SOLUBLE SODIUM SILICATE MANUFACTURE

Soluble sodium silicates (waterglass) are liquids containing dissolved glass which have some water like properties. They are widely used in industry as sealants, binders, deflocculants, emulsifiers and buffers. Their most common applications in New Zealand are in the pulp and paper industry (where they improve the brightness and efficiency of peroxide bleaching) and the detergent industry, in which they improve the action of the detergent and lower the viscosity of liquid soaps etc.

Sodium silicates are produced in a two or three step process, depending on the desired end products of the waterglass.

Step 1 - Cullet production
Na_2CO_3 and SiO_2 (from sand) are fused at 1100 - 1200^oC to produce an amorphous solid glass known as cullet, consisting of a mixture of SiO_2 and Na_2O. This is done in Australia, and the cullet shipped to New Zealand to be converted to waterglass.

Step 2 - Conversion to waterglass
The cullet is fed into a reactor and mixed with water and steam to create a high pressure environment in which it dissolves. This solution is known as waterglass. The waterglass is then sent to holding tanks before being fed into barrels or tankers to deliver it to consumers.

Step 3 - Ratio alteration
The properties of waterglass vary depending on the SiO_2/Na_2O ratio. This can be altered by the addition of NaOH, and so some of the soluble sodium silicate is thus treated before leaving the factory.

Soluble sodium silicate manufacture has a minimal environmental impact because the process has no harmful byproducts and makes naturally occuring endproducts.

INTRODUCTION

Soluble sodium silicates (or waterglass) are solutions of water and soluble glasses manufactured from varied proportions of Na_2CO_3 and SiO_2.

Sodium Silicates contain three components:

Silica	- Primary constituent
Alkali	- Sodium oxide
Water	- Hydrous and anhydrous properties

These components provide the end user with varied uses and applications associated with one or more of these elements.

Soluble sodium silicates are silicate polymers[1]. The higher the degree of polymerisation the greater the proportion of oxygens shared between SiO_4^{2-} tetrahedra and hence the smaller the Na_2O:SiO_2 ratio. A range of different SiO_2 and Na_2O polymers can exist. Hence one of the important determinants of the properties and functional activity of a particular type of sodium silicate is its "SiO_2/Na_2O" ratio usually expressed as a ratio by weight.

This ratio determines the physical properties of the product as well as its chemistry. Varying it allows for many different uses for sodium silicate.

Uses of sodium silicates
The two major consumers of sodium silicate in New Zealand are the Pulp and Paper industry and the Detergent industry.

In the peroxide bleaching process of the Pulp and Paper industry sodium silicate functions as:
- Transition metal ion chelate
- pH buffer
- Stabiliser
- Surface active agent/penetrant
- Corrosion control agent

These properties help improve the brightness of the pulp and reduce bleaching costs.

In the detergent industry sodium silicate provides the following functional properties:
- Dispersion and suspension of particulate matter
- Provision of an alkaline environment conductive to efficient cleaning
- Emulsification of organic oils and fats
- Inhibition of corrosion of metals in processing and washing equipment
- Prevention of phosphate reversion in liquid detergents

Household laundry and machine dishwashing detergents typically contain sodium silicate.

Table 1 provides a summary of typical industrial uses of sodium silicates in New Zealand.

THE MANUFACTURING PROCESS

Soluble sodium silicate is manufactured by IChem Ltd at Morrinsville in conjunction with PQ Australia Pty Ltd. Lever Rexona Ltd also manufacture sodium silicate in Wellington for captive use in detergents.

Step 1 - Cullet production
Sodium silicates are manufactured by fusing Na_2CO_3 and specially selected silica sands at 1100 - 1200^oC . The resulting product is an amorphous glass (commonly called cullet) which can be dissolved to produce hydrated sodium silicate in a variety of forms (**Figure 1**).

[1]A section on the chemistry of silicates will be included elsewhere, perhaps in a 'Part One' of the book before a 'Part Two' including the articles.

The fusing of Na_2CO_3 and silica is carried out in Australia to produce a cullet with a specific SiO_2/Na_2O ratio. This is then sent to IChem Ltd for further processing to soluble sodium silicates.

Table 1: Typical Industries Using Sodium Silicates

Industry	**Function**	**Method**
Slip casting for ceramics	High solids	Deflocculant
Hardening concrete	Oil and dust proof. Acid resistant	Chemical reaction, sealant
Peroxide bleaching of pulp	Conserves peroxide, produces whiter pulp	Chemical reaction
Compounding special cleaners and detergents	Increased detergence, agglomeration aid	Buffer, deflocculant
Liquid soaps and detergents	Spray dryable, lowers viscosity	Binder, chemical reaction
Porous castings for metals	Seals leaks	Impregnation, binder
Foundry molds and core binder	Fast set	Deflocculant, binder

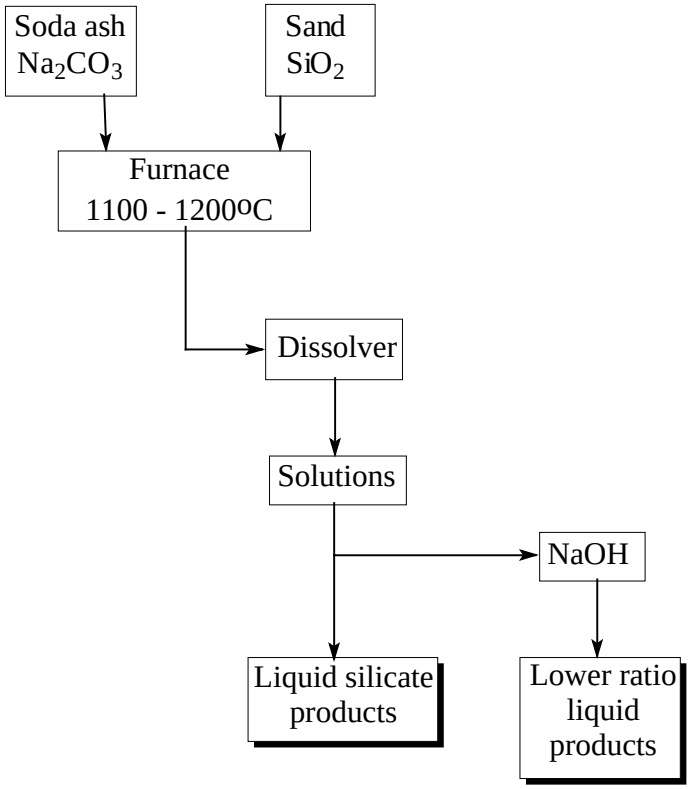

Figure 1 – Furnace process for the manufacture an processing of soluble sodium silicate products

Step 2 - Conversion to water glass
The cullet arrives at Morrinsville in 1 tonne bags and these are fed into the reactor which is then sealed. Process water and steam are then fed into the reactor under pressure and the solid cullet begins to dissolve. Steam and process water are continually fed into the reactor until the cullet has dissolved and the required concentration of the soluble sodium silicate has been reached.

Step 3 - Ratio alteration
The soluble sodium silicate is then transferred to an intermediate tank where it is cooled and again transferred to storage. At this point solid sodium hydroxide may be added to produce soluble silicates with lower SiO_2/Na_2O ratios.

The product is analysed for Na_2O and SiO_2 content to calculate its mean weight ratio, total solids, specific gravity and viscosity in the laboratory before being dispatched to customers in 200L drums or bulk tankers.

ENVIRONMENTAL IMPLICATIONS

Soluble silicates are derived from, and ultimately return to nature, as silica (SiO_2) and soluble sodium compounds. Since these are among the Earth's most common chemical components they offer minimum potential for harmful environmental effects.

The process described produces no effluent or by-products and any spills are contained and pumped to be either reused in the process or go to the effluent system on site.

The effluent is monitored and analysed for a variety of compounds and elements which are then reported to Environment Waikato.

IChem Ltd, Morrinsville is ISO9002 registered.

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