

Temperature Measurement in Meat Processing Plants

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Carcass chilling is one of the most critical stages in the hygienic production of meat. The effectiveness of chilling influences food safety, the ultimate shelf-life of the product, carcass appearance, eating quality, weight loss and bone-ability.

A basic requirement for effective temperature control is the accurate determination of the temperature of meat and air.

Although more emphasis is being placed on control of the surface temperature, deep meat temperature is still important. After all, there is no point in having a surface temperature of 7°C if the deep meat temperature is 25°C. As the deep meat and surface temperatures equilibrate in transit, the surface temperature could increase and support the growth of dangerous bacteria.

Deep butt temperature is also important from the point of view of bone taint.

Thermometers

Electronic digital thermometers should be used for all meat-related temperature measurements. These thermometers have a temperature-sensing device in the tip of a stainless steel spear probe. For frozen meats, a hole for inserting the probe must be made using a power drill with a suitable drilling bit.

For use with meat and meat products, an electronic thermometer's probe should be stainless steel, adequate length and not more than 3mm in diameter. Although electronic thermometers require batteries and are a little more expensive than other types, they are easy to read, fairly robust and normally quite reliable.

Using Thermometers

To use a thermometer correctly, the thermometer must be calibrated at regular intervals, and the sensing tip must be located at the point in the meat or air where the temperature is to be measured.

When making temperature measurements, avoid exposing the shaft of the thermometer probe to large temperature differences between the material being measured and its environment. This will minimise thermal conduction from hot to cold areas and eliminate the risks of conduction errors.

One effective way of doing this is to insert the thermometer along the "longest thermal path". This means leaving as little as possible of the shaft of the probe exposed to external temperatures whilst ensuring the sensing tip is located precisely at the area to be measured. If used properly, modern electronic thermometers will give negligible conduction errors.

The thermometer must remain in place until its reading stabilises. In some cases, this may require a minute or more. The amount of time required should be noted for each thermometer.

Many electronic instruments take time to settle when moved from one environment to another, such as from ambient conditions of 25°C to a chiller at 5°C.

The probe must be sterilised before use and regularly during use.

Measurement of Deep Butt Temperature

Although short (100mm long) thermometer probes are often used to take beef deep butt temperature measurements, these probes are inadequate if true deep butt temperatures are to be attained. Using a 100mm probe on heavy carcasses can result in the reading being 5°C or more lower than the true deep butt temperature.

Probes should be at least 150mm long – and preferably 180mm long – and 3mm diameter.

Correct deep butt measurements are also dependent on correct insertion of the thermometer probe. The true deep butt temperature is measured by locating the tip of the thermometer probe against the

Trochanter Major, which is the knob of bone on the opposite side of the femur to the hip joint.

Chilled Beef With chilled beef, this point is approached by inserting the probe upwards through the Pope's Eye at an angle of 15-20°C. (Fig. 1)

The tissue surrounding the bone can be felt

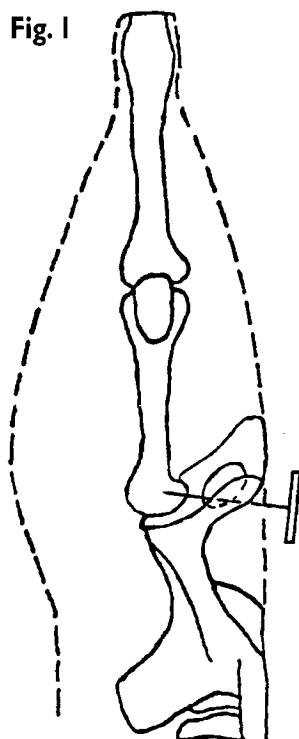


Fig. 2



through the thermometer probe. The probe should be aimed at an imaginary vertical line approximately one-third of the distance from the Achilles Tendon to the last tail-bone. (Fig. 2 on previous page)

Frozen Beef Hind Quarters A hole matching the diameter of the thermometer probe must be drilled starting on the outer surface of the frozen beef hindquarter and continuing until reaching the surface of the Trochanter Major. (Fig. 3)

Remove the drill and insert the probe firmly. To minimise the risk of conduction errors, angle the hole so most of the length of the probe

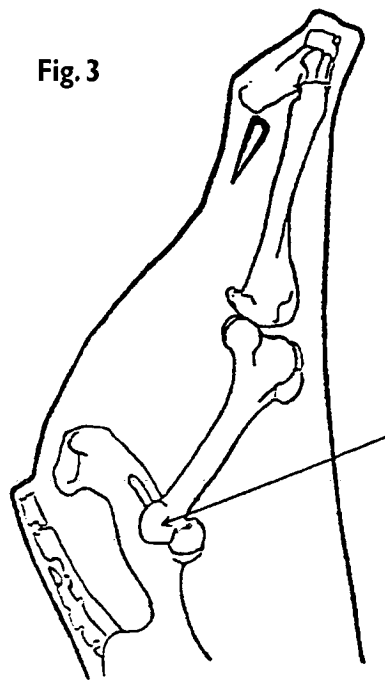


Fig. 3

1. Inserting the tip of the probe up to 5mm under the carcass surface, with the probe inserted parallel to, and just under, the surface.
2. Pressing the side and tip of the probe hard against the fat or meat surface.
3. Placing the probe between the pressed together surfaces of two adjacent carcasses.
4. Shielding the probe from room air by holding the probe against the carcass surface with a dry sponge (with the sponge placed in a sterile plastic bag).

An additional method is placing the head of a surface measuring probe against the carcass. Response times for the surface probe are more rapid than for the spear probe.

Fig. 4



can be inserted, or wrap the exposed probe section with insulating material.

Note the reading when the thermometer has stabilised.

In the case of lambs and whole pig carcasses, the best way to measure deep butt temperature is through the topside. (Fig. 4) Push the probe downwards through the topside, aiming for the junction of the femur bone and H-bone.

Surface Temperature Measurement

Because the measurement of carcass surface temperature is critical in assessing the effectiveness of chilling, it must be performed properly with the correct instrument.

Surface temperature can be measured using two methods: contact and non-contact.

Contact Measurement

Measurement can be taken with the normal spear probe with a temperature sensing device in the tip, connected to a digital electronic thermometer, using any of these four methods:

Non-Contact Measurement

Non-contact infrared thermometers are ideal for surface temperature measurement, as they are accurate and easy to use, allow one-handed operation and have a rapid response time of less than one second. These instruments measure the radiant heat emitted by the surface and from this determine the temperature. The radiant heat emitted depends on the temperature and emissivity – a measure of the efficiency of emitting infrared radiation – of the surface.

The more sophisticated, and expensive, infrared thermometers use a laser beam to pinpoint the centre of the target area and have adjustable emissivity.

Fixed emissivity and non-laser models are suitable for most meat industry applications and are available for little more than the cost of a good quality digital thermometer.

Air Temperature Measurement

Air circulating in cold rooms will vary in temperature. The temperature will be coldest at the outlet of the refrigeration unit and, on average, warmest at the inlet. Local variations will occur, however. For example, the air will be warm near hot carcasses. Because of the possibility for variations, location of the sensor is important so it measures the temperature at an appropriate position. Air control temperature measurement in the wrong place in chillers could lead to carcass surface temperatures

being higher than desired, resulting in excessive bacterial growth.

For room temperature control, the sensor should be positioned well away from the cooling unit and from other hot or cold bodies. The area should have good air flow and not be obstructed by rails, carcasses, etc. It should be away from doors and openings through which warmer air might enter the room.

As with hand-held thermometers, calibrations must be checked regularly. Air temperatures should be measured at the inlet of a refrigeration unit. If the sensor is placed in the air stream within a few centimetres of the coils, radiation between the sensor and the coils will tend to give false temperature readings, unless the sensor is shielded by means of a cover. This, while permitting a good air flow between the cover and the sensor, cuts the line of sight between the sensor and the coils. As a result, errors due to radiative heat exchange can be eliminated.

For manual routine measurements and spot checks, care should be taken to ensure open doors and other openings do not result in misleading temperature readings being taken. The probe must be dry, since a wet probe will result in a falsely low reading due to evaporation of moisture.

Calibration

The accuracy of thermometers should be checked regularly as part of a quality assurance program. The accuracy can be checked by measuring the temperature of a stirred mixture of ice, and water in an insulated container or vacuum flask. The ice and water mixture should be mostly ice with excess water drained off if the ice is floating. Assuming reasonably pure water is used to make the ice, the temperature of this mixture is 0°C.

If the thermometer is inserted into the water and ice mixture and does not read 0°C, the calibration of the instrument should be adjusted or the temperature readings of meat should be adjusted accordingly. For example, if the thermometer reads +0.8°C in ice, deduct 0.8°C from the reading of meat temperature.

Loggers

Small temperature loggers are available and are ideal for use in both quality assurance and trouble-shooting.

Thermometer Suppliers

AMT can advise where suitable thermometers can be purchased.

Additional Information

A more detailed description of the chilled beef procedure is provided in AMT Meat Technology Update 95/1: "Measurement of Temperatures in Fresh Processed Meats".

A review of procedures for the measurement of carcass surface temperature is given in AMT Meat Technology Update 95/6: "Measurement of Surface Temperatures of Chilled Carcasses and Sides".

More detailed information concerning calibration is available in "Carcass Chilling" in *Production of Chilled Meat for Export*, pp 39-52.

Other documents of interest: "Monitoring Chilled Product" in *The Production of Chilled Meat for Export (1991)*, pp 97-116; "Evaluation of Non-Contact Infrared Thermometry for Measuring the Temperature of Pig Carcasses in Chillers", in *Meat Science* 32 (1992) 1-9; and Australian Meat Technology Pty Ltd, 1996 Training Manual, "Food Safety - Hygienic Meat Made Even Better!"

Additional information

Additional help and advice are available from Food Science Australia, Meat Industry Services Section:

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