ACCURATELY MEASURING SEAFOOD TEMPERATURES

PURPOSE

One of the critical control strategies in the handling of seafood involves monitoring and maintaining records of temperatures throughout the entire process cycle because the safety and shelf life of seafood is rapidly reduced at elevated temperatures. This article covers the calibration and usage of dial and electronic thermometers that will operate in the temperature range from -40 deg C(F) to 100 deg C (212 deg F). This article was written originally for tuna processors but the techniques are valid to use for measuring any seafood temperature. This article will not cover calibrating mercury-in-glass retort thermometers which are detailed in Chapter 21, Code of Federal Regulations, Section 113 (21 CFR 113).

The purpose of this document is to assist seafood suppliers in understanding:

- how dial and electronic thermometers to measure temperatures and
- how to measure the backbone temperatures of tuna or other seafood products accurately.

To properly implement a temperature control strategy, it is important to know how:

- to measure the temperatures correctly and
- to verify the accuracy of the thermometer.

RESPONSIBILITY

It is the responsibility of each seafood processor to:

- teach their workers how to calibrate and verify the accuracy of the thermometer,
- teach their workers how to measure and record backbone temperatures correctly,
- provide enough functional thermometers for them to do the tasks assigned,
- provide the proper data collection forms to record and summarize the information, and

➧calibrate all thermometers in ice water at least once a day or as often as needed.

The temperature reading used to monitor and control the various processes is vital management information, and must be recorded accurately and correctly. Each person taking temperatures reading must be properly equipped with functional accurate thermometers, forms to record the information accurately, a pen or pencil to write with, and adequate light (use a flashlight if needed) to observe the temperature reading.

THERMOMETER DESCRIPTIONS

Mercury-in-Glass thermometers

Mercury-in-glass thermometers must ***never, ever*** be used in or around fish or other seafood because they could break causing glass or the mercury to contaminate the product. Mercury-in-glass thermometers can be used indirectly to calibrate other thermometers, but using an ice water bath for calibration is just as effective and much safer when processing fresh and frozen fish.

Dial thermometers

Dial thermometers use a helix coiled bimetallic strip located within the thermometer stem to measure temperature. The temperature-sensing zone includes the area from the tip of the thermometer up to an indentation on the stem of the thermometer (See Fig. 1). Dial thermometers can generally be calibrated to a known temperature by adjusting a hex nut located under the dial (see calibration section).

To measure temperatures accurately with a dial thermometer,

➧the thermometer must be properly calibrated and
➧the ***entire*** temperature sensing zone must be in contact with the location to be measured, i.e. the backbone.

If only the tip of the dial thermometer is in contact with the backbone, readings will not truly measure the backbone temperature.

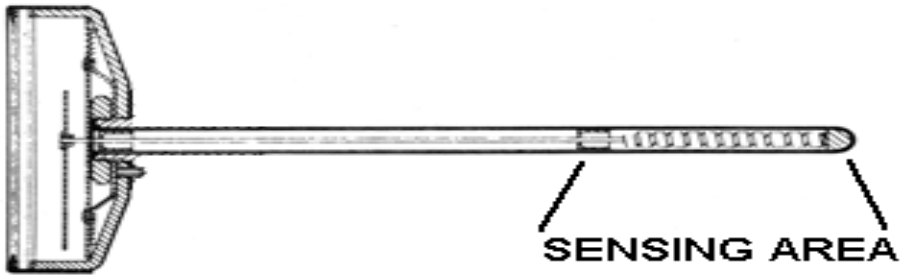

Figure 1
Cutaway drawing of a dial thermometer (courtesy of Marshall Instruments, Inc.)

Electronic thermometers

The temperature sensing zone for the electronic thermometer is in the tip of the probe, where two different types of wire are joined together (See Fig. 2). Electronic thermometers can generally be adjusted with a zeroing screw on the electronic display unit.

To measure backbone temperatures accurately with an electronic thermometer,

- the thermometer must be calibrated and
- the tip of the sensing probe must be in contact with the backbone.

Figure 2
An electronic thermometer probe

CALIBRATION PROCEDURES

All thermometers should be calibrated daily to be certain the correct temperatures are being measured. An inaccurate thermometer reading is as flawed as using improper procedures while taking temperatures--because either way the wrong information is being recorded. To calibrate a thermometer only takes a few minutes and is essential for good business practices.

Calibration with ice

The temperature of an ice-water slurry is 0 deg C (32 deg F), the freezing / melting temperature of fresh water. Fill a plastic or metal container (a large Styrofoam cup, for example) with chipped or crushed ice; then add clean fresh water to a depth of at least 10 cm (4 inches). Stir the ice and water for a minimum of 2 minutes to be certain the water is completely cooled and good mixing has occurred. Always make certain there is plenty of ice in the mixture, and be sure to use fresh water, not seawater.

Dial Thermometers:

Immerse the stem of the dial thermometer in the ice-water slurry for a minimum of 2 minutes. After 2 minutes, read the temperature on the thermometer(s) without removing it(them) from the ice/water slurry. Adjust the thermometer to 0 deg C (32 deg F), if necessary, by gripping the hex nut under the dial with a wrench or pliers and turning the dial face until the pointer reads the temperature correctly. To check several thermometers for accuracy at the same time, punch holes in a plastic lid and insert the thermometers through the holes into the ice-water slurry. Paper clips may be formed to hold the thermometers in place. The thermometers should not touch the sides or the bottom of the container nor should they touch each other. The case around the dial thermometer generally has a metal hoop on the pocket clip that can be used to hold the thermometer in an ice/water slurry.

Electronic Thermometers:

Immerse the probe of the electronic thermometer in the ice/water slurry for a minimum of 2 minutes. After 2 minutes, read the temperatures without removing the probe from the ice/water slurry. Adjust the thermometer to 0 deg C (32 deg F), if necessary, by following the manufacturer's directions. These thermometers are generally adjusted with a zeroing screw.

Calibration with boiling water - at sea-level and standard atmospheric pressures

This is much more dangerous than calibrating with ice so be extra careful. You must first calculate the boiling point of fresh water for your working altitude. See the last section of this article for the factors to use to calculate the adjusted boiling point.

Because of the complexity involved in calibrating a thermometer in boiling water, this method should only be used to confirm that a thermometer calibration at 0 deg C (32 deg F) is measuring accurately at higher temperatures.

Heat the fresh water until a rolling boil is achieved. Immerse the stem of the dial thermometer or the probe of the electronic thermometer in the boiling water for a minimum a minute. After at least a minute, read the temperatures on the thermometer without removing it from the boiling water. Adjust the thermometer as necessary to the calculated boiling point for the altitude and atmospheric pressure.

TEMPERATURE COLLECTION PROCEDURES

Chilled Raw Fish

Fish that are being chilled may have different temperatures from the outside of the fish to the backbone, with the outside of the fish at a lower temperature than the backbone. The outside of the fish may be chilled, while the backbone area may still be warm. Select the thickest part of the fish, and insert the point of the thermometer into the fish with the tip pointed towards the backbone (Figure 3). Once the tip has touched the backbone, continue to slide the tip about 2.5 cm (an inch) past the backbone (stop at the backbone with an electronic thermometer probe). Take the thermometer reading after the temperature indicator has stopped moving. Be sure to insert the thermometer above the backbone so you are not collecting the belly cavity temperature.

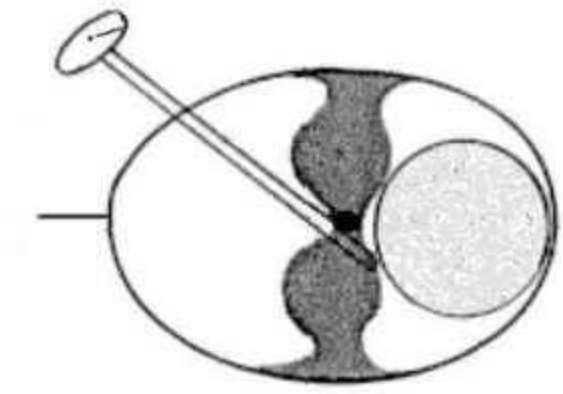

Figure 3
Cutaway of a fish and dial thermometer

Frozen Fish

Frozen fish just recently removed (5 to 10 minutes) from a ship's hatch or a cold storage generally will have the same temperature throughout the fish. It is very important to be certain that the backbone temperature is being measured because pricing agreements and/or shipping documents generally refer to backbone temperatures. The backbone temperature may also be referred to as the pulp temperature in some shipping documents. Drill a hole to the backbone of the fish just slightly larger than the stem of the dial thermometer or probe of an electronic thermometer. If you are using a dial thermometer, the hole should go at least an inch past the backbone.

Insert the thermometer to or past the backbone according to the type of thermometer being used, and wait at least a minute for the thermometer to measure the temperature correctly. Read the temperature, record the reading, and then remove the thermometer.

If you have to twist the dial thermometer to remove it from the frozen fish, you must calibrate the thermometer again, in case the thermometer adjustment was inadvertently changed.

RECORDING THE TEMPERATURES COLLECTED

The temperatures should be read and recorded while the thermometer is still in the fish or other seafood product, prior to removal of the thermometer and insertion into

another fish or storage. This will help assure that the temperature information is recorded promptly and accurately.

The records should be kept in an organized fashion so that if there are any problems the temperatures at the various processing steps can be analyzed to try to understand the problems.

TUNA BACKBONE TEMPERATURES

The various tuna species are unique among fish in that they can maintain a body temperature several degrees above the temperature of the surrounding seawater. Freshly caught tuna can have internal temperatures that exceed the seawater temperature by anywhere from 2 to 10 degrees C depending on the species, the depth of the water they are caught in, the actual seawater temperature, and the length of the struggle at capture. In the tropical oceans, the surface water temperature can easily reach 27 deg C (~80 deg F), meaning the internal temperature of tuna at capture could range from 29 to 38 deg C (85 to100 deg F).

Histamine quickly forms at temperatures above 21 deg C (~70 deg F) so it is very important to get the tuna chilled and frozen as quickly as possible. Histamine formation slows down very quickly as the temperature is lowered and is not a problem if the temperature is lowered quickly enough.

There are many articles written about how to prevent histamine formation and other decomposition problems in tuna. If you would like a list of them or any other information, please contact the tuna processors or myself.

PHYSICAL CONSTANTS

The formulas for converting between Fahrenheit and Celsius temperature scales are:

Deg C = 5/9 * (deg F - 32)

Deg F = 32 + deg C * 9/5

The normal human body temperature is 37 deg C (98.6 deg F). Fresh water boils at 100 deg C (212 deg F) at sea-level at a standard atmospheric pressure (760 mm Hg), and freezes at 0 deg C (32 deg F). The freezing point of water does not change with normal variations of atmospheric pressure.

The boiling point of water varies with changes in atmospheric pressure; at higher altitudes the boiling point of water is lowered depending on the altitude. If you are

using the boiling point of water to calibrate a thermometer, you must estimate the boiling point is based on your altitude. In general, for each 293 meter (960-foot) increase in altitude the boiling point changes by 1 deg C (1.8 deg F), however, it is the change in atmospheric pressure that causes the change in the boiling point. Please refer to a handbook of chemistry and physics for the exact boiling point of water at different atmospheric (vapor) pressures. To properly determine the atmospheric pressure you will also need a barometer.

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Email your comments, suggestions or corrections to: