Attachment: 4202 Determination of Hydrolytic Resistance of the Inner Surfaces for Glass Containers

4202 Determination of Hydrolytic Resistance of the Inner Surfaces for Glass Containers

Hydrolytic resistance of the inner surface of glass containers can evaluate the resistance of glass containers' inner surface to water erosion. The container to be tested are filled with test water to a specific capacity, then heated under specific conditions. The degree of water resistance of glass containers' inner surface is determined by titration of the extraction solutions.

Instruments: Autoclave, electronic balance, burettes, pipettes, beakers, and conical flasks (Note: The beakers, and conical flasks must be made of borosilicate glass or quartz glass. The mean linear thermal expansion coefficient is about $3.3\times10^{-6}K^{-1}$ for borosilicate glass. New glass containers must undergo repeated aging treatment according to the specified procedures until the water is neutral to 0.025% methyl red sodium aqueous solution).

The test water should comply with the following requirements:

(1) The conductivity of the test water shall not exceed 0.1 mS/m at 25℃±1℃.

(2) To remove carbon dioxide and other dissolved gas, the test water should be boiled vigorously for more than 15 min in an aging-treated conical flask.

(3) The test water shall be neutral to the 0.025% methyl red sodium aqueous solution. The color of the water turns to orange-red (pH5.4-5.6) after adding 4 drops of 0.025% methyl red sodium aqueous solution to 50 ml of water. The test water can be used for blank test.

Determination of filling volume: In accordance with Method I of Determination of Capacity for Glass Containers (General Chapter 4024), for injection vials made of glass, infusion glass bottles, pharmaceutical glass bottles, glass barrels for pen-injector, and glass barrels for prefilled syringes, the filling volume should be 90% of the brimful capacity. Determine the mean value of the brimful capacity from three containers that having a capacity exceed 100 ml, or six containers that having a capacity less than or equal to 100 ml. Expressed the values to one decimal place. Among them, the glass barrels for pen injectors and glass syringes for prefilled syringes shall be sealed with inert materials at the small mouth, and then carry out the following test.

For glass ampoules, the filling volume shall reach the shoulder of the bottle (see Figure), and the filling volume should be the mean value from at least six ampoules, expressed to one decimal place.

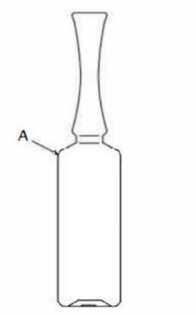

Figure Filling volumes of ampules up to point A.

Sample preparation: The number of containers to be tested depends on the capacity of the container, the volume of extraction solution for one titration and the number of titrations required, which can be calculated according to the requirements given in Table 1.

Table 1. The number of containers required of hydrolytic resistance determination by titration

Filling volume (ml)	The minimum number of containers for one titration	Volume of extraction solution for one titration (ml)	Number of titrations
≤3	10	25.0	1
>3-30	5	50.0	2
>30-100	3	100.0	2
>100	1	100.0	3

The cleaning process for each container shall be completed within 20-25 min, and remove debris or dust inside. Rinse each container thoroughly at least twice with purified water at ambient temperature, then fill the containers with the purified water for later use. Empty the containers before use, rinse once with purified water and test water, respectively, allow the containers to drain completely.

Determination: Fill the cleaned containers with test water to the filling volume. Cap the containers with inverted beakers (after aging treatment) or other suitable material. Place all the samples into the autoclave. Leave the vent-cock open and heat the autoclave at a regular rate for 20-30 min. The steam is released vigorously from the vent-cock for 10 min after heating. Close the vent-cock, and raise the temperature to 121℃±1℃ at a rate of 1℃/min within 20-22 min, counting from the time when this temperature is reached. Maintain the temperature at 121℃±1℃ for 60 min±1 min. Cool down and decompress slowly to 100℃ within 40-44min (to prevent the formation of ~~a~~ vacuum). Take out the samples when the temperature is lower than 95℃, combine the extraction solution and cool to room temperature. The titration should be completed within 1 hour after removing from the autoclave.

According to Table 1, for the glass containers with a filling volume that less than or equal to 100 ml, combine all the extraction solution obtained from the containers into a dry beaker**.** Transfer the extraction solutions into a conical flask with a pipette. Prepare the prescribed number of samples in the same manner.

According to Table 1, for the glass containers with a filling volume that more than 100 ml, transfer 100 ml extraction solutions from containers into a conical flask with a pipette. Prepare 3 samples in the same manner.

Use test water for blank correction.

Add 2 drops of 0.025% methyl red sodium aqueous solution to each 25 ml of extraction solution. Titrate the extraction solutions with hydrochloric acid (0.01 mol/L) VS until the color matches that obtained with the blank solution.

Result representation: ~~Calculate the mean value of the consumed volume~~ The results are expressed as milliliter of hydrochloric acid (0.01 mol/L) VS per 100 ml of the extraction solution.(The results are expressed as the average value if more than one titration) Express the titration values that less than 1.0 ml to two decimal places; express the titration values that greater than or equal to 1.0 ml to one decimal place.

Grade: The hydrolytic resistance of the inner surfaces of glass containers shall be classified according to the consumed volume in milliliter of hydrochloric acid (0.01mol/L) VS in Table 2.

Table 2. Classification of hydrolytic resistance for the surface test

Filling volume (ml)	Maximum volume of hydrochloric acid (0.01mol/L) VS per 100 ml of the extraction solution		
	HC1 or HC2	HC3	HCB
>0.5~1	2.0	20.0	4.0
>1-2	1.8	17.6	3.6
>2-3	1.6	16.1	3.2
>3-5	1.3	13.2	2.6
>5-10	1.0	10.2	2.0
>10-20	0.80	8.1	1.6
>20-50	0.60	6.1	1.2
>50-100	0.50	4.8	1.0
>100-200	0.40	3.8	0.80
>200-500	0.30	2.9	0.60
>500	0.20	2.2	0.40

NOTE1: For samples with filling volume ≤0.5ml, the limit should be set according to the actual situation.

NOTE2:HC2 is suitable for glass containers with inner surface treatment. The surface etching test is used when it is necessary to determine whether a container has been surface treated. The surface etching test method: fill to the brimful point with a mixture of 40% hydrofluoric acid and 2 mol/L hydrochloric acid (volume ratio: 9:1), and allow to stand for 10 min at room temperature. Empty the containers carefully, and rinse with purified water for three times, and with test water for two or more times. Submit these containers to the same autoclaving and determination procedure as described above. If the test results are more than 5 times higher than the result of the original inner surface, it is considered that these containers have undergone surface treatment. (NOTE: Hydrofluoric acid is extremely corrosive, even a very small amount may cause life-threatening injuries.)

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