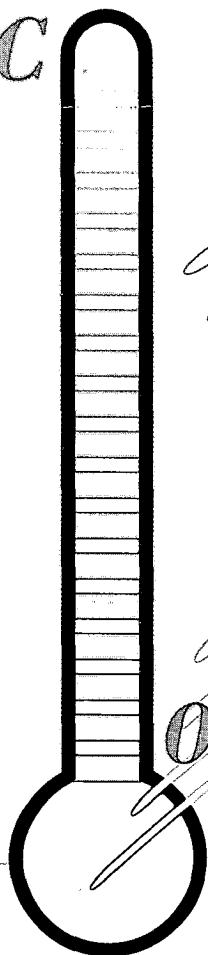
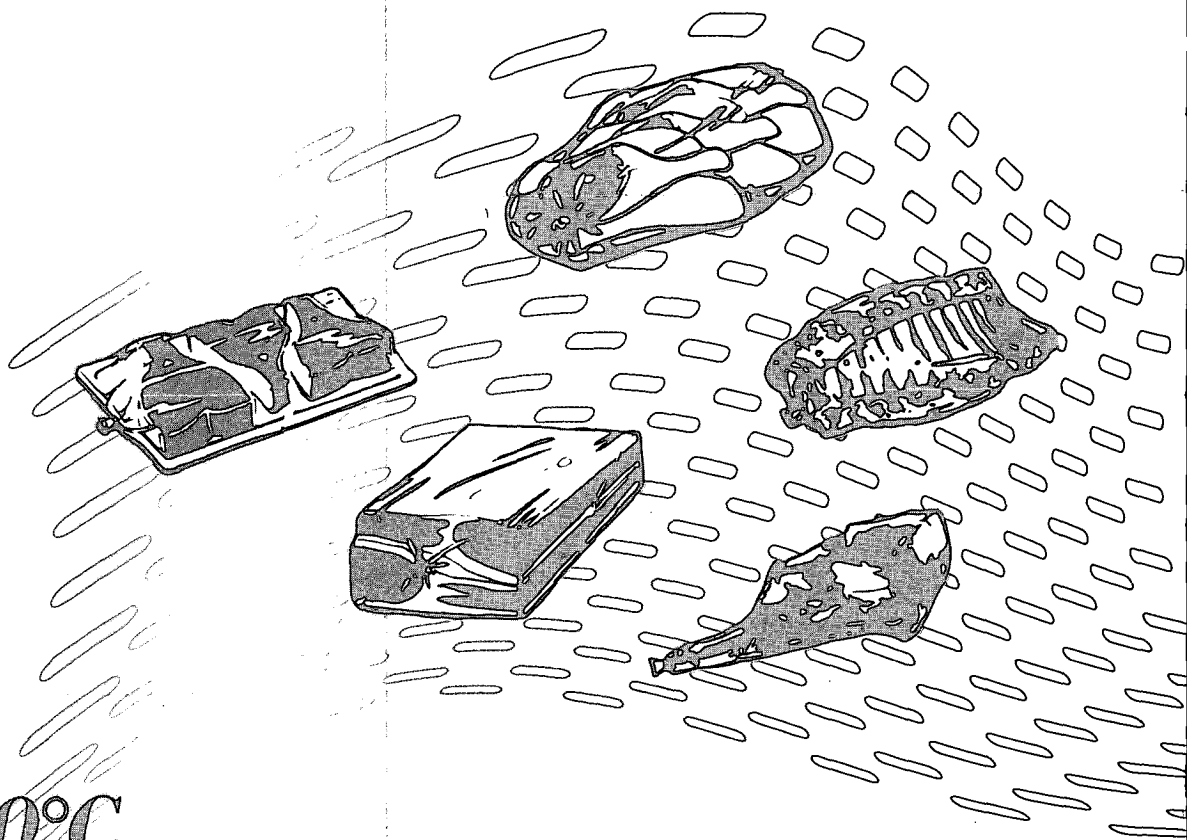


100°C



0°C



Chilling Vacuum-Packed Product

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Meat
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Processors have several options for chilling vacuum-packed product. These options depend, however, on existing available facilities, required turn-around time, labour availability and requirements for ageing. The best option for a particular plant must be determined by the setting of priorities.

The optimum storage temperature for chilled meat is the lowest possible temperature at which no freezing occurs. Since non-vacuum-packed meat commences to freeze at -1.5°C , and vacuum-packed meat starts to freeze at -2°C , the aim is to reduce the meat temperature to -1 to 0°C as soon as possible after packaging. Ideally, no vacuum-packed product should be loaded out until the meat temperature is at or below 0°C .

Reducing meat temperature quickly has three main advantages:

1. Bacterial growth is restricted, enhancing storage life.
2. Weep is reduced, improving visual quality of the packaged product.
3. Product is available for dispatch earlier. (The product reaches the load-out temperature of 0°C quickly.)

Three options are available to reduce the meat temperature:

1. Chill in holding chiller
2. Chill in blast chiller
3. Chill uncartoned

Holding Chiller

Chilling vacuum-packed meat in a holding chiller is the least costly method – and the least effective method. Cost savings are obtained by having all product in one room, thus minimising capital costs, refrigeration costs and handling costs.

Vacuum-packed primal cuts from a conventional boning process could be expected to be packed at a product temperature of 10° - 15°C . Under these conditions, a target time from packing to 0°C would be a maximum of 48 hours.

Unfortunately, cartons of heavy cuts may take more than three days to reach 0°C .

Warm- or hot-boned vacuum-packed primal cuts will take significantly longer to reach 0°C in a holding chiller. Under these conditions, excessive bacterial growth may occur causing a reduction in storage life and the subsequent food safety risk.

The shortest chilling time to 0°C is achieved by:

- Chilling carcasses well before boning (deep butt temperature below -15°C and preferably close to 10°C).
- Allowing sufficient air gaps between cartons to maximise air flow over the carton surfaces.

Chilling rates are dependent on air temperatures in the chiller and air flow over the cartons. Heat is removed most effectively over the top and bottom surfaces of the carton because these are the larger surfaces. These surfaces are those closer to the carton thermal centre – the warmest spot in the carton.

Air flow over these carton surfaces is maximised by placing cartons on racks or stillages designed with a minimum 20mm-30mm gap for free air flow. Alternatively, plastic egg crate dunnage or spacers can be placed between layers on a pallet – although this is not as effective. Even with gaps of 20mm-30mm between the cartons, air movement within a pallet or stillage is reduced. Subsequently, air temperature between cartons in the centre of the stack can be 5°C higher than the temperature around those cartons on the edge of the stack.

- Never stacking vacuum-packed primals on pallets until the product temperature at the centre of the carton is at or below 0°C .

Blast Chilling

Blast chilling involves placing cartons on racks or stillages in a room with high air velocity similar to a blast freezer (3-5m/s). A blast chiller with a fixed air temperature of -1°C to -2°C may take up to 36 hours for the product to reach 0°C .

In batch rooms, more sophisticated air temperature control can be employed, such as using sub-freezing air temperatures of -10°C to -5°C for the initial portion of the cycle. As meat surface temperature

approaches freezing, air temperature is raised to -1°C , facilitating more rapid chilling without surface freezing. Using this cooling regime, 0°C can be achieved in less than 20 hours.

The main disadvantage of this system is the higher cost for additional handling. Another disadvantage is the requirement for additional refrigeration capacity, both in the chiller and the engine room – but this can be balanced by the assurance that product temperature criteria are being met.

For optimum performance, air velocity over the cartons should be in excess of 2m/s. Arrangement of the fans and orientation of cartons and racking should be such that even air distribution is attained by eliminating large voids and restrictions which promote preferential air flows (and air by-passing other cartons). The long axis of the cartons should be aligned with the direction of air flow to enhance the surface heat transfer through the top, bottom and sides.

In some instances batch or continuous blast freezers have been converted to carton chillers.

Chilling in unlidded cartons

An alternative to conventional cartoned chilling is to chill with the lids off. When compared to lidded, strapped or glued cartons, this method reduces cooling time. (Time reduction for the surface of primals, for example, amounts to about 30%.) Chilling in unlidded cartons is generally only suitable for two-piece cartons where a cap-style lid can be fitted separately at a later time.

Chilling of unlidded cartons can be carried out in either holding chillers or blast chillers. One note of caution: If blast chillers are used, greater care must be taken not to use air temperatures below the freezing point of meat for extended periods because this could lead to crust freezing, resulting in excessive weep.

Chilling of unlidded cartons will generally require additional labour for later lidding and strapping as well as additional capital for a separate lidding area.

Chilling Uncartoned

An alternative to the conventional approach of chilling after cartoning is pre-cooling vacuum-packed cuts prior to cartoning. Rapid chilling vacuum-packed cuts reduces weep and improves shelf-life and meat colour.

Chilling cuts individually has two other sound, practical arguments:

- A temperature of below 0°C in even the heaviest cuts can be attained within less than 24 hours. This enables packed cartons to by-pass the holding chiller and be loaded directly into shipping containers.
- Detection of “slow leakers” is enhanced.

Negative aspects to chilling cuts individually include:

- Cartoning arrangements need to be re-organised.
- Cuts destined for a particular order or to meet a non-standard specification need to be appropriately identified.
- A higher capital cost may be involved.
- Additional handling of bagged cuts may increase the incidence of “leakers” if workers are not adequately trained and supervised.

Chilling of vacuum-packed products can be accomplished either by immersion in chilled water for several hours or by chilling in air overnight. According to trials, chilling vacuum-packed cuts in air for slightly longer than in ice/water is equally effective, except that initial surface temperature fall is not as rapid. This is because the surface heat transfer co-efficient in ice/water is about 10 times that in air but the thermal conductivity of the product is fixed, reducing the advantages of immersion chilling over air chilling for large cuts.

An effective way to overcome undesirable aspects of uncartoned chilling is to install a continuous conveyerised chilling tunnel in the shape of a spiral or some other configuration. This may either return the cuts to the boning room or transfer them to a separate cartoning area. The implementation of this system will provide adequate control without excessive labour.

Design parameters for such a system would be:

- Air temperature: -1.5°C (Lower temperatures could be tolerated in the initial stages.)
- Air velocity: 2 to 3m/s (Higher air velocities may be advantageous initially.)
- Time in tunnel: 4 hours to overnight
- Support cuts on solid trays to avoid marking meat

- System must be smooth in operation with no protrusions into the product flow to avoid rough handling and damage to bags

Cartoning of cuts at the exit from a high intensity chiller could be carried out by a later shift or, if above freezing temperatures are used, cuts may remain overnight in the chiller and be packed the next day.

Modified atmosphere packed cuts

Modified atmosphere packed cuts have an envelope of gas around them and are effectively insulated against changes in temperature. As a result, the product must be reduced to close to the storage temperature before primary packing. Failure to do so will result in slow chilling, reduced shelf-life and an increased risk of the growth of pathogenic bacteria.

Holding vacuum-packed meat

It is advantageous, in most cases, to dispatch chilled meat as soon as possible. Unfortunately this isn't always possible and extended holding periods are necessary.

If ageing is required, then a product may need to be held for 14 - 21 days or longer, and care must be taken in selecting storage temperatures. About 70% of the tenderising effect of beef occurs over 10 days at 2°C, with maximum tenderness after four weeks.

Ageing is a chemical reaction which is temperature dependent. By increasing the temperature, ageing time can be shortened. Increasing temperatures also increases bacterial growth, shortening product storage life and increasing the risk of pathogenic growth. As a general rule, a 4°C increase in storage temperature will halve the product storage life. Storage temperatures for ageing should be in the range -1°C to 4°C.

When a product has been aged, its shelf-life is shortened once the vacuum-pack is opened and the product is displayed in retail. Therefore, vacuum-packs should not be opened until the product is required. Likewise, packs damaged during storage should be either used as soon as possible or frozen, provided the product has not deteriorated to the point of spoilage.

A holding chiller – assuming it is not to be used as an active chiller – should meet these specifications:

- Air temperature: $-1 \pm 0.5^{\circ}\text{C}$
- Air velocity: 0.5m/s or less to provide air distribution
- To reduce ingress of warm air, doors should not open directly to outside or to areas of high ambient temperatures
- A constant temperature should be maintained, since fluctuations in meat temperature promote weep

Load-out

Meat temperature at load-out should be as low as possible without freezing the meat – ideally 0°C + 1.5°C.

Additional information

CSIRO, Production of chilled meat for export
– Workshop Proceedings, 1991

Additional information

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

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