

Valentine's Day, Easter and Mother's Day. This is true with mail order companies and chain stores which stockpile candies and sell on highly competitive markets. Candies frozen and handled in this manner are carefully thawed in the unopened packages and sold at retail as fresh candies.

A more recent development is that of retailing frozen candies from low-temperature cabinets in candy shops and specialty food stores. While most candies may be handled in this manner, divinity, soft creams and chocolate-coated candies with soft centers are especially suitable for handling frozen from the manufacturer to consumer. See Chapter 50 for additional information on storage.

REFRIGERATION PLANT

Large candy manufacturers often use a central refrigeration plant with centrifugal refrigeration for cooling water or brine. Ammonia was used in the past, and although it is satisfactory from an operating standpoint, the refrigerant is classed as hazardous and toxic, and must be handled with care. For packing and dipping rooms, where the number of employees is large, it is important that ammonia not be directly expanded in a coil in the conditioned air path, since a leak at this point would rapidly transmit ammonia throughout the entire packing room. Most city ordinances prohibit this practice where the occupancy is more than one or two receiving or shipping workers. It is recommended that the ammonia be confined to the machine room, and a brine or water cooler be used. Chilled brine or water can then be safely circulated throughout the plant for the various requirements.

In some of the smaller modern plants, Refrigerant 12 equipment has been utilized with excellent results. With this arrangement (since Refrigerant 12 is classed as a safe refrigerant) the restriction of direct expansion is not necessary. Normally small units are used for each requirement or each group of requirements. Thus, one compressor may be installed on a cooling tunnel, while separate compressors are used in each of the departments for packing, storing and other operations. This arrangement permits a planned program of expansion or rehabilitation of a portion of the plant at a time, so that over a period of years, complete modernization of any plant can be accomplished. If the plant is rather large, this results in a multiplicity of small units and adds considerably to the work of the operation and maintenance departments. Therefore, consideration must be given to the central system even though the capital outlay may be large.

Centrifugal machines using Refrigerant 11 have been installed in most large candy plants in this country. This equipment is applied satisfactorily providing there is sufficient load (50-60 tons or more) to make its first cost feasible, or if management is far-sighted enough to plan for future expansion.

A centrifugal machine consisting of a complete assembly of cooler, condenser, compressor, and drive, can be located remotely in the engine room under direct supervision of the operating engineer. Brine piping can be extended throughout the building. The centrifugal machine can be driven by either motor or turbine. Most candy plants generate steam at high pressure for use in various cooking operations. Turbines either can utilize this high pressure steam, exhausting at a back pressure for lower temperature cooking operations, or can take exhaust steam to condensing, and thus can be made an integral part of the heat balance of the entire plant. The centrifugal unit has the advantage of extreme reliability, low operating cost, ease of maintenance, and long life.

It has been the practice in the past to refrigerate brine to a temperature of 20-25 F for all services in the plant. Although this temperature is lower than that necessary for many of the

operations, the advantages gained by load factor balance and central plant operation have warranted its installation. In the past this temperature was necessary because of the evaporator design which in many cases consisted of prime surface coils in the storage and packing departments. Use of modern air-conditioning units with fin-type evaporators has eliminated the necessity of the low temperature brine. Experience has indicated that high temperature brine of 28-32 F is very desirable for central station installations. This brine temperature is sufficiently low to obtain the necessary low dew-point temperatures for many of the processes, but is high enough to prevent frosting on the finned evaporators. Solutions of alcohol and water, or a weak solution of calcium chloride brine, have been used in some plants. Because of increased production, the tendency is to lower brine temperatures, particularly to cool air to a lower temperature supplied to tunnels.

The brine distribution system makes it possible to connect all of the varied services to one source of refrigeration, and by the use of control devices, dry-bulb and dew-point temperatures can be maintained with more precision. Cold slabs for caramels, nougats, and other similar products are supplied with this temperature brine, and its use is even extended to comfort cooling in the offices and various clerical operations.

For the smaller manufacturing plant, multiple condensing units using halocarbon refrigerants and direct expansion air conditioning units are usually more satisfactory. As various departments are altered or expanded, the old ammonia systems can be replaced with individual air-conditioning units with separate single or duplex compressors.

Similarly, cooling tunnels are equipped with separate cold diffusers and connected to individual halocarbon refrigerant compressors or a group of units are connected to one single or duplex compressor. These compressors vary in size from 5 to 50 hp and can be located adjacent to the spaces conditioned. A planned program of rehabilitation can be accomplished without shutdown and without the necessity of financing a single large project at any one time.

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CHAPTER 34

BAKERIES

Ingredient Storage, Mixing, Fermentation, Bread Cooling, Slicing and Wrapping, Bread Freezing, Freezing Other Bakery Products, Retarding Doughs and Batters

MIXING

Bread is perhaps the most important baked product from the standpoint of production volume.

Mixing is the first active process in the production of bread. Refrigeration is required because of the generation of heat and the necessity of controlling the temperature of the dough at the end of the mix.

The mixer is a large bowl having heavy revolving blades or agitator arms which mix the flour, water, yeast and other ingredients into a homogenous dough.

There are two principal types of dough mixes: the *straight dough process* and the *sponge dough process*. In the straight dough process all of the ingredients are mixed together at once. In the sponge dough process, only 50-70 percent of the total amount of flour and water required are mixed with all of the yeast, yeast food and malt. The resulting sponge, as it is called, is then fermented for a period before being returned for a final mix with the remainder of the flour and water, together with the rest of the ingredients.

The principal heat generation during the mixing process comes from the production of the heat of hydration as the flour absorbs water and from the heat of friction which is a conversion of the electrical energy required to turn the mixer.

Because the dough must come from the mixer at a temperature of 76-78 F, any excess heat of hydration and friction must be removed. To absorb this excess heat the ingredient water is usually supplied to the mix at a temperature of 35-40 F, and the mixer is jacketed to allow the circulation of a cooling medium around the bowl.

In many older plants central ammonia systems are in use for cooling sufficient water both for ingredient use and for jacket cooling.

The modern approach is to cool the ingredient water in self-contained water coolers. These range in capacity from 75 to 650 gph, with 3 to 30 hp Refrigerant 12 condensing units.

For jacket cooling, direct expansion of the refrigerant at temperatures of approximately 30 F in the jacket is increasing in usage on the new larger mixers. Individual condensing units for each mixer are employed and are usually located within 15 ft of the mixer. Where a battery of mixers are used in large plants, a compressor room is often located adjacent to the mixing and fermentation rooms.

In an effort to handle ever larger batches of dough in the mixers, the required cooling sometimes becomes larger than the available heat transfer surface can produce at 30 F, and the refrigerant temperature must be lowered. The low limit is the point at which frost formation inside the bowl becomes a problem.

REFRIGERATION plays an important part in the production of baked products. In the large wholesale baking operations it aids in securing both uniformity of product, which is one of the most important sales requirements, and time control, the important factor in maintaining rigid delivery schedules. In the small retail or variety operation it provides flexibility in production to meet variations in demand.

INGREDIENT STORAGE

Most of the ingredients that go into baked products require storage at temperatures low enough to require refrigerated cooling of the air in the storage area.

Flour, powdered milk, and other powdered or dry materials should be stored at a temperature between 70 and 80 F with a relative humidity of approximately 60 percent. A temperature in this range is cool enough to control insect propagation and general deterioration from acidity. A relative humidity of approximately 60 percent tends to stabilize the moisture content of the material at an acceptable point.

Provisions to introduce 30-50 percent outdoor air into the circulation system will keep the flour free of objectionable odors.

Many bakeries do not seem to place emphasis on maintaining close control and are apparently satisfied with storing flour in the most naturally cool locale, usually the basement. The flour is stored in sacks and stacked on skids in such a way as to allow good air circulation around the sacks. When air conditioning is used, one of the problems encountered is the presence of flour dust in the air that tends to clog the air passages of the conditioning equipment.

Modern installations often employ bulk storage of the flour in large bins with pneumatic or screw conveying systems moving the flour from bulk shipping containers to the bins, and from the bins to the mixers. Temperature and humidity control are not required in this type of storage because the insulating character of the flour keeps conditions fairly constant throughout the mass.

STORAGE OF OTHER INGREDIENTS

Yeast, butter, liquid milk and shortening are best stored under conditions of 35-45 F. Standard cold storage cabinets are required for these ingredients (see Chapter 60).

Refrigeration requirements are based on the following average specific heats:

Butter	0.57 Btu per lb
Milk	0.55 Btu per lb
Lard	0.45 Btu per lb