IMPROVING AND EXPANDING THE DISTRIBUTION OF FRESH (UNFROZEN) SEAFOODS BY MEANS OF INSULATED CONTAINERS [1/]

By Staff of the BCF Technological Laboratory, Gloucester, Massachusetts

The rigidly limited distribution of fresh (unfrozen) fish fillets has traditionally meant that inland consumers seldom have enjoyed fresh seafood products in their homes. To remedy this situation, the Bureau of Commercial Fisheries has developed an insulated, leakproof, non-returnable container suitable for extended shipments of seafood products in non-refrigerated air, rail, or truck freight. With certain accessories, this container may well make possible the transcontinental shipment of unfrozen seafoods by refrigerated (0° F.) trucks. Shipments on such refrigerated trucks to consuming areas well beyond present markets have already been made.

The discriminating U. S. consumer wants fresh (unfrozen) fish of high quality. How else explain the crowded seafood restaurants of our coastal cities and towns? Relatively few of our inland consumers, however, enjoy in their homes the delicate flavors and succulent textures of ocean-fresh, unfrozen seafoods.

There are many reasons that this demand goes unsatisfied. The major reason is the unavailability of an adequate distribution system, or of a wholly satisfactory means of utilizing the system. The fresh fish industry has never, for example, been able to fit its products into the efficient, modern, and flexible frozen-food distribution system, nor, for that matter, fully into the air-freight system. In an attempt to correct this situation, the Bureau of Commercial Fisheries Technological Laboratory at Gloucester, Massachusetts, has devised a versatile shipping container adaptable to the air, rail, or truck systems--either non-refrigerated or refrigerated to temperatures as low as 0° F.

The ideal container would be one which, while protecting the quality and appearance of fresh seafoods, would be capable of maintaining a fixed internal temperature, be entirely independent of external temperatures, be leakproof, be easily handled, be adaptable to small-order marketing and, most important, be inexpensive. It would be useful in rail, truck, and air shipments and be reasonably independent of any limitations as to time and distance in storage and transit. Since no small, inexpensive container can, as yet, maintain a fixed internal temperature nor be wholly independent of external temperatures, since many trucks have uncertain schedules, and distributors, at present, require ice on their delivered seafoods, no ideal container yet exists.

The Bureau-developed container is, in effect, a single basic container which, through use of available accessories, can be adapted to many different distribution conditions. It is insulated, leakproof, and with appropriate adjustments is suited for use in rail, truck, and air shipments. With small quantities of ice, it can be used in non-refrigerated 900-mile rail or truck shipments or on non-refrigerated, transcontinental air-freight, assuming normal transit times. Reefer-truck shipments, with van temperatures of 0° F., from Boston to Chicago and to Dallas have been made with satisfactory results. Experimental shipments, using special insulation and inexpensive "heat-source" devices in 0° F. vans from Gloucester to Los Angeles are in progress.

General Characteristics of the Basic Container

A corrugated, non-returnable box (specifications given in Figure 1) holds the structure together. A polyethylene bag, used as a liner, catches and holds any liquid which may drain

1/This is a general report on recent developments in shipping containers for fresh fish. Detailed reports on individual phases of the research will be published later. This is published in view of an expression of urgency by industry.

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	NOMINAL SIZE	100-LB. BOX	$	75-LB. BOX	$		$
	CORRUGATED FIBRE-BOARD BOX, WHITE, PRINTED ON 4 SIDES	19-1/4" x 16-1/4" x 22-1/4" 275 PSI SINGLEWALL	.62	18-1/2" x 16" x 17-1/2" 200 PSI SINGLEWALL	.44		
	POLYETHYLENE BAG 0.003 GAUGE	38" x 54"	.16	38" x 50"	.15		
	FOAMED POLYSTYRENE @ $0.065 PER BOARD FT.	1-1/2" x 16-1/4" x 19-1/4" (6 PIECES)	1.27	1-1/4" x 16" x 18-1/2" (2 PIECES) 1-1/4" x 16" x 15" (4 PIECES)	.88		
	TOTAL MATERIAL COST (OPTIONS NOT INCL.)		2.05		1.47		
OPTIONS	ABSORBENT FOAM (UREA FORMALDEHYDE)	$0.29 PER BOARD FT. 1 PIECE 13" x 16" x 3"	1.25	$0.29 PER BOARD FT. 1 PIECE 13" x 16" x 3"	1.25	FOR TRANSCONTINENTAL SHIPPING, ADDITIONAL FOAM IS RECOMMENDED	0.60
	DOUBLE STRAPPING		.10		.09		

Note: Cost data are based on 1,000 quantity delivered to New England (tentative).

Fig. 1 - General characteristics and costs of corrugated, non-returnable shipping container.

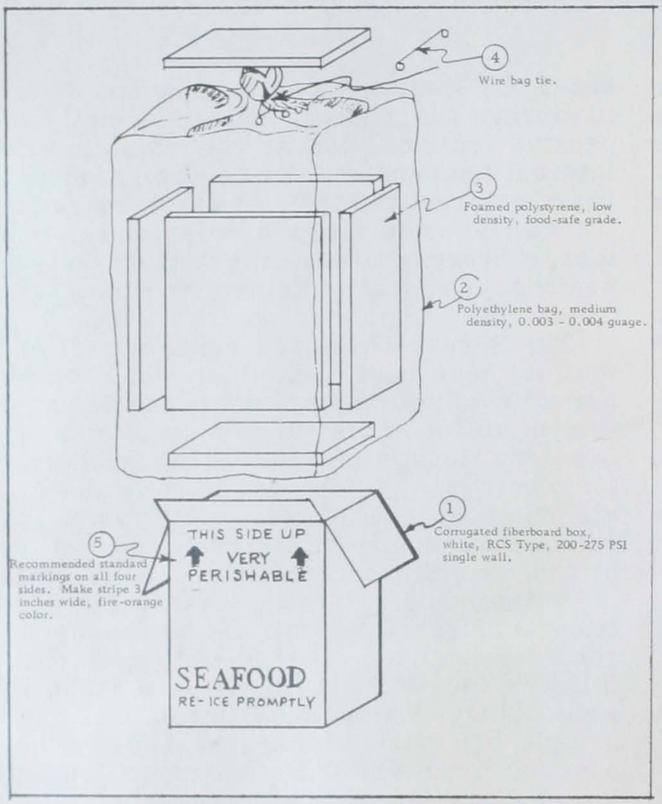


Fig. 2 - Method of assembly.

from the ice or the seafood. Slabs of foamed, food-safe plastic (density, thickness, and type to be determined by expected use) are placed on all six sides of the container to insulate the food product from its surroundings. Strapping may be used to give additional strength and dimensional stability to the package if deemed necessary. If it is anticipated that the container will be exposed to highly humid conditions, the corrugated outer shell should be wax-impregnated. The method of assembling the container is shown in Figure 2.

Non-Refrigerated Air, Rail, or Truck Transport

For this type of shipment, the basic container is used. Low-density, food-grade polystyrene slabs ($1\frac{1}{4}$ inches in thickness) are used as insulating agents. The product being shipped is either pre-chilled and iced, or a quantity of ice sufficient to both chill and maintain a low product temperature is placed in the container. (See Figure 3 for chilling and icing guidelines.)

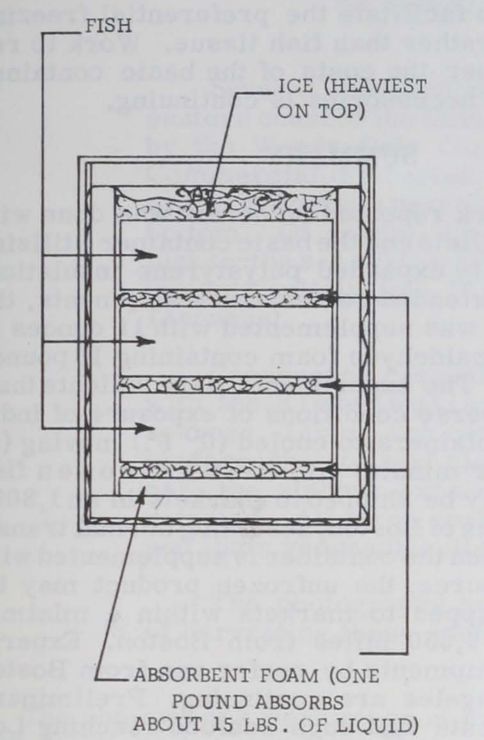
Melt-water from the ice may, if desired, be absorbed into a foamed urea-formaldehyde pad placed on the bottom of the container. One board-foot of the foamed plastic, costing about 29 cents, will absorb about five (5) pounds of melt-water. Distribution time is the limiting factor in the use of this container since the product temperature cannot be lowered below that of melting ice (32° F.). It appears to be ideally suited for transcontinental air-freight shipments and for non-refrigerated truck or rail shipments to current markets.

Refrigerated Truck Transport

For extended transcontinental reefer-truck shipments, a variety of accessories to the basic BCF container is available. Thus the type of insulation may be varied, from the reasonably effective expanded polystyrene to the extremely effective polyurethane. Secondly, the thickness of the insulation may be increased. Thirdly, a temperature-regulating (heat-source) device may be included in the container.

The temperature-regulating accessory utilizes the fact that freezing can be a heating process. For every pound of water frozen, 144 (BTU's) of energy must be withdrawn in the form of heat. This heat is absorbed by the immediate surroundings, be they the plates of a shelf-freezer, other food products, or the surrounding air. The net effect, if the energy dissipation is limited, is a localized heating inhibition or cooling.

Pure water, under normal atmospheric conditions, freezes at 32° F. The water in fish tissue, since it contains dissolved salts such as sodium chloride, freezes at a lower temperature--between 29.8° and 30.3° F. Therefore, in an insulated container, a quantity of water will freeze completely before the water content of accompanying fish flesh begins to freeze; and, the heat slowly withdrawn from the water during freezing will serve to regulate the internal temperature of the container at 32° F. for a considerable period of time.



ICING GUIDELINES (BASED ON 1-1/4 INCHES OF FOAMED POLYSTYRENE INSULATION)

There must be sufficient ice to cool the fish to 32° F. and keep it at that temperature until it reaches its destination. To cool the fish to 32. F. from:

40° F., add 5 lbs. of ice per 100 lbs. of fish
50° F., add 10 lbs. of ice per 100 lbs. of fish
60° F., add 16 lbs. of ice per 100 lbs. of fish
70° F., add 21 lbs. of ice per 100 lbs. of fish

To keep the fish cool when the ambient temperature is:

40° F., add 2 lbs. of ice per 24 hrs.
60° F., add 6 lbs. of ice per 24 hrs.
80° F., add 10 lbs. of ice per 24 hrs.
100° F., add 14 lbs. of ice per 24 hrs.

Example: How much ice is needed for a 50-lb. box of fish when the initial product temperature is 60° F., the estimated time in transit is 1-1/2 days, and the average ambient temperature in transit is estimated at 80° F.?

To cool: $\frac{16}{100} \times 50 = 8$ lbs.

To keep cool: $10 \times 1\text{-}1/2 = 15$ lbs.

Total ice required = $8 + 15 = 23$ lbs. minimum

Fig. 3 - Icing guidelines.

One such heat-regulating accessory is a water-soaked, foamed urea-formaldehyde plastic. It acts like a sponge, absorbing a quantity of water 15 times its own weight. The placement of six thin (one-inch) slabs of water-soaked formed plastic next to the polystyrene insulation ensures maximum absorption within the container of the heat energy released by the water upon freezing. (See Figure 4 for comparison of product temperatures in two insulated containers, one of which is equipped with such a temperature-regulating device.) Note that while the seafoods in the control (no-foam) container went into the zero-degree (0° F.) room at a higher temperature than that in the foam-containing container, there was a "cross-over" in product temperature after 36 hours of simulated transit storage. In addition, the temperature of the control container continued to drop until the product therein began to freeze at 29° F. In contrast, the temperatures of the seafoods in the experimental (foam) container held constant at 31° F. for an additional period of 56 hours, at which time the test was terminated.

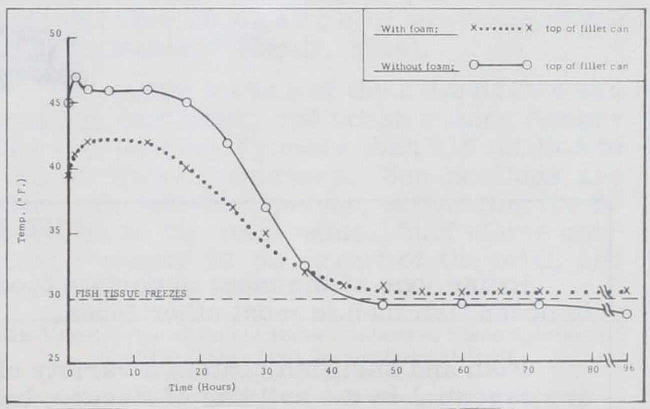


Fig. 4 - Cooling curves of fish packed in insulated containers, with and without water-absorbent foam, and stored at an ambient temperature of 0° F.

Such "crust-freezing" of the seafood, as occurred in the control container, could be damaging to the fish tissue even if maintained for only a relatively short time, and even if the temperature of the product, upon arrival, is brought rapidly up to 32° F. The appearance and the moisture-holding capacities of the fillets are adversely affected. Moreover, maintenance by the receiver of special facilities for elevating the temperature of the "crust-frozen" product prior to final distribution and retail sale would be necessary.

Counting the Costs

A summary of the costs of this type of packaging is given in Figure 1. Without the options, the per-pound cost is seen to be 2.05 cents for the 100-pound size, and 1.96 cents for the 75-pound size. This is about double the per-pound cost of the commonly used nailed wood boxes. The new container, however, is acceptable on any carrier whether ice is used or not, and as more carriers refuse to accept leaky packages, this factor becomes of increasing importance. Also important is the fact that if ice is used in the new container, the marketing area for fresh fish can be extended to an 1,800-mile radius; and our preliminary tests indicate that although using the absorbent foam will increase the package costs to about $3\frac{1}{2}$ cents per pound, marketing areas over 3,000 miles distant can be reached via ordinary refrigerated trucks at a cost of approximately one-sixth that of air freight.

While the urea-formaldehyde absorbent foam is relatively expensive, it can be reused many times. It is, therefore, possible to reduce its cost per-pound of fish fillet by arranging for its return to the shipper. An inexpensive, closed, tinned container shaped like a cake tin and filled with water may be used in place of the plastic. It is only necessary that the container, regardless of composition, be such as to facilitate the preferential freezing of water rather than fish tissue. Work to reduce further the costs of the basic container and of its accessories is continuing.

SUMMARY

All work reported on herein was done with haddock fillets and the basic container utilizing low-density expanded polystyrene insulation. For the extended reefer-truck shipments, the container was supplemented with 11 ounces of urea-formaldehyde foam containing 13 pounds of water. The experimental data indicate that, under adverse conditions of exposure of individual containers to cooled (0^{o} F.) moving (to 200 ft. per minute) air, fresh unfrozen fish fillets may be shipped to markets in an 1,800-mile radius of Boston, assuming normal transit times. When the container is supplemented with a heat-source, the unfrozen product may be safely shipped to markets within a minimal radius of 2,650 miles from Boston. Experimental shipments by reefer van from Boston to Los Angeles are continuing. Preliminary data indicate that such seafood reaching Los Angeles after 5 days in transit will still enjoy a high quality shelf-life of up to 8 days.

FISH FACTS

Iodine, one of the most important food elements, is found in a higher percentage in ocean fish than in most other foods.

Fish and shellfish contain a variety of health-giving minerals. These minerals are essential in the building of tissues, bones and teeth.

The high nutritive quality and digestability of fish proteins class seafood among the more desirable food products.

Fish within the many marketed varieties gives you a choice of a great diversity of taste treats, and remember, fish fats are those healthful polyunsaturated fats.

Fish supplies nutritionally complete protein for proper body growth and repair, and always many essential vitamins and minerals for your complete body health and vigor.