

EXPERIMENT NO: 16.5

EVALUATION OF GLASS CONTAINERS

Glass is commonly used in pharmaceutical packaging because it possesses protective qualities. It is economical and readily available in various shapes and sizes. It is essentially chemically inert, impermeable, strong and rigid. It does not deteriorate with age and provides an excellent barrier against practically every element except light. Amber coloured glass can give protection against light. Glass has major disadvantage of weight and fragility.

Glass is composed of the following constituents:

Component	Chemical composition	Use
Sand	Silica pure (silicon dioxide)	Basic material
Soda ash	Sodium carbonate	improves the properties
Lime stone	Calcium carbonate	improves the properties
Cullet	Broken glass	Fusion agent

Type of glass and its use / characteristics

- | | | |
|------------|--------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| I | Highly resistant borosilicate glass | <ul style="list-style-type: none"> For aqueous solutions, buffered and unbuffered solutions Expensive Used for potent and costly drugs only Not used for packing intravenous infusions |
| II | Treated soda-lime glass | <ul style="list-style-type: none"> For Buffered solutions (pH < 7.0), dry powders, oleaginous solutions Used for citrate solutions and sodium bicarbonate solutions |
| III | Soda-lime glass | <ul style="list-style-type: none"> For dry powders, oleaginous solutions |
| NP | General purpose soda-lime glass | <ul style="list-style-type: none"> For Tablets, solutions, suspensions (Not for Parenteral use) |

The different chemical composition of glass leads to certain problems during storage for prolonged time,

- Oxides leach into solutions, raise the pH, hydrolyse or catalyse chemical reactions.
- Sometimes, glass flakes are formed in solution.

These interactions are accelerated during processing, such as cleaning with detergent water, autoclaving for sterilization. Hence, there is a need to control the limits of leaching of alkali oxides into the pure water.

USP and IP provide two tests to determine the chemical resistance of glass containers:

1. Powdered Glass Test: From the glass containers, alkaline constituents (oxides of sodium, potassium, calcium, aluminium, etc.) are leached into purified water under conditions of elevated temperatures. When the glass is powdered, the leaching of alkali can be enhanced. The amount of alkali leached is critical.

The principle involved in the powdered glass test is to estimate the amount of alkali leached from the powdered glass. The basic analysis is acid-base titration using methyl red indicator. The maximum allowable amount of acid necessary to neutralize the released alkali (a specified limit) is specified in the Pharmacopoeia.

2. Water Attack Test: This test is conducted only with containers that are exposed to sulphur dioxide fumes under controlled humidity conditions. Such a treatment neutralizes the surface alkali. Now the glass becomes chemically more resistant. This resistance will be lost, if the container is subjected to repeated autoclaving, hot-air sterilization or hot-detergent treatment. Water attack test is used to test the limits of alkali particularly in Type II (treated soda-lime glass) glass containers.

The principle involved in the water attack test is to determine whether the alkali leached from the surface of a container is within the specified limits or not. Since the inner surface is under stress, entire container (ampoule) has to be used. The amount of acid that is necessary to neutralize the released alkali from the surface is estimated. The leaching of alkali is accelerated using elevated temperature for a specified time. The basic analysis is acid-base titration using methyl red indicator.

Aim : To evaluate glass containers for its suitability for packaging pharmaceutical liquids in terms of powdered glass and water attack test.

Requirements : Empty glass containers, ampoules, vials, Mortar and pestle, Conical flasks, Beakers, Burettes, Measuring cylinders, Autoclave, Balance, Sieves,

Reagents : Methyl red indicator solution, de-ionised water, Acetone, Sulphuric acid solution (0.02 N)

Procedure :

(1) Powdered Glass Test-Method**Preparation of glass powder sample:**

- A specified numbers of given containers (10 ampoules or 2 vials of 5 ml capacity) are rinsed thoroughly with purified water. The containers are dried with a stream of clean and dry air. The containers are crushed to fine powder using mortar and pestle. 22 - 44 # glass powder is obtained by passing through sieves.

- The powdered sample (10 g of 22- 44# grounded glass) is transferred into a 250 ml conical flask previously washed with de-ionized water. The sample is washed repeatedly with about 30 ml of acetone. Every time acetone is carefully decanted. After washing the sample should be free from agglomerates. This sample is used for the test (or used within 48 hours after drying).

Method :

The powdered and washed glass powder sample (10 g) is accurately weighed and transferred into a 250 ml conical flask. Fifty ml of de-ionized water is added to this flask. The flask is capped and placed in an autoclave. The autoclave is closed securely. The sample is autoclaved at $121 \pm 2^\circ\text{C}$ temperature for 30 minutes. The autoclave is allowed to come back to atmospheric conditions. The lid is opened; the sample is taken out and cooled under running water. The solution is decanted into another conical flask. The residual powder is washed with small portions of de-ionized water. Again aliquot is decanted into the conical flask (main portions). The total volume is made up to 100 ml. About 5 drops of methyl red solution is added and titrated immediately with 0.02 N sulphuric acid solution. The volume of 0.02N sulphuric acid solution consumed is recorded. The volume should not exceed the limit that indicated in pharmacopoeia.

(2) Water Attack Test-Method

Three or more containers are rinsed thoroughly with de-ionised water. Each container is filled with high purity water up to 90% of its volume capacity. The containers are capped (or sealed if ampoules are used) and placed in an autoclave. The autoclave is closed securely. The sample is autoclaved at $121 \pm 2^\circ\text{C}$ for 60 minutes. The autoclave is allowed to come back to atmospheric conditions. The contents are emptied into a 100 ml graduated cylinder. Make the total volume 100 ml with purified water (de-ionised). The solution is transferred into a 250 ml conical flask, 5 drops of methyl red solution is added. The warm solution is titrated with 0.02 N sulphuric acid. The volume of 0.02 N sulphuric acid solution required to get end point is recorded.

The blank is carried out by titrating 100 ml of de-ionized water at the same temperature and with the same amount of indicator. The blank reading is subtracted from the sample reading. The volume with 0.02 N sulphuric acid solution consumed is recorded. The volume should not exceed the limits as indicated in the pharmacopoeia.

Observation data:

Standard limits given in Official pharmacopoeia (USP)

Tests	Containers	Limits, ml of 0.02 N H ₂ SO ₄
Powdered glass test	Type I	1.0
	Type III	8.5
	Type NP	15.0
Water attack test	Type II (100 ml or less)	0.7
	Type II (over 100 ml)	0.2

Powdered glass test

Burette: 0.02 N sulphuric acid solution
 Indicator: methyl red solution
 End point: yellow to red

Burette readings	Sample Reading (V1)	Blank Reading (V2)	(V1) - (V2)
1			
2			
3			
Average Reading			

Water attack test

Burette: 0.02 N sulphuric acid solution
 Indicator: methyl red
 End point: yellow to red

Burette readings	Sample Reading (V1)	Blank Reading (V2)	(V1) - (V2)
1			
2			
3			
Average Reading			

Results :

- In powdered glass test, the volume of 0.02 N sulphuric acid solution consumed is _____
- In water attack test, the volume of 0.02 N sulphuric acid solution consumed is _____

Conclusion:

The given glass container sample complies / does not complies with the official limits

Precautions to be taken during experiment:

- Take a paper and make a hole at the center. Insert the pestle through the hole and place in mortar. This precaution prevents the glass pieces striking the eyes and face.
- Do not filter the aliquot with filter paper. Acetone should only be decanted.
- Tapping and gyration movement of the sieve should be done while sieving the sample. Do not use hand for passing the powder sample.
- For water attack test do not cooled down the sample. Use warm sample only.