Thawing and Tempering

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A reasonable amount of research is available concerning the thawing and tempering of frozen foods. Nutritive losses, moisture or drip loss, quality deterioration and microbial dangers are well documented for frozen foods in general and to some degree specific for certain commodity groups. However, the majority of this is directed towards small quantities of product, such as a single turkey or a loaf of bread. There is virtually no published information on thawing or tempering large bulk items of commodities such as pallets, 55-gallon drums, 5-gallon pails, or 30- to 60-lb. frozen blocks of fish and/or meat.

Thawing:

Thawing can be defined as "Increasing frozen product temperatures up to the melted or unfrozen state." Commonly called "defrosting," thawing involves elevating the temperature of the product to the point where there is no more ice, and is considered the opposite of freezing. It is important to understand that while modern technology allows for rapid or blast freezing, the thawing process should be much slower. It is recommended that the thawing process take four (4) times as long as the freezing process. For example, products that are frozen over a two-day period should be allowed 8 days to properly and slowly thaw, whereas products that were blast frozen within hours can thaw much more quickly.

When products freeze, water in the cells expands to become ice. The more rapid products are frozen, the smaller the ice crystals and the less potential loss due to cell rupture, thus preserving product quality and minimizing microbial growth opportunity. However, when products are thawed, slow temperature changes are necessary to prevent the ice inside the cell from puncturing the cell wall, thereby draining valuable fluids from the cell and leading to quality and microbial deterioration. The cellular fluids that leak out during the thawing process are commonly called "Purge." Quick-freezing and slow thawing are the best methods for maximum quality, yield and safety.

Many warehouse personnel assume that any quality or nutritive losses have already occurred at the time of freezing, but fail to recognize that improper thawing will severely affect the quality, nutritive value and safety of the products. This is especially true with large-sized items, such as 5-gallon pails or 30- to 60-pound cases. These products are susceptive to severe quality and microbiological risk, since the outside surface of the product will remain at an elevated temperature for a much longer time than the frozen center, thereby allowing more time for moisture loss and/or microbiological growth during the thawing process. It is important to plan ahead when determining thawing time, taking into account when the products are needed for commercial uses and thus allowing enough time for proper and slow thawing. Accelerating thawing time by using warmer temperatures or warm water presents significant food safety and quality issues.

Packaging Materials:

Another consideration during thawing is the impact of thawing on the packaging materials. Packaging materials may deteriorate or weaken during the thawing process as moisture and drip from the products permeates or soaks into the packaging material. These boxes or cases may become soft, and have the potential to collapse as the products inside shrink and soften. Soft cases or damaged boxes are at risk to collapse and cause injury or product damage.

Tempering:

Tempering is different than thawing. Tempering typically means to change the temperature of a frozen food item, up or down, to a temperature point where a substantial amount of the water in the product is in the form of ice, but not all of the water has turned to ice. This temperature must be below the freezing point, and is usually between 23 and 28 °F (-5 to -2°C). Generally speaking, the product is rigid but not hard, usable, and will not cause harm to subsequent processing operations or destroying desirable properties in the food itself. The desired endpoint temperature for tempering is contingent upon the type of product, and thus there is no standard temperature. For example, the common endpoint temperature for tempering frozen products is approximately 26°F (-3°C), however the common endpoint temperature for tempering frozen bags of hot dog buns (rolls) is approximately 72°F (22°C) for direct retail sale. In the first example, microbiological growth would very likely be a prime consideration in determining the method and temperature of tempering, and in the latter the formation of condensation on the product inside and/or the outside of the package along with mold growth would be prime concerns. For the purposes of this section of the CSM we will use tempering in its broadest sense.

Users of this section of the manual should also review the section on **CONDENSATION CONTROL**, as it contains important information directly related to tempering.

Practical Application:

When determining appropriate thawing and/or tempering times and procedures, consider the following:

Product History

- Has the product been previously frozen and thawed? If yes, is there evidence of excessive moisture loss or accumulation in packaging materials? Previously frozen and thawed products may have quality and/or safety issues that the customer should be made aware of prior to thawing or tempering again.
- How far from the end of its shelf life was the product prior to freezing? If products were frozen just before the pull date or at the end of the usable fresh shelf life period, they will have a very short shelf life once thawed a final time. Customers should be aware of these sensitive time constraints.
- Is there any microbiological or quality data available to corroborate the product quality? If products are out of condition or contain high bacterial loads prior to freezing, those bacteria will become active once the products are thawed, potentially presenting a food safety risk very quickly after the thawing process begins. This can be a risk to other products in the facility, as well as to consumers.
- What was the rate of freezing originally? If the products were frozen under normal freezer conditions the freezing process may have taken days, depending on the size of the products, freezer temperatures and packaging materials. Slow freezing allows for larger ice crystals in the product cells, and can result in greater moisture loss during freezing as well as greater potential moisture loss during thawing or tempering. Rapid freezing, such as blast or Individual Quick Freezing (IQF) results in smaller ice crystals in the product cells,

which results in much less moisture loss during freezing as well as less potential moisture loss during thawing or tempering.

Container Size

- What type of storage container was used to freeze the product? Since thawing or tempering occurs when heat is transferred in through the container surface, the amount of heat required to thaw or temper products directly relates to the container volume. As a result, the larger the storage container the less efficient the thawing process will be. If product must be tempered or thawed, it is preferable to use the smallest practical container, to minimize the risk of surface microbiological growth and moisture loss due to extended thawing periods.

Post-Thawing Spoilage Potential

- Microbiological growth during and after the thawing or tempering process is a significant concern. Meats and dairy products are especially prone to spoilage from lactic acid bacteria as well as pathogens such as Listeria and E. coli. These pathogens and spoilage bacteria grow effectively at refrigerated temperatures. It is important to consider the initial load of microorganisms on the product prior to freezing, since the freezing process only disables most bacteria rather than killing them. Since the bacteria are invisible to the human eye, information about the age of the product prior to freezing, the quantitative bacterial loads and the type of packaging are important.
- A visual inspection to look for off-color or off-condition products prior to thawing or tempering may detect potential problems. Proper temperature controls and sanitation will help prevent serious product deterioration from microbial growth during the thawing or tempering process. Packaged products that are leaking (vacuum packaging that is torn or punctured) are of greater concern, since bacterial in the package can begin to grow during the thawing or tempering process, under refrigerated conditions. It is important to understand that while the center of a large block of meat or dairy products is still frozen, the surface may be soft and thawed. The bacteria on the surface of this product can begin to multiply while the center is still thawing out.
- On certain fruits and vegetables products mold can quickly form under refrigerated temperatures. It is important to understand that while the center of a pail or barrel of products fruit product is still frozen, the surface under the lid may be soft and thawed. The bacteria on the surface of this product (in the airspace between the lid and product) can begin to multiply while the center is still thawing out.

Product Density

- How dense or packed are the products to be thawed or tempered? Dense products, such as solid fish or meat blocks, or pureed fruits and juices require more heat to thaw. Loosely packed items, such as chicken wings or parts, have more available air space between the frozen pieces and are quicker to thaw. Even though the cases may weigh the same, the thawing or tempering times will differ based upon the density of the contents. It is also important to note that the heat transfer into a loose pack may be very inefficient, and that thawing times for loose packs could be much longer than one would expect from the inefficient heat exchange needed.

- What size is the container to be thawed or tempered? Identical products in different size packaging will thaw at different rates.
- What is the available air flow around the products to be thawed or tempered? If the products are palletized or tightly packed, it is recommended that spacers be inserted to reduce the density of the pallet while improving air flow around the boxes or containers.

Packaging Material

- What is the condition of containers or cases? Since the container material, especially corrugated box materials, are susceptible to deterioration during the thawing or tempering process, it is important to note the quality of the containers being used for thawing. If the case material is already showing signs of wear or tear, or appear prone to collapse, preventative measures should be considered.
- What is the leakage potential of product in existing container? If products to be thawed or tempered are not in plastic liners or self-contained units, will drip and moisture loss drain onto the floor, thus potentially creating a microbiological and/or sanitary mess?
- Is there any chance for odors emanating from thawed product or its drip loss to contaminate other products? If so, care should be taken to isolate the products being thawed or tempered.
- Will the container withstand thawing and the subsequent drip from the products and wet conditions of the cooler? Once thawed, will the packaging material withstand transport to storage coolers and/or to the customer or end user?
- Does the packaging material allow efficient heat transfer to the product? Some packaging materials inhibit heat transfer while others promote heat transfer. Steel v. plastic drums and corrugated v. wax impregnated boxes have different heat transfer indexes.
- Is there inner packaging, and if so what effect will it have on tempering and thawing times?
- Do the containers have hand holds or other hole-patterns to permit better circulation of air within the container? If not, can spacers be inserted to improve air circulation?

Room Conditions

- Has the room been cleaned from previous use so there are no odor or microbiological contamination problems being created?
- Will the thawing or tempering service create odor or microbiological contamination? If so, has any additional cost for cleaning or re-conditioning been considered?
- Does the thawing or tempering room have floor drains for leakage of liquids? If not, have plans been developed for proper cleaning and sanitation programs?
- What is the source of air for thawing or tempering? If air flow is pulled from areas with possible contamination, it is foreseeable that contaminated air will enhance microbiological growth and/or spoilage.

- Where does the air from the thawing or tempering room go? If this air is circulated to other areas where products can be contaminated, care should be taken to avoid distribution of bacteria.
- Does the air used for thawing or tempering have adequate:
  - **Velocity –** Appropriate for product type.
  - **Movement** – Appropriate introduction, distribution, equalization, venting.
  - **Temperature** – Appropriate for product with proper regulation & control.
  - **Humidity –** Appropriate for product, considering high humidity increases energy transfer and speeds thawing or tempering.

Product Liability

- Who has legal title to what's being tempered or thawed? If there is excessive drip loss or microbial contamination evident after the thawing or tempering process, who is responsible for losses. It is important to have a basic understanding of the finished product parameters so that all parties are aware of potential losses due to drip or spoilage after thawing or tempering. Pre-thawing inspection or testing are recommended.
- Is the recordkeeping up to date? Consider the following:
  - Is product properly identified, labeled, date coded?
  - Was the incoming temperature and product history properly recorded?
  - Was the product originally frozen in-house or at an outside facility?
  - Were room temperatures, product temperatures and thawing times properly recorded during tempering or thawing?
  - Is accurate thawing or tempering records on hand in case of a claim?

Miscellaneous Recommendations

- If multiple types of products are to be thawed or tempered at the same time, what are implications of each product on the other(s)? Odors or microbiological contamination are important considerations when thawing or tempering different types of products. Thawing and/or tempering temperatures and air flow may be different, so only products with similar thawing or tempering criteria should be placed together.
- If tempering products, it is recommended that an agreed upon endpoint internal temperature be established.
- It is recommended that a minimum and maximum endpoint temperature range be established, such that a reasonable tolerance is in place to protect the facility from claims if specific temperatures are not met. As with all systems, there will be some degree of variability in the thawing or tempering process, generally due to differences is fat content, packaging, density or size of cuts. It is recommended that a tolerance of +/- 2°F be established.

- It is recommended that facilities monitor and record thawing or tempering curves, using surface and penetration thermometers to ensure proper temperature changes during the process.

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