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**Method of heat distribution test for food thermal
sterilization equipment**

食品热力杀菌设备热分布测试规程

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Method of heat distribution test for food thermal sterilization equipment

1 Scope

This Standard specifies the terms and definitions, principle of heat distribution test, heat distribution test instruments, preparation before heat distribution test, heat distribution test records, heat distribution data analysis, test report, and anomaly analysis requirements of heat distribution test for food thermal sterilization equipment; and gives recommendations on the number of food heat penetration tests and validity period.

This Standard applies to the heat distribution test for thermal sterilization equipment, such as high-pressure static type (vertical, horizontal, including spray type, full water type), rotary type, high-pressure basketless type, hydrostatic pressure type, atmospheric-pressure water-bath continuous type, atmospheric-pressure tunnel continuous type, atmospheric-pressure steam box, and water-bath sterilization tank (pool), which use steam, hot water, steam-air-water, or steam-air mixture as heat-transfer medium.

This Standard does not apply to the heat distribution test of microwave heating and flame heating sterilization equipment.

2 Normative references

The following documents are indispensable for the application of this document. For the dated references, only the editions with the dates indicated are applicable to this document. For the undated references, the latest edition (including all the amendments) are applicable to this document.

GB 8950 Hygienic specifications of cannery

GB/T 20938 Good manufacturing practice for canned food enterprises

JJF 1366 Calibration Specification of Temperature Data Acquisition Instruments

QB/T 5218 Terms of canned food industries

5.2 Temperature display device of sterilization equipment

It shall meet the requirements of GB 8950.

5.3 Automatic temperature recorder of sterilization equipment

It shall meet the requirements of GB 8950.

5.4 Pressure gauge of sterilization equipment

It shall meet the requirements of GB 8950.

5.5 Pressure recorder of sterilization equipment

It shall meet the requirements of GB/T 20938.

6 Preparation before heat distribution test

6.1 Requirements for thermal sterilization equipment and ancillary facilities

6.1.1 The thermal sterilization equipment and sterilization ancillary facilities to be tested shall meet the requirements of GB/T 20938; including the requirements of devices such as exhaust pipe diameter, exhaust valve type, steam pipe diameter, electronic thermometer, air release valve, circulating pump. Before the test, it shall check and ensure that the supply of water, electricity, steam, compressed air, etc. is in a normal state. In the heat distribution test, the ratio OF the opening area of the loading bottom plate and packaging container separation plate used TO the entire plate area shall meet the following requirements: No less than 20% for steam sterilization; no less than 30% for hot water sterilization.

6.1.2 Before use, the temperature data acquisition instrument shall be calibrated. The calibration method shall meet the requirements of JJF 1366: That is, in a standard constant-temperature oil bath or other constant-temperature facilities, it is checked against a mercury thermometer or electronic thermometer of known accuracy (division value needs to be 0.1 °C or better). Generally, a fixed-point temperature calibration method is used. For example, fixed-point calibration is carried out on the commonly-used sterilization temperatures 100 °C, 116 °C, 121 °C or other specific sterilization temperature points. The deviation value BETWEEN the recorded value of the temperature measurement data recorder AND the mercury thermometer or electronic thermometer of known accuracy shall be recorded and archived; and corrected during data processing.

thermometer of the sterilization equipment;

- 2) Place 1 temperature measurement probe close to the sensor of the automatic temperature recorder of the sterilization equipment. If the mercury thermometer and the automatic temperature recorder sensor are located at the same place, there is no need to repeatedly place the temperature measurement probe;
- 3) Place 1 temperature measurement probe at the axial center of the sterilization basket (usually this location is at a lower temperature);
- 4) Between the bottom and the upper container layers of the sterilization basket, according to the principle of uniform distribution, select the location for placing 1 temperature measurement probe respectively;
- 5) For the sterilization basket close to both ends of the sterilization equipment, it is possible to respectively place 1 temperature measurement probe between the bottom or the upper container layers near the sterilization equipment door and pot tail;
- 6) If temperature measurement probe is to be added, in addition to the above locations, it can be randomly placed in other locations of the sterilization basket;
- 7) 1 temperature measurement probe shall be placed at the vacuum suction cup where the partition is automatically loaded.

For the locations of the temperature measurement probe, it is possible to refer to Figure 1 and Figure 2.

- b) The location of the temperature measurement probe of the basketless sterilization equipment is determined according to the following principles:
 - 1) The structure of the basketless sterilization equipment is special. Most of its mercury thermometer and recorder temperature measurement probes are installed at the bottom of the sterilization equipment; so when the heat distribution points are placed, the temperature sensing heads next to these two positions can be placed first. When placing, it is best to use special tools to complete positioning;
 - 2) For the rest, fix the temperature measurement probes on the marked food packaging containers. According to the set time interval, in the direction of human intervention, let them successively drop from the top of the sterilization equipment into the buffer water in the sterilization equipment. And randomly stack in the sterilization equipment in disorder;

carrier (plate/tank/basket/drawer type) on the same horizontal line at one time.

6.3.3.3 Atmospheric-pressure continuous sterilization equipment

According to the width of the conveyor chain, every 200 mm~250 mm, simultaneously put all the temperature measurement probes into the entrance end of the input chain; or put them in groups and staggered at the same time.

6.4 Specification of packaging container for heat distribution test

6.4.1 The packaging container used for testing shall be the smallest-specification packaging container used by the production of the enterprise under the test.

6.4.2 If the enterprise is producing a product with the smallest-specification packaging container, use that product for testing. If the packaging container of the production line is not the smallest specification, the smallest-specification packaging container is filled with water, to simulate the product (commonly known as water can) or other simulants test.

6.4.3 The heat distribution test of the rolling atmospheric-pressure continuous sterilization equipment is not limited by the container specification. However, the heat distribution test of the bucket or tank type atmospheric-pressure continuous sterilization equipment still needs to be carried out using the product packaged in the smallest specification.

6.5 Initial temperature of canned food

When testing the heat distribution, the initial temperature of canned food shall be slightly lower than or refer to the initial temperature in the sterilization specification.

6.6 Temperature data sampling interval

The temperature sampling time can be self-defined. The temperature data is usually collected every 0.5 min. If the sterilization time is short, the interval time for collecting the temperature can be shortened. Based on the sterilization constant-temperature stage, each temperature measurement probe shall collect no less than 25 temperature data.

Use filled can for heat distribution test. No matter what type of temperature data acquisition instrument, only after the entire sterilization process is completed, can the temperature data acquisition be terminated.

If the heat distribution test is performed with a water can as a load, after 15 min of constant temperature, the data acquisition can be ended; and enter the

to be sterilized. After the whole process of heating, constant temperature, sterilization and cooling, the heat distribution in the sterilization equipment can be obtained.

6.7.5 High-pressure hot water sterilization

For high-pressure and high-temperature hot water sterilization operations using hot water as the heat-transfer medium (including full water type and spray type), after the water is injected to the specified water level, start to heat up. When the water temperature reaches 80 °C, write down the time; and continue to heat to the sterilization constant temperature. The time period from 80 °C to the sterilization constant temperature is defined as the come-up time (CUT for short).

After reaching the sterilization temperature, the sterilization constant temperature timing can be started.

At the end of the constant temperature, enter the cooling stage and complete the whole process of hot water sterilization.

Note 1: In view of the fact that the enthalpy of hot water is not as high as that of steam, the heat transfer rate during sterilization is not as fast as steam; and the temperature in the sterilization equipment is not easy to reach uniformity; so a reasonable come-up time needs to be specified. The U.S. FDA "Minimum CUT" is quoted here, which means: After the minimum come-up time of the sterilization equipment, the temperature in the whole pot has become uniform. If the specified minimum come-up time is 15 min, but the actual come-up takes 14 min to reach the sterilization constant temperature, at this time, the sterilization timing shall not be started. It is necessary to wait for another 1 min and reach the specified 15 min (that is, the two conditions of temperature and time are met at the same time) before the sterilization timing can be started. The purpose is to ensure that the temperature in the sterilization equipment is uniform.

Note 2: Due to the different inlet water temperature, products, and seasons of the sterilization operation, the actual initial water temperature in the sterilization equipment is bound to be inconsistent. In order to have a unified starting point for the set minimum come-up time, this Standard stipulates that the minimum come-up time starts at 80 °C.

Note 3: After obtaining the minimum (shortest) come-up time from the heat distribution test data, combined with the heating capacity of the sterilization equipment, the time can be specified after adding a 10% to 15% time safety factor.

6.7.6 Basketless high-pressure sterilization

After the temperature measurement probes are placed from the top of the

- a) After 3 min of constant temperature, the temperature discrete value of all temperature measurement probes shall be reduced. Compared with the reference temperature, the standard deviation (σ_i) of the temperature at different locations in the sterilization equipment during the entire constant-temperature process shall be less than 0.5 °C.
- b) After the come-up stage of thermal sterilization is over, and within 1 min of the constant temperature, the lowest temperature of the temperature measurement probe is 1.67 °C (3.0 °F) lower than the reference temperature (refers to the temperature measurement value of the temperature measurement probe placed next to the mercury thermometer, the same below), which is regarded as acceptable.
- c) If the come-up stage is over, and within 3 min of constant temperature, the lowest temperature of the temperature measurement probe is 0.56 °C (1.0 °F) lower than the reference temperature, which is considered acceptable.

8.3.2 Hot water sterilization equipment

If the following two conditions are met at the same time, the heat distribution can be considered acceptable:

- a) If the come-up stage is over, and within 6 min of constant temperature, the lowest temperature of the temperature measurement probe is 1.1 °C (2.0 °F) lower than the reference temperature, which is considered acceptable.
- b) The average temperature value $\bar{X}_i$ of each temperature measurement probe in the constant-temperature stage is compared with the re-average temperature value $\bar{\bar{X}}$ of the average values $\bar{X}_1, \bar{X}_2, \bar{X}_3, \dots, \bar{X}_n$ of all other temperature measurement probes. The deviation value is within the range of 0.56 °C.

8.3.3 Atmospheric-pressure sterilization equipment

When using atmospheric-pressure continuous tunnel sterilization equipment to sterilize acidic foods, in the constant-temperature stage, in the heat distribution test, the lowest temperature of the temperature measurement probe shall not be lower than the sterilization reference temperature specified in the process.

9 Test report

It is recommended that the heat distribution test report includes the following:

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