Tokyokobunshi

Sulfur Treatment

Tokyokobunshi Co., Ltd.
371 Minamiushiroya, Yashio, Saitama 340-0831, Japan
Contact Tel: +81-48-935-7313, Fax: +81-48-931-3965
e-mail address: soka@tokyokobunshi.co.jp
Website: https://tokyokobunshi.co.jp/

Effect of Sulfur Treatment to Reduce Alkali Component Eluting from Glass Container

As a container for a pharmaceutical product, chemical resistance is regarded as an important function of a glass container. However, in some cases, elusion of alkali component from the glass container causes a problem.

A sulfur treatment extracts and removes the alkali component on the surface of the glass container selectively by reacting the glass and sulfur compound at a high temperature. As a result of the chemical reaction, various effects such as a reduction in elusion of the alkali component from the glass, and the prevention of variations in contents over time, a reduction in potency and the production of flakes are expected.

Sulfur treatment has been used to prevent the elusion of alkali component since long ago and the effect and stability in the quality of the treatment has been proven.

Consider the sulfur treatment as an aid to improve the quality of your product.

Mechanism of Sulfur Treatment

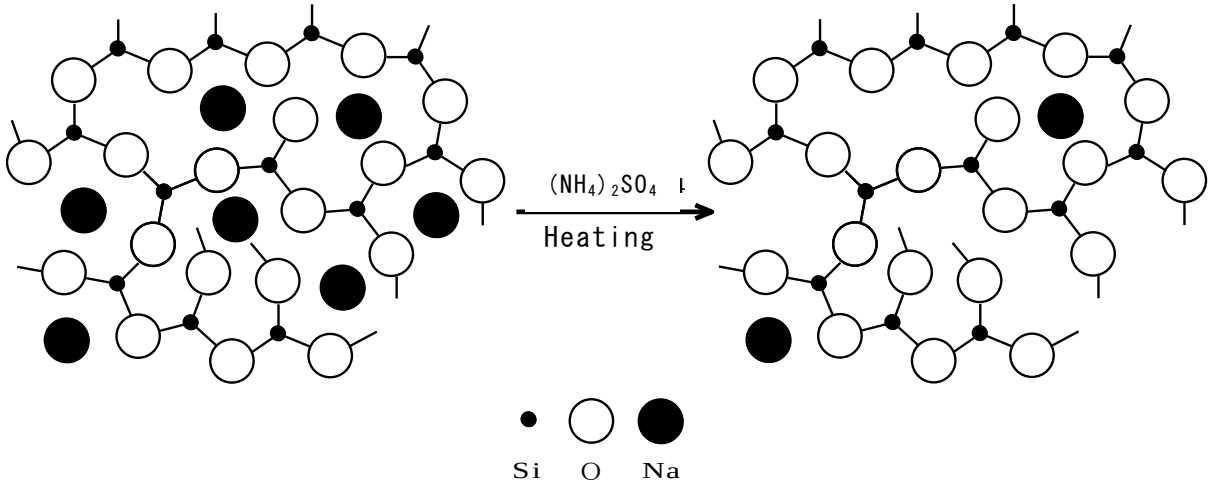

Fig. 1 Two-Dimensional Model of Glass Network Structure

As expressed with the following expression, when Na_2O contained in glass reacts with $(NH_4)HSO_4$, and white powder (bloom) of Na_2SO_4 is generated on the surface of the glass.

$$(NH_4)_2SO_4 \rightarrow \text{Heating} \rightarrow (NH_4)HSO_4 + NH_3\uparrow$$

$$Na_2O + (NH_4)HSO_4 \rightarrow \text{Heating} \rightarrow Na_2SO_4 + NH_3\uparrow + H_2O\uparrow$$

Amount of Alkali Eluting from Sulfur-Treated Glass Containers

Figs. 2 and 3 show variations of Na eluting from 100-ml white and brown blown bottles (made from soda glass) per hour.

Figs. 4 and 5 show variations of Na eluting from 10-ml white and brown vials (made from borosilicate glass) per hour.

Fig. 6 shows variations of Na eluting from a 2-ml white ampoule (made from borosilicate glass) per hour.

The figures show that the amounts of Na eluting from the sulfur-treated glass containers are significantly small in comparison with the non-treated containers and the eluting amounts do not change substantially over time. The sulfur treatment was applied by heating the containers at 121℃ in an autoclave for 3 hours. It is said that the amount of alkali component removed by the sulfur treatment is equivalent to elusion of alkali from glass at 25℃ for about 5 years[1)].

Procedures to Measure the Amount of Eluting Na

i) Wash sulfur-treated containers and non-treated containers with ultrasonic waves. Then rinse the containers with distilled water as a finish.

ii) Fill the washed glass containers with distilled water. In 100-ml blown bottles, pour 100 ml of distilled water. In 10-ml vials, pour 10 ml of distilled water. In a 2-ml ampoule, pour 2 ml of distilled water.

iii) Seal the blown bottles and vials by rolling an aluminum cap with a rubber plug. The ampoule is sealed by melting its tip.

iv) After sealing the containers, heat them at 121℃ in an autoclave. Then cool the containers to room temperature. Use the cooled containers as samples for the Na measurement. The heating time with the autoclave should be measured from when the temperature of the autoclave reaches 121℃.

v) Measure an amount of Na eluting from the containers with the flame photometry and determine the numerical values with a calibration curve.

Examples of Chemical Compositions of Glass Used for Pharmaceutical Bottles[*2]

	SiO_2	Na_2O	K_2O	CaO	MgO	BaO	B_2O_3	Al_2O_3
Soda lime glass (white)	70-74	13-16		10-13		0-0.5	-	1.5-2.5
Borosilicate glass (white)	74.7	6.4	0.5	0.9	-	2.2	9.6	5.6

Referenced Literature

[*1 and 2] Yoichi Oba, Glass Surface Design, Kindai Editing Company, 1983

Amounts of Na Eluting from White and Brown Blown Bottles (100 ml)

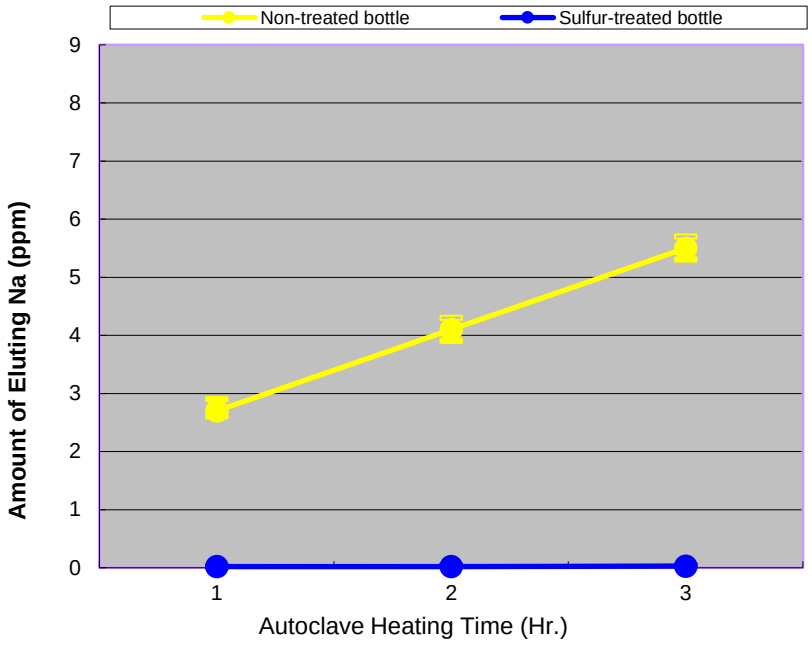

Fig. 2 Amount of Na Eluting from White Blown Bottle

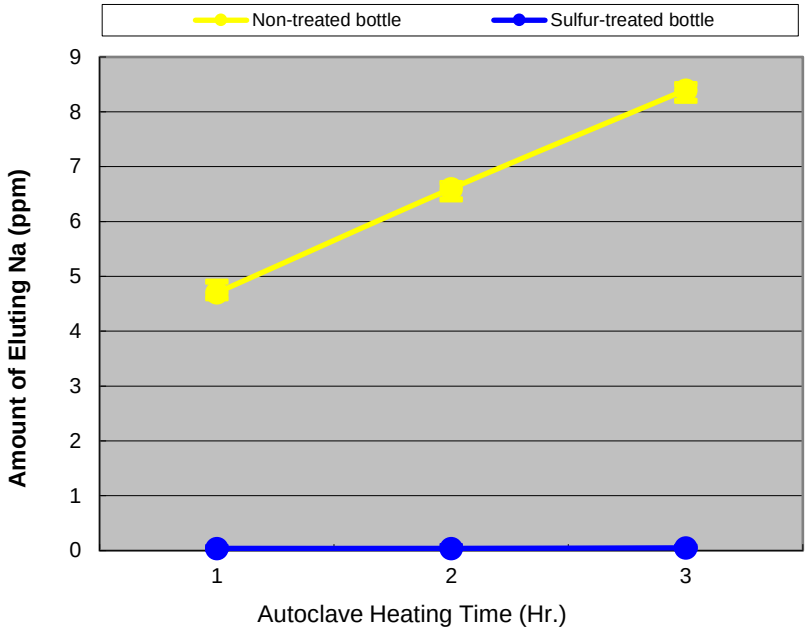

Fig. 3 Amount of Na Eluting from Brown Blown Bottle

Amounts of Na Eluting from White and Brown Vials (10 ml)

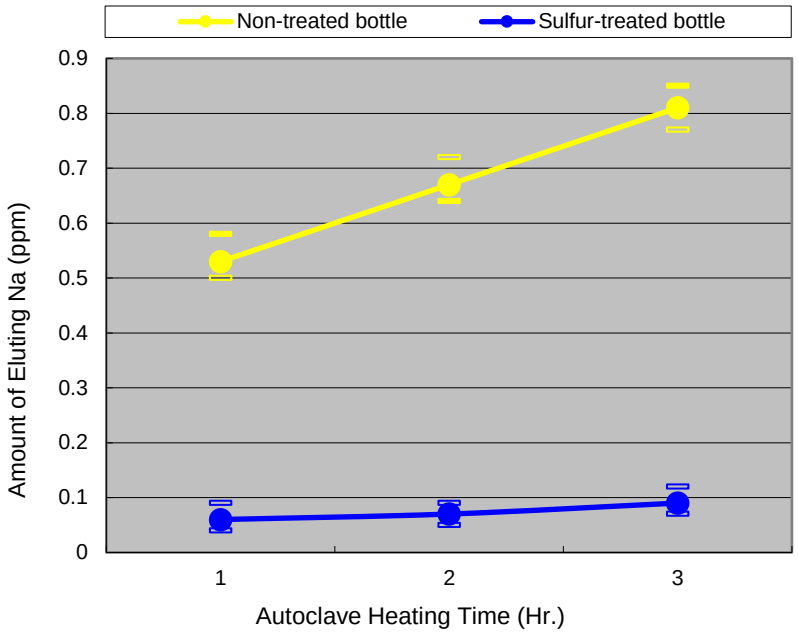

Fig. 4 Amount of Na Eluting from White Vial

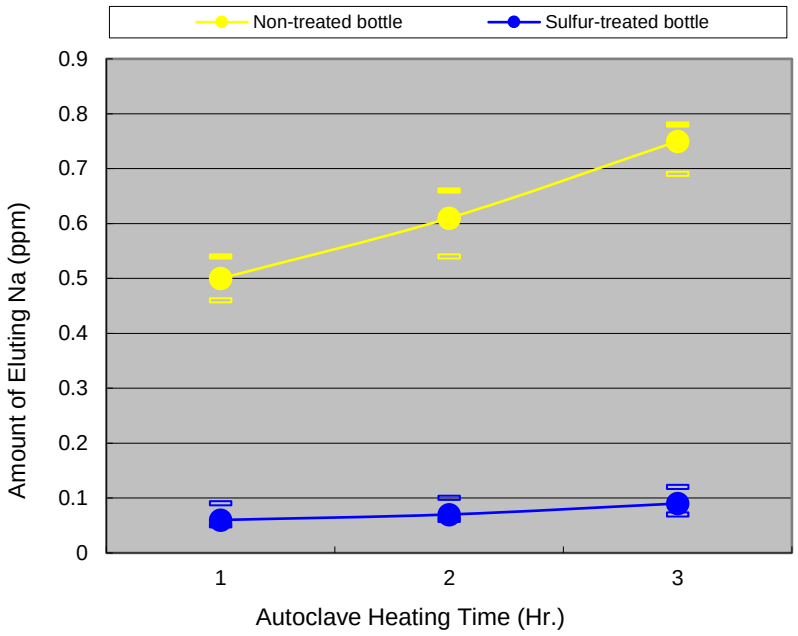

Fig. 5 Amount of Na Eluting from Brown Vial

Amount of Na Eluting from White Ampoule (2 ml)

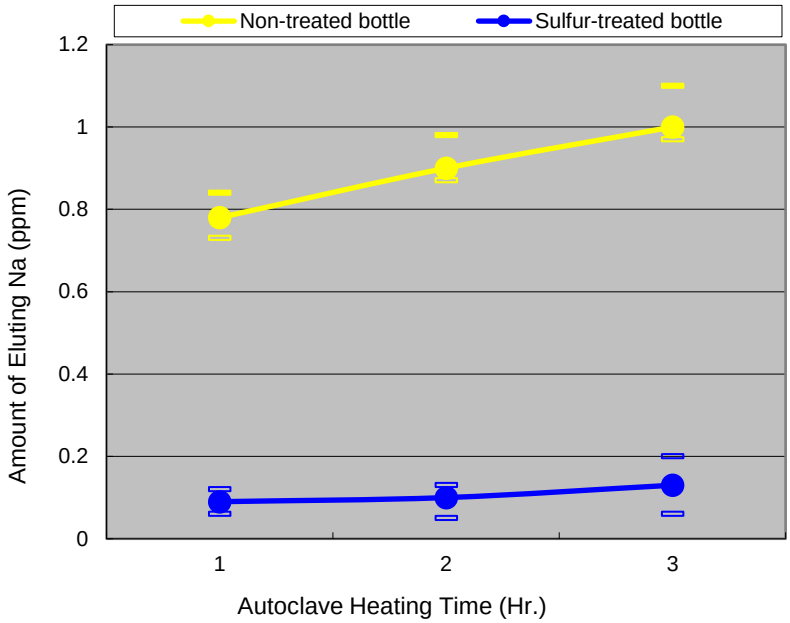

Fig. 6 Amount of Na Eluting from White Ampoule (2 ml)

Methods to Determine and Measure Sulfide Ions

There are various methods to confirm sulfide ions. On this page, some of the methods will be introduced.

1) Barium Chromate Absorptiometry

The barium chromate absorptiometry is a widely-known test method and is prescribed in JIS K0102.

Barium sulfate is precipitated by adding a barium chromate suspension to a specimen. Then add ammonia water containing calcium ions and ethanol to the specimen to precipitate excess barium chromate. Then separate the precipitates by centrifugation. Measure yellow light absorbance of chromic acid ions that are replaced with sulfide ions and determine the amount of the sulfide ions.

Determination limit: 5-50 μg/ml

2) Barium Chromate-Diphenylcarbazide Absorptiometry

This test method is used to determine a small amount of sulfide ions with barium chromate absorptiometry as described above. (JIS K0101)

Barium sulfate is precipitated by adding a barium chromate suspension to a specimen. Then add ammonia water containing calcium ions and ethanol to the specimen to precipitate excess barium chromate. Then separate the precipitates by centrifugation. Change chromic acid ions that are replaced with sulfide ions to dichromate ions and determine an amount of the sulfide ions by measuring the absorbance of reddish-purple light that is produced by reacting diphenylcarbazide with 1,5-diphenylcarbazide .

Determination limit: 0.2-5 μg/ml

3) Ion Chromatography

This test method is effective to analyze a small amount of inorganic anion. Inorganic anions can be measured with this method speedily and easily. However, expensive equipment is required.

Inject a specimen into a column, which is filled with an ion exchange resin, with a pump. In the column, ions contained in the specimen are separated in accordance with differences between the ion exchange resolutions. Detect and determine targeted ions separated in the column with an electric conductivity detector.

Measurement limit: 0.1 μg/ml

4) Sulfate Limit Test

This test method is used as a marginal test, prescribed by the Japanese Pharmacopoeia, general test methods and the sulfate limit test. With this method, the existence of sulfur ions can be confirmed with a few experimental instruments and simple operations.

Put a specimen in a Nessler tube. Change the specimen to hydrochloric acid by adding dilute hydrochloric acid. Prepare a comparison fluid in the same manner. Add barium chloride to the test solution and the comparison solution. After leaving the solutions for 10 minutes, compare a degree of turbidity of barium sulfate. The concentration of sulfuric acid can be broadly confirmed by preparing a sulfuric acid solution in a known concentration as a comparison fluid.

Identification of Sulfide Ions with Sulfate Limit Test

We performed a sulfuric acid ion identification test that is prescribed in the standards for injection water purity tests, prescribed in accordance with the sulfate limit test described in Paragraph 4) Sulfate Limit Test. The test was performed using white blown bottles (100 ml) and white vials (10 ml) as specimens.

Procedures to Prepare Specimens

i) Wash sulfur-treated containers and non-treated containers with ultrasonic waves. Then rinse the containers with distilled water as a finish.

ii) Fill the washed glass containers with distilled water. In the white 100-ml blown bottles, pour 100 ml of distilled water. In the 10-ml white vials, pour 10 ml of distilled water.

iii) Seal the blown bottles and vials by rolling an aluminum cap that has a rubber plug.

iv) After sealing the containers, heat them at 121℃ in an autoclave for 1 hour. Then cool the containers to room temperature. Use the cooled containers as samples for the Na measurement. The heating time with the autoclave should be measured from when the temperature of the autoclave reaches 121℃.

v) Identify sulfuric acid ions in accordance with the standards for injection water purity tests.

Test Results

The specimens comply with the standards for injection water purity tests.

The specimens did not change and the existence of sulfuric acid ions were not confirmed.

Instructions for Handling of Sulfur-Treated Containers

- When a sulfur-treated glass container is heated at about the glass transition temperatures (500-600℃), the amount of alkali eluting from the glass increases slightly. If it is necessary to heat a sulfur-treated glass container, confirm the effects of the heating before use.
- White inorganic crystal (bloom) that adheres to the surface of a sulfur-treated glass container is a reactant of an alkali component extracted from the glass. Wash out the bloom thoroughly in warm water with ultrasonic waves before use. If the bloom cannot be washed out completely through ultrasonic washing in warm water, review the wash conditions such as the wash time before use. Washing services of sulfur-treated containers are available from Tokyo High Polymer. We are ready to offer the service.
- The sulfur treatment only affects the very shallow layer of the glass surface. Note that if the surface is damaged by hydrofluoric acid or a strong alkali solution, the effect of the treatment is changed.
- We evaluate the effect of the sulfur treatment by measuring an amount of eluting Na. If you have a request for the quality of the sulfur treatment, specify an amount of eluting Na so that we can satisfy your requirements.
- If you have any questions about the contents of this material or the use of a silicone-coated container, contact Research and Development Division or Quality Control Division. For a request for a sample or estimation of silicon coating, contact Sales Division.