

CHAPTER 13, SUBJECT 2**GUIDELINES FOR TEMPERATURE DISTRIBUTION STUDIES WHEN
PROCESSING IN STEAM-STILL RETORTS EXCLUDING CRATELESS RETORTS****1. INTRODUCTION**

These guidelines have been formulated jointly by Agriculture Canada, Fisheries and Oceans Canada and Health Canada. They represent important elements to be considered when carrying out a temperature distribution study¹ for any product to be thermally processed in steam-still retorts excluding crateless retorts.

When appropriate, temperature distribution studies will be evaluated by these departments using the elements given in these guidelines. Only persons experienced and knowledgeable on thermal processing in steam-still retorts should carry out and evaluate the results of such studies.

2. APPLICATION

Temperature distribution studies should be done to: develop or validate a venting schedule; to locate cold or slow heating zones in preparation for heat-penetration studies; in the case of new installations; and for any changes to an installation which may influence the temperature distribution in the product zone. Examples are: changes to steam spreaders, decreased steam pressure in lines, changes to the product loading patterns, changes to the basket and/or dividers, etc.

3. INVENTORY OF THE THERMAL PROCESSING SYSTEM

Prior to the selection of the test retort(s) a survey should be made of the following:

3.1 Lay-out Diagram

A detailed diagram identifying all equipment for which the use of steam is required (including the numbering system used to identify each retort) and the steam supply line

¹Adapted from Temperature Distribution Protocol for Processing in Steam-Still Retorts, from the Institute for Thermal Processing Specialists, P.O. Box 2764, Fairfax, Virginia, U.S.A. 22301-0764, (703) 591-1108.

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arrangement should be made as prescribed in this section. (Note that it is recommended that all steam lines from the main line to the retort(s) be clearly identified in the diagram from those steam lines feeding other equipment).

3.2 Steam Supply to the Retorts

3.2.1 Boiler(s) Capacity (psi or kPa)

Record potential and actual settings, amount of steam developed and available, i.e., pounds or kilograms of steam produced per unit time.

3.2.2 Retort Header Pressure

It is important to insure that adequate steam pressure and volume is being delivered to the retort(s). This measurement should be taken when maximum operational demand is made on the steam supply.

3.2.3 Headers, Manifolds, Lines and Valves

Record pipe size and length, valve size and types, of the main steam line from the boiler(s) immediately before the pressure/steam regulator to the retort(s).

3.2.4 All Connecting Steam Lines Other than to the Retort

Record size of all connecting steam lines to the main steam line noting other equipment using steam (e.g., blanchers, exhaust boxes, etc.).

3.3 Retort(s)

A detailed diagram of each retort, including associated operational equipment as identified below, should be made. Where identical retort configurations exist, one diagram is sufficient. The designated retort number(s) must be shown on the diagram. The system should include the full manifold system.

3.3.1 Retort shell

Record retort type and internal dimensions. For vertical retorts, note the presence of centring guides and/or baffle plates.

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3.3.2 Retort Crates

Record maximum number of crates used in each run as well as their design and dimensions.

3.3.3 Steam Supply from Pressure/Steam Regulator to Retort

Record pipe sizes, valve type and sizes, pressure/steam regulators or reducers and all pipe fittings including steam by-pass lines and steam spreaders (shape, pipe size, length, location; number, size and location of holes in pipe).

3.3.4 Steam Control

Record type of controller (i.e., pressure to air, temperature to air) and location of sensor.

3.3.5 Air System for Controls (if applicable)

Record size of air compressors, air dryer capacity, filter type and location(s). Include the line pressure that must be maintained for operation of the controls and how this pressure is controlled.

3.3.6 Other Piping and Required Equipment

Record the following information:

1. Vents: location, length and size of pipes, also type and size of valves
2. Vent manifold or manifold headers: location, length and size of all pipes, connecting pipes, and valve(s) type(s) and size, where applicable.
3. Bleeders, mufflers: location, number, size and construction
4. Drains: location and size. In addition, note where they drain and whether they are open to the atmosphere.
5. Water supply (if applicable): location and size of pipes, valve type and size.
6. Air supply (if applicable): location and size of pipes, valve type and size, and the available air pressure.
7. Temperature-indicating device (Mercury-in-glass (MIG) thermometer or equivalent): location of the sensing point in the retort and date/year when it was last calibrated.
8. Temperature controller: sensing point location in the

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retort.

9. Pressure gauge: location of the sensing point in the retort and date/year it was last calibrated.
10. Additional piping or equipment such as condensate removal systems, etc.

3.3.7 Recording Device

Note type of recording device (recorder or recorder/controller). For more information consult section 7.6.2.2 of the **Recommended Canadian Code of Hygienic Practice for Low-acid and Acidified Low-Acid Foods in Hermetically Sealed Containers (Canned Foods)**.

3.4 Loading Equipment

Record the following information:

1. Container size, loading configuration and maximum number of containers per layer or per basket (scramble pack).
2. Maximum number of baskets in each retort.
3. Hole size and spacing of the basket base plate.
4. Determine the percent open area of the base plate and separator sheets if used in the crates or baskets. Where separator sheets are located over a base plate, they should be positioned to reflect the worst case scenario.

Note: It is important to document the survey findings correctly in order to enable a proper evaluation before selecting the test retort(s). The documented survey should be maintained on company's file and updated when necessary.

3.5 Selection of Test Retort(s)

All information required in section 3 above must be taken into consideration when selecting the test retort(s). The retort(s) selected should represent the worst possible condition that could influence the delivery of the venting procedure. Note that under certain conditions (i.e., when the plumbing and equipment configuration is not identical for all retorts), it may be necessary to carry out a temperature-distribution study of a number of retorts in a system in order to determine which one represents the worst case.

Where all plumbing and equipment configurations are identical, it is generally advisable to select as the worst

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possible case the retort which is located at the end of the steam line. However, this is not always the case. This is an area where the knowledge and experience of the specialist supervising the study are of utmost importance.

4. TEST EQUIPMENT

4.1 Data Logger

Note if data logger has a sufficient number of channels to monitor adequately and record temperatures during the temperature-distribution study.

4.2 Thermocouples

Note if thermocouples and lead wires, or other temperature-measuring devices used are of an appropriate type, size, length and number to adequately monitor the temperatures within the retort.

4.3 Temperature-Indicating Device(s)

Note which type used (Mercury-in-glass thermometer or other) see 3.3.6 item 8.

4.4 Pressure-Indicating Device(s)

Note which type used (if required) see 3.3.6 item 9.

4.5 Stuffing Box (packing gland)

Note if diameter is sufficient to accommodate number of lead wires (if thermocouples are used as the temperature measuring device) and specify its location on the retort.

5. STANDARDIZATION OF TEST EQUIPMENT

5.1 Retort Mercury-in-glass (MIG) Thermometer (or equivalent temperature-indicating device)

The MIG shall conform with section 7.6.2.1 of the **Recommended Canadian Code of Hygienic Practice for Low-acid and Acidified Low-Acid Foods in Hermetically Sealed Containers (Canned Foods)**. Prior to performing a temperature-distribution test, the MIG thermometer (or equivalent) shall be certified by a recognized authority as

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meeting the stated accuracy according to specifications, such as set out by the National Research Council of Canada (NRC), and calibrated. If it has been calibrated and certified in the past 12 months, then it should not have to be done again unless there is doubt as to its accuracy.

5.2 Temperature-Measurement System (e.g., data logger, thermocouples, extension wires or other temperature-measuring devices (TMD), etc.)

1. Prior to conducting a temperature-distribution test, standardization of test equipment (see Section 4) must be performed using the test retort selected. All leads, extensions and connections should be assembled as they will be used under actual operational conditions.
2. Place one or more TMDs in close proximity of the known accurate retort MIG thermometer probe (or equivalent). Care should be taken not to inhibit steam flow past the thermometer probe (or equivalent).
3. The retort is brought up to the temperature to be used during the temperature-distribution tests and the entire system is allowed to run for 10 minutes after equilibrium is reached.
4. All TMDs should be standardized at the intended retort operational temperature. Thus a variance amongst the TMDs to be used can be identified and those which vary by more than 0.3C° (0.5F°) from the standard thermometer should be discarded. The range of all thermometers should be no more than 0.6C° (1F°). After correction factors have been incorporated, all TMDs should give the same reading.
5. In order to meet the above calibration criteria, consideration must be given to minimizing errors due to variables inherent in any component of the temperature-measuring system. For example, the use of thermocouple wire from the same spool is recommended to make all thermocouple leads and extensions².

²For more information consult the "Standard Guide for Use in the Establishment of Thermal Processes for Foods Packaged in Flexible Containers" ASTM F 1168-88, 1988.

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6. PLACEMENT OF THE TEMPERATURE MEASURING DEVICES IN THE RETORT

A minimum of 12 TMDs (or equivalent) should be used. However, the number of TMDs depends upon many factors, for example, size of the retort chamber zone, container size, number and configuration in the baskets, etc.

TMDs shall be placed in the following locations in the retort vessel:

1. In close proximity to the MIG thermometer probe (or equivalent).
2. In close proximity to the temperature controller probe. If this probe is in close proximity to the thermometer probe, this location is not necessary.
3. Guidance as to the placement of TMDs in the product zone can be obtained from the design of the retort and the steam supply and distribution system as well as the loading pattern in the baskets or crates. However, location of cold zones does not always follow logic, specially when determining a venting schedule which requires freedom from steam/air pockets. This is an area where the knowledge and experience of the specialist supervising the study are of utmost importance.

As a general guidance it is recommended to place TMDs in the following manner:

- 3a. For **Vertical**³ Retorts:
Temperatures should be measured in the middle of each basket at the top, centre and bottom. If more thermocouples are available, points along the edge at the top and bottom of each basket may be measured. If still more thermocouples are available, other points around the periphery of the basket may be measured.
- 3b. For **Horizontal**³ Retorts:
In this type of retort the product is usually in cars. In a horizontal retort thermocouples should be located in the middle of the basket at

³Procedures for carrying out a heat penetration test and analysis of the resulting data. Prepared by Irving Pflug, University of Minnesota, 1975. Published by Department of Food Science and Nutrition, University of Minnesota, 100 Union Street, Minneapolis, MN 55455.

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the top, centre and bottom of each car. If more thermocouples are available, they should be located at the centre of the outside of the four sides of the car.

Note: A schematic diagram of the placement of all TMDs within the retort and covering all three dimensions should become part of information recorded for the temperature-distribution tests.

4. For determining the initial temperature (IT), TMDs should be placed in a sufficient number of medium-filled testing containers. Generally two containers have been found to be acceptable. Alternatively, a hand-held thermometer may also be used to make that determination. Ideally all containers in the retort should be equilibrated to a previously identified IT.

7. PREPARING THE TEST CRATES OR BASKETS WITH CONTAINERS

- a. Select the container size processed in the retorts, usually the smallest, that will yield the worst-case situation for the operation.
- b. The product that has the highest heat absorption rate (convection heating) processed in the retorts should be used. Water may be used in the cans in place of product.
- c. Containers are placed in the crates or baskets in a manner that is equivalent to the worst-case situation under the commercial operation. If separator or divider sheets are used between the layers of containers, the sheets having the smallest percent total open area shall be used for testing.

8. TEMPERATURE-DISTRIBUTION TEST

8.1 Set-up

1. Review the retort survey
2. Initial Temperature (IT):

The initial temperature is usually determined from the container having the lowest temperature. When determining the test IT, the range of initial temperatures to be encountered during normal commercial operation should be taken into account and the coldest IT be selected.

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8.2 Critical Items

The following are critical and should be monitored and recorded during the test.

1. Controller temperature set point.
2. Initial temperature (IT).
3. Retort steam header pressure.
4. Time steam on or "0" time.
5. Time when the drain is closed, if it is open during a portion of the vent.
6. Time that vent is closed, retort temperature at the time the vent is closed as determined by the reference temperature-measuring device (TMD).
7. Time when the reference temperature-measuring device reaches the processing temperature.
8. Time when the controller (if applicable) advances to the "cook" cycle in the program or when the cook begins.
9. Reference temperature-measuring device readings at sufficient intervals, including the time it reaches the processing temperature.

8.3 Important Items

In addition, the following points are important and are highly recommended to be monitored and recorded during the test.

1. Time when the temperature-recording device reaches the processing temperature set point.
2. Retort pressure gauge (optional) readings, at sufficient intervals.

8.4 Conducting the Test

1. The data logger should record the temperature of each TMD just prior to "steam on" and at sufficient intervals - not to exceed one minute - throughout the test. The data logger record shall become part of the test records.
2. Critical items (see 8.2) should be recorded, as required, at intervals of sufficient frequency to describe and verify retort operating parameters during the test. These records shall become part of the test records and shall include the temperature-recording chart(s).
3. The test should extend for at least ten minutes after the retort control systems have stabilized and a definite temperature profile has been established for

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all TMDs.

4. In the absence of a maintenance system, each retort should be tested every two years under the worst-case scenario.

8.5 Required Parameters for the Determination of a Vent Schedule

1. On the basis of the data accumulated during the performance of temperature-distribution testing on steam-still retorts, excluding crateless retorts, a vent schedule should specify as a minimum the following critical parameters:
 - a. Vent time ("steam on" to vent closed).
 - b. Vent temperature (when the vent valve is closed).
 - c. Where appropriate, minimum initial temperature (IT).
 - d. Use of any opening in the retort (other than the vent valve) during the vent period to increase vent capacity.
 - e. Time and temperature when the drain is closed if it is opened during a portion of the vent.
2. For a vent schedule to be determined successfully, it should be based on a minimum of three (3) repeatable runs, and conducted under "worst-case" conditions. "Repeatable" means that all three (3) runs, conducted under the same test conditions, must show that adequate temperature distribution is achieved.

For more information on vents and venting system refer to sections 7.6.3.1.7. and 7.6.3.1.8 of the **Recommended Canadian Code of Hygienic Practice for Low-acid and Acidified Low-acid Foods in Hermetically Sealed Containers (Canned Foods)**.