

cartons are manufactured in various sizes and dimensions with capacities of from 3 to 15 or 20 lb of product.

Overwrapping materials are used to cover the container and reduce the moisture migration from the product to the surrounding environment. The requirements of an acceptable overwrapping material are that it be highly resistant to moisture transmission, inexpensive, heat sealable, adaptable to machinery application, and of attractive appearance to the customer. Various types of microcrystalline waxed paper, cellophane, polyethylene and aluminum foil are available in many different forms and laminant combinations which make possible the selection of an overwrapping material best suited for the degree of protection desired for each fishery product.

Consumer-sized packages. These have a capacity of 3 to 5 lb, are usually of the self-locking type of carton with a hinged cover, and can be preformed by machines, or by hand, without using glue. The fish is added, usually by hand, or in some cases by machines, and the carton is then closed and overwrapped by machinery. Products such as shrimp, fish steaks, fish sticks, scallops, fish fillets and bite-sized portions are generally packaged in these same self-locking hinged-cover containers. Ease and rapidity of handling are some of the advantages offered by these techniques. These cartons must be overwrapped with a moisture-vapor resistant film to reduce this dehydration. Cartons that can be cold-sealed satisfactorily have been developed, eliminating the need for overwrapping and thereby reducing packaging costs. The keeping quality of fish packaged in these cartons has not been reported. In some applications, cartons coated inside with polyethylene are being used in lieu of cartons coated with wax. Special grease-resistant coatings are being used in packaging oily products. Rigid containers made of aluminum foil or polystyrene employing specially designed covers are also in commercial use. However, the keeping quality of fish packaged in these containers has not been reported.

Materials such as polyethylene combined with cellophane; polyvinylidene chloride, or polyester and combinations of other plastic materials are being used with high speed automatic packaging machines to package shrimp, dressed fish, fish fillets, fish portions and fish steaks prior to freezing. In some instances tearing of the wrapping material due to fins protruding from the fish has been a problem. Otherwise this method of packaging is satisfactory and affords the product considerable protection against dehydration and rancidity at a comparatively low cost. This packaging method has also created new markets for merchandising frozen fishery products. Boil-in-the-bag type pouches made of polyester-polyethylene and combinations of foil, polyethylene, and paper have been developed and are being used for packaging shrimp and fish fillets.

Institutional-sized packages. The 5 lb and larger capacity cartons used in the institutional trade are almost exclusively constructed out of bleached paper board coated with microcrystalline wax. These cartons are generally not of the self-locking hinged-cover type, the cover is separate and telescopes snugly over the tray of the carton. Shrimp, scallops, fish fillet, round or eviscerated fish, fish steaks, lobster tails and fish fillet blocks are usually packaged in the 5 lb and larger sized cartons. These cartons usually are not overwrapped, and excessive dehydration can occur.

Products such as fish fillets and steaks are individually wrapped in cellophane or other moisture-vapor resistant film, then packed in the carton. Fish, such as headed and dressed whiting and scallop meats, are packed into the carton and covered with a sheet of cellophane. The cover is then put on and the package frozen upside down in the freezer. Fish fillets, for fish blocks, are all too often packaged in the carton

without any protective material except the carton itself, and considerable product desiccation occurs during frozen storage. Tests recently conducted by the Bureau of Commercial Fisheries show that overwrapping of fish fillet block cartons with suitable moisture-vapor proof films will minimize product desiccation and provide better quality maintenance during frozen storage. One of the best examples of a well protected package is one used for shrimp. Peeled and deveined or raw headless shrimp are frozen individually prior to packaging, and glazed and packed into a carton which is then overwrapped; or unfrozen shrimp are packed tightly into the package prior to freezing, the package overwrapped, and the shrimp frozen in the form of a block. Much could be done to improve many of the existing methods of packaging fishery products in the larger sized cartons. Maximum retention of quality during frozen storage can be attained by individually preglazing shellfish and steaks, or wrapping fillets and dressed fish in moisture-vapor resistant films prior to packaging, and overwrapping the carton with a suitable moisture-vapor resistant film.

FREEZING

The product characteristics such as size and shape, freezing method, and the rate of freezing affect the quality, the appearance and the cost of production of the product. Several theories have been expressed on the relative effect of the freezing rate (slow or quick freezing) on product quality (see Chapter 36).

Quick freezing of fish possesses the following advantages:

1. It chills the product rapidly, preventing bacterial spoilage.
2. It facilitates rapid handling of large quantities of product.
3. It makes utilization of conveyors and automatic devices practicable, thus materially reducing handling costs.
4. It promotes maximum utilization of freezer space.
5. It produces a packaged product of uniform appearance, with a minimum of voids or bulges.

Because of these advantages, quick freezing is predominantly employed in the fishing industry today although *sharp* (slow) freezing is still used to a limited extent.

Sharp Freezing of Fish

The oldest method of freezing fish commercially is termed *sharp* freezing. In view of current practices this name should now be changed to *slow* freezing.

Fish to be frozen by this method are placed on shelves comprised of refrigerated pipe coils in which ammonia, Refrigerant 12, or chilled brine is circulated to provide the necessary refrigeration effect. Often iron or aluminum pans or plates are placed over the coils to form flat surfaces upon which the fish rest. The heat transfer between the refrigerant in the pipes and the fish at the point of contact is relatively high. However, the overall heat transfer rate is quite low because an extensive surface area of the product is not in contact with the pipes and is cooled largely by the natural circulation of the air within the freezer.

Use of the *sharp* freezer is limited to freezing such round fish as salmon and halibut, panned small fish such as fresh water chubs, dressed fish, and institutional type packages of fish such as fillets, scallops, whiting or shrimp. For proper freezing the temperatures of the shelf coils should be between -20 and -40 F, and the fish should be placed on the shelves in a single layer. Fans should not be used when freezing unpackaged fish because excessive dehydration will occur. Packaged fishery products requiring close dimension tolerances, such as consumer sized fish fillet packages and fish blocks, should be prevented from bulging during freezing. Expansion can be controlled somewhat by using metal trays with heavily

Frozen Fishery Products

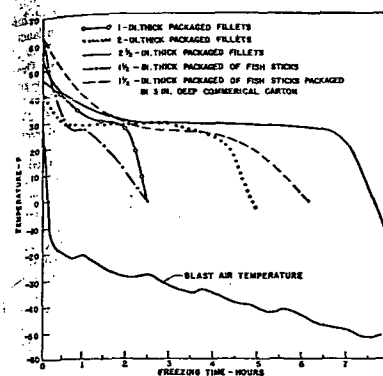


Fig. 1 Freezing Packaged Fish Fillets and Sticks in Tunnel-Type Blast Freezer

weighted covers. About one sq ft of shelf space should be allocated for each 7½ lb of round fish, or for each 10 lb of packaged fish packed in institutional type cartons (5 or 10 lb capacity, 2½ in. thick).

The rate of freezing in commercial installations is quite slow. At evaporator temperatures of -5 to -20 F, 14 and 16.5 hr are required to cool 2-in. and 2½-in. thick packaged fish fillets, respectively, from 50 to 0 F. At a temperature of -30 F, a 10-12 lb round fish will freeze to 0 F in about 12 hr. Faster freezing can be accomplished by using lower evaporator temperatures or by circulating cold air over the products. Excessive handling of the product is another disadvantage in the use of shelf freezers. As much as 3 hr are required for loading, and 3 hr for unloading, 40,000 lb of fish fillets. Infiltration of air and accumulation of frost on the shelf coils during loading and unloading are also problems. Handling requirements and air infiltration have been reduced by utilizing conveyors to carry the product from the processing room into the freezer and from the freezer to the cold-storage room. Some labor still is required, however, to transport the product from the conveyor to the freezer shelves and from the shelves to the conveyor.

Blast Freezing of Fish

Blast freezers for fishery products are generally small rooms or tunnels in which cold air is circulated by one or more fans over an evaporator and around the product to be frozen. A refrigerant, such as ammonia, a halocarbon, or brine flowing through a pipe coil evaporator furnishes the necessary refrigeration effect.

Static pressure in these rooms is considerable and air velocities average between 500 and 1500 fpm, with 1200 fpm being common. Air velocities between 500 and 1000 fpm give the most economical freezing. Lower air velocities result in slow product freezing, while at higher air velocities the freezing costs per pound of fish frozen per hour increases considerably. Most blast freezers are fully loaded at one time by rolling or *bulging* a rack of shelves of fish into the freezer. More recently conveyors have been used to move fish continuously through a blast room or tunnel.

Blast freezers are used for freezing such fishery products as shrimp, fish fillets, steaks, scallops, or breaded precooked products packed in institutional size packages; round, dressed, or panned fish; and shrimp, clams, or oysters packed in metal cans. More recently, they have been used for freezing fish fillets wrapped in moisture-vapor-proof heat-sealable packaging films and for freezing unpackaged shrimp and precooked fish sticks. Unpackaged fish sticks frozen in a conveyor-type freezer are automatically packaged after freezing, which further reduces the cost of handling.

Dehydration of product or freezer burn may occur in freezing unpackaged whole or dressed fish in blast freezers unless the velocity of air is kept to about 500 fpm and the period of exposure to the air is controlled. Consumer-size packages of fish fillets or fish-fillet blocks requiring close dimensional tolerances undergo bulging and distortion during freezing. In blast rooms or tunnels, where the product is frozen on trucks, the use of specially designed freezer trucks enabling distribution of pressure on the surfaces of the package will remedy this condition. No easy solution has been found for controlling the expansion of the product on conveyor installations.

The freezing times for various sizes of packaged fishery products are shown in Fig. 1.

Plate Freezing of Fish

In the multi-plate freezer, freezing is accomplished by refrigerant flowing through connected passageways in the horizontal movable plates stacked vertically within an insulated cabinet or in an insulated room.

The plate freezer is used extensively in the freezing of fishery products packaged in consumer size cartons and in 5 and 10 lb institutional type cartons. Among packaged fishery products frozen in the plate freezer are fillets, steaks, shrimp, fish sticks, fish blocks and scallops. Fish to be plate frozen should be properly packaged to keep air spaces in the package at an absolute minimum. In addition, during freezing, spacers should be used between the plates to prevent crushing or bulging of the package. For most products the thickness of the spacers should be about ¼-in. less than that of the package. Where very close package tolerances are required, as in the manufacture of fish fillet blocks, a metal tray is employed to hold the packages of fish during freezing. The tray is generally the width of the package and as long as the width of the freezer plates. After the tray is filled with fish blocks, wooden spacers are inserted between the last block and the end of the tray to prevent bulging of the packages. A spacer ¼-in. thinner than the package is generally used between the plates. A tray is not necessary for other packaged seafoods such as shrimp, fillets, fish steaks, or scallops where close package tolerances are not as essential. Therefore, an automatic continuous freezer with properly sized spacers can be satisfactorily used for these products.

The plate freezer provides rapid and efficient freezing of packaged fishery products. Tests conducted by the Bureau of Commercial Fisheries show that the freezing time and energy required for freezing packaged fish sticks is greater than that required for freezing packaged fish fillets, because of the slower rate of heat transfer due to the air space within the package; and the ratio of energy requirements for freezing to pounds of product frozen increases with thickness of the product. The freezing rates of consumer and institutional size packages of fish fillets and fish sticks are shown in Fig. 2.

Immersion Freezing of Fish

Immersion in low-temperature brine was one of the first methods used for quick freezing fishery products. A number