stable food and does not require refrigeration although whole egg and yolk solids benefit from some refrigeration. If long term storage is indicated, temperatures of 30 to 40 F will materially aid in retaining flavor and performance characteristics. The relative humidity should be low enough not to cause softening of the fiber drums (if used).

## DEFROSTING

Frozen eggs are conveniently and safely defrosted in shallow tanks containing running water maintained at 40 to 50 F. They may be much more rapidly defrosted by removing them from the can after a few hours of the above treatment and *putting them through a stainless ice crusher into a coil vat.* Water at 70 to 110 F circulated through the rotating coils provides the necessary heat to complete thawing without damage to the product. Both methods are used commercially. Defrosted eggs should be used promptly. In no case should they be allowed to warm up above 45 to 50 F where bacterial spoilage will occur very rapidly.

## REFRIGERATION DESIGN DATA

### Shell Egg Storage

Typical conditions affecting the refrigeration load are as follows:

| | | | |
|---|---|---|---|
| Storage Temperature | | F | 30 |
| Relative Humidity | | % | 80 to 90 |
| Average Weight of Egg Case | | lb | 50 |
| Standard Case Size | width | in. | 12 |
| | height | in. | 13 |
| | length | in. | 26 |
| Insulation Losses | | | Normal |
| Air Infiltration Losses | | | Normal |
| Lighting per sq ft floor | | watts | 1 |
| Occupant per 400 sq ft floor | | | 1 |
| Max. Allowable Air Velocity across Eggs (forced circulation) | | fpm | 40 |

### Evaporator Design

The evaporator for egg coolers can be industrial air conditioners, bare pipe coils or a combination. In smaller plants, any halogenated hydrocarbon would be acceptable as a refrigerant. In larger cold storage application the refrigerant would probably be direct expansion ammonia. There is a safety factor in using brine as the source of refrigerant to avoid the costly hazard of an ammonia leak. The brine installation is usually used in larger plants. In large installations it is desirable to have pipe coils either of the fin type or bare pipe for holding duty. When eggs are stored in a storage room space should be provided on all sides for the circulation of air.

### Egg Freezing

Weight Per Can: 30 lb net, 32 lb gross
Can Size: 10 in. dia × 12½ in. high
Specific Heat above Freezing: 0.6
Specific Heat below Freezing: 0.4
Latent Heat of Freezing: 100
Approximate Freezing Temp: 27 F
Freezing Time: Varies from approximately 18 hr at −25 F blast freezing to 72 hr at −5 F still air with proper spreading and staggering of cans in either case

*General*—*It is desirable to have a tailor-made design for the freezing evaporator coils and to incorporate in that design a suitable means of defrosting, with hot gas, water, air, or a combination. One important design factor of a freezer is the conveying mechanism to minimize labor.*

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CHAPTER 50

# STORAGE OF CANDIES, NUTS, DRIED FRUITS, AND VEGETABLES

*Candies: Color, Flavor, Texture, Insects, Storage Temperature, Humidity Requirements, Cost of Storage; Nuts: Temperature, Relative Humidity, Atmosphere, Packaging; Dried Fruits and Vegetables: Storage*

THE storage conditions for candies, nuts, dried fruits and dried vegetables are similar in that all are more stable at low temperatures, low humidities and in odor-free atmospheres.

## CANDIES

Practically all candies are held for a period between manufacture and consumption. This may be in the plant where made, in warehouses, during transit, or in retail outlets. The period of holding may vary from one week to more than a year. It is very important that the candy not lose quality during that time.

Proper use of refrigeration in prolonging the shelf life of candies is becoming increasingly important. The combined effects of refrigeration, antioxidants, humectants, emulsifiers, better packaging and improved formulas are resulting in more and better candies throughout the world, especially for export. Only in recent years has low temperature been recommended as a means of maintaining candy quality, as it was generally believed that refrigeration was unnecessary, if not detrimental, to the finish of candies, particularly chocolates.

A surprisingly large proportion of candy manufacturers, salesmen, wholesalers, and warehousemen believe that refrigeration, below what is generally considered good air conditioning, is detrimental to candies. The belief has been substantiated by a few observations of poorly packaged candies that were placed in relatively humid cold rooms, and later removed directly to room temperatures and humidities. Within an hour or two, most candies under these conditions appear moist, sticky and without finish.

However, recent experiments have shown that low temperature storage does not produce these undesirable results if (1) the candies are made of proper ingredients for refrigerated storage, (2) the packages have a moisture barrier, (3) the storage room is held at equilibrium humidity with a desirable moisture of the candy, and (4) the candy is brought to room temperature before the packages are opened.

In 1921 Lay reported on 10,000,000 lb of chocolate cream, chocolate nut bars, caramels, and hard candy stored in warehouses around Chicago, for one year, without complaint. They were held at moderate temperatures (40 F) with rh (relative humidity) below 80 percent.

Since that time millions of pounds of candies have been successfully held, from periods of low consumption to times when demand was high, under refrigerated storage. The storage period depends upon (1) the marketing season of the particular candy, (2) the stability of the candy, (3) the storage temperature and (4) humidity.

The shelf life of a particular kind of candy is determined by the stability of its individual ingredients. Common candy ingredients are sugars, including sucrose, dextrose, corn sirups, corn sirup solids and invert sirup; dark and milk chocolates; nuts, including coconut, peanuts, pecans, almonds, walnuts, and others; fruits, including cherries, dates, raisins, figs, apricots and strawberries; dried milk and milk products, butter, dried eggs, cream of tartar, gelatin, soy bean flour, wheat flour, starch; and artificial colors.

Refrigerated storage of candy ingredients is especially advantageous for seasonal products, such as, peanuts, pecans, almonds, cherries, coconut and chocolate. Ingredients with delicate flavors and colors such as butter, dried eggs and dried milk, retain quality more evenly the year round if kept refrigerated as directed for these products. Unless properly refrigerated, ingredients containing fats or proteins may lose considerable flavor or develop off-flavors before being used.

Candies are semi-perishable. Experience has shown that the finest candies or candy ingredients may be ruined by a few weeks of improper storage. This includes many candy bars, packaged candies, and some choice bulk candies, especially those with chocolate coating. Unless refrigeration is provided, from the time of manufacture through the retail outlet, the types of candies offered for sale must be greatly reduced in the summer.

Benefits from refrigerated storage of candies, especially during the summer are: (1) insects are rendered inactive at temperatures below 48 F; (2) the tendency to become stale or rancid is reduced as the temperature is reduced; (3) candies remain firm as an insurance against sticking to the wrapper or becoming mashed; (4) loss of colors, aromas and flavors is reduced as the temperature is reduced; and (5) candies can be manufactured the year around, and accumulated for periods of heavy sales.

### Color

Many colors used in hard candies, hard creams, bonbons, and others, gradually fade when stored at room temperature, especially in the light. However, the most marked effect of storage temperature on color occurs with chocolates. In candies containing high protein and nuts there is a gradual darkening of color, especially at higher storage temperatures.

Temperatures from 85 to 95 F cause graying of chocolates, even though exposure is only a few hours; or cause darkening of nuts within a month. Graying or fat bloom appears as *cold grease* on the surface and is due to crystals of fat on the surface of the chocolate coating. This is associated with old candies, but new candies also become gray in one day under adverse storage conditions. Chilling of chocolates, following exposure