages in which they are used as adhesives. Sodium silicate is "generally recognized as safe" (GRAS Status) by the Food and

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TABLE 1—PQ[®] SODIUM SILICATE SOLUTIONS

PRODUCT NAME	WT. RATIO SiO ₂ /Na ₂ O	% Na ₂ O	% SiO ₂	VISCOSITY AT 20°C Poises	TYPICAL USES
STIXSO [®] RR	3.25	9.22	30.0	8.3	Tube winding, paper board, fiber board, wall board plywood laminating
N [®]	3.22	8.90	28.7	1.8	
O [®]	3.22	9.15	29.5	4.0	Fiber drum & tube winding
K [®]	2.88	11.0	31.7	9.6	Tube winding, paper/foil lamination

TABLE 2—VISCOSITIES OF PQ[®] SODIUM SILICATE SOLUTIONS

PRODUCT NAME	WT. RATIO SiO ₂ /Na ₂ O	VISCOSITY AT 20°C (Poises)			APPROXIMATE WT. LOSS FOR INITIAL SET
		Initial	6% Wt. Loss	12% Wt. Loss	
STIXSO [®] RR	3.25	8.3	>20,000	—	6.0%
N [®]	3.22	1.8	20	2,300	13.6%
O [®]	3.22	4.0	120	20,000	11.2%
K [®]	2.88	9.6	150	10,000	12.0%

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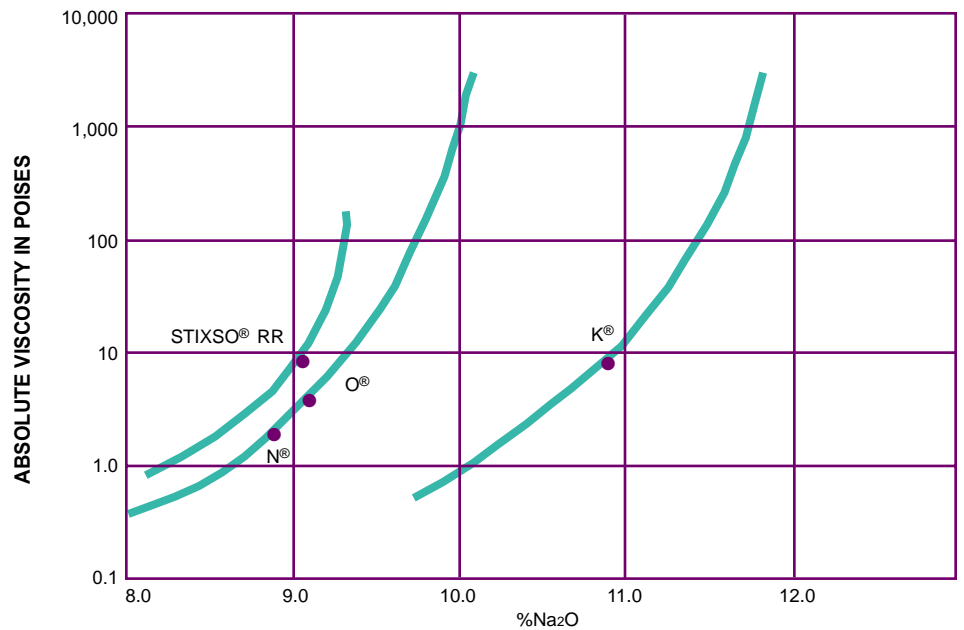
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FIGURE 1—VISCOSITIES OF SODIUM SILICATE SOLUTIONS AS A FUNCTION OF CONCENTRATION



Drug Administration for use as an adhesive in the manufacture of food packaging materials made from paper, paperboard or other materials.

In addition to providing strength, silicates are resistant to grease and oil. There is no attraction for rodents or vermin to destroy stored containers since these pests do not ingest silicates.

When used as adhesives, liquid silicates offer versatility and ease of handling. Some additional advantages are:

- Available in selective viscosities and ratios (SiO₂:Na₂O) to provide control of properties and performance.
- Adaptable for air-drying, heat setting, or chemical setting mechanisms.
- Easy to dilute to the required viscosity.
- Spread easily and provide good substrate-to-substrate contact.
- Quick set with relatively little water loss.
- Cleanup with water. When allowed to harden, silicates may need hot water to remove.

TYPICAL APPLICATIONS

1. TUBE WINDING

Silicate adhesives are widely used in the production of both spiral and convolute wound tubes and cores. The silicate binds by anchoring to the individual fibers and imparts greater strength to the tube.

STIXSO[®] RR, N[®] and O[®] silicates are generally the most economical and efficient adhesives for tube winding. K[®] silicate is suggested for first-time use since added tack and greater latitude in setting time are helpful until experience is gained in working with silicate adhesives.

Paper tubes and cores gain rigidity from silicate. It is economical to use silicates because they cost less per pound than the equivalent amount of paper fiber necessary for a comparable improvement in strength.

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2. CORNERBOARD

Cornerboard is composed of layers of paper bonded with sodium silicate and bent into a V. In addition to economical bonding the silicate provides strength and rigidity to the cornerboard. The bonding occurs as the silicate penetrates the paper and dehydrates.

3. LAMINATING METAL FOIL

Sodium silicates are well-adapted for bonding aluminum and other metal foils to paper.

K[®] silicate, which is commonly used for this application, forms an adhesive bond by losing moisture into the paper laminate and to the air. To obtain good adhesion, the foil should be clean and the silicate must wet the foil. PQ silicates give high bond strength, greater than that of the laminated materials. The foil or paper will tear while the silicate bond remains intact.

Other lamination applications are wood to felt, mica sheets, cork, and other fibers.

4. PAPERBOARD COATING

Sodium silicate adds stiffness and strength to paperboard and increases its resistance to fire, grease and vermin. For some requirements, silicate is used alone as a greaseproofing agent.

5. CASE SEALING


For a number of years, O[®] and K[®] silicates have been used for sealing boxes. The silicate is picked up by the glue rolls of an automatic case-sealing machine and spread on the flaps of the cases. As in other adhesives applications, the silicate sets by losing moisture to the paper and the air, thus forming a strong bond.

APPLICATION TIPS

When properly applied, sodium silicates penetrate the surfaces to be joined. In addition to bonding, the silicates harden and strengthen the substrates. Penetration and consistency of the bonding can be enhanced by using sodium silicate at slightly elevated temperatures; i.e, 75°F-85°F. The elevated temperature should be maintained with minimal variation in the glue pot. This keeps the viscosity at a constant level. Since drying will occur more quickly, line speeds may be increased.

In addition to maintaining a constant temperature, control over % solids should be regulated. Any addition of water should be done only by measuring and checking with a hydrometer. The viscosity decreases as water is added and the solids decrease. Many adhesive users experience adhesion problems in the winter. Cooler silicate temperature results in a more viscous silicate so they add water to reduce viscosity and do not realize the solids reduction slows the set time.

Silicates can be used as an adhesive alone or in combination with an anionic or non-ionic surfactant. In some cases it is desirable to modify the surface tension of a silicate adhesive to improve penetration into the substrates being bonded. The addition of a small amount of a surface active agent can enhance adhesive penetration and improve the final bond. This may be



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needed when a large amount of recycled fiber in the board makes the surface more hydrophobic. Solids concentration, ratio and temperature play an integral part in finding the best conditions for adhesion to occur.

PACKAGING AND STORAGE

STIXSO® RR, N®, O® and K® sodium silicate are shipped in bulk and through authorized distributors in 55-gallon, non-returnable drums. Silicate solutions should be stored at room temperature (70°).

In cold climates, storage tanks and drums should be located inside a heated building. No direct heat source should be applied to the silicate. Please see Bulletin 17-70, "Storing and Handling PQ® Liquid Sodium and Potassium Silicates" for more information.

SAFETY

Sodium silicates are alkaline products that warrant care in handling to prevent injury or discomfort. PQ's commercial and sample packages carry precautionary labels that instruct the user regarding potential hazards. These labels explain what to do in case of accidental contact with the skin and/or eyes, or through ingestion.

TECHNICAL ASSISTANCE

For more information, or assistance in selecting a silicate product for your adhesives applications, contact PQ's Industrial Chemicals Division.

Technical bulletins are also available for the complete line of PQ sodium and potassium silicates. Your PQ sales representative will be happy to help you.

Information herein is accurate to the best of our knowledge. Suggestions are made without warranty or guarantee of results. Before using, user should determine the suitability of the product for his intended use and user assumes the risk and liability in connection therewith. We do not suggest violation of any existing patents or give permission to practice any patented invention without a license.