

Fig. 14 .... Temperature of Strawberries Shipped by Air and Rail

offset by a loss in quality due to the unfavorable temperature. It should be emphasized again that the top quality of many of the most perishable commodities can be significantly reduced by only a few hours exposure to unfavorably high temperatures, and no compromise should be accepted. Many drugs (biologicals) and other items such as whole blood can be rendered completely ineffective or toxic if not kept at the specified low temperature.

The effect of reduced pressure at high altitudes on fruits, vegetables and cut flowers was found to be negligible in tests conducted by the USDA in cooperation with one of the aircraft manufacturers. Consequently, pressurization of cargo compartments in all-cargo aircraft has not been required for these commodities, although many all-cargo and practically all passenger aircraft maintain pressure in their cargo compartments. Pressurization is, of course, required for shipment of most live animals.

SHIPPING CONTAINERS

Suitable containers for perishable air cargo are of great importance. The major factors involved are weight, thermal performance and mechanical protection of the contents. In most instances, the containers are furnished by the shippers, but the carriers are vitally concerned with the effect these factors have on their operations. Fruits and vegetables are generally shipped in the same containers used for surface transporation. These may be wooden boxes, veneer crates of various types, or fiberboard cartons. Most flower containers are constructed of fiberboard material, either plain or corrugated. Wooden cleats are used for bracing material, generally as dividers or corner braces inside the cargo box. Where lading may be exposed to very cold surfaces, external cleats may be used as spacers to prevent direct contact. Certain flowers such as gardenias and orchids may be packaged in individual cellophane-wrapped boxes or trays and placed in a master container. When any film wrap is tightly sealed, it must be perforated by a least one small hole to permit the release of air from the container during ascent to high altitudes. If sealed tightly, the package would swell and burst.

Fresh fish, shrimp and oysters may be packed in boxes, barrels or special containers. Proper precaution must be taken to prevent drippage from melted ice into the cargo space. Live lobsters are packed in insulated containers with salt water seaweed. Frozen foods are always packed in insulated containers. Whole blood is shipped in specially developed containers. Insulated bags of various sizes are also used.

Considerable research is in progress on the development of unit shipping containers to eliminate multiple handling in transit of smaller product packages, afford physical protection for the commodity, and provide more economical unit handling and loading on the ground and in the aircraft. One of the larger containers in use is 82 × 40 × 57 in. Made of aluminum, it is uninsulated, castor mounted, and handled by fork lift. All types of cargo are carried and when used for perishables it should be covered with special insulating blankets available for this purpose. A smaller shipping unit is insulated with a foamed plastic, has inside dimensions of 45 × 21 × 24 in., and a capacity of 13 cu ft. The insulation has a k factor of 0.14 Btu per (hr)(sq ft)(F deg). The thermal conductance of the container is reported as 2.8 Btu per (hr)(F deg). A larger unit holding around 75 cu ft with similar insulation is under development. The increased availability and proper use of these improved containers will contribute considerably to the maintenance of top quality of perishables shipped by air.

GROUND HANDLING

Because of the generally high temperatures prevailing on the ground at shipping point terminals and at intermediate points, most of the perishable agricultural commodities should be precooled to a safe carrying temperature as soon after harvesting as possible and delivered to the air terminal in properly refrigerated vehicles, particularly if shipped in uninsulated containers. At the terminal, provision must be made to hold these shipments at proper temperatures, if loading promptly from the pick-up vehicle is not possible. Refrigerated holding rooms should be provided for this purpose and may be refrigerated mechanically or by means of water ice. During seasonal loading peaks, refrigerated trucks or trailers may be used as temporary holding rooms. During hot weather it is important to provide some cooling of the cargo space before loading. This can be accomplished with portable air conditioning equipment such as used for passenger aircraft. Every effort should be made to protect the cargo during loading.

The airlines have developed rather comprehensive rules for use by their employees in handling the various perishable commodities. These include the temperatures desired in transit, the amount of protection needed according to the season, loading methods for various types of containers and other factors involved in the proper handling of these cargoes.

TRANSIT REFRIGERATION

As previously noted, many commodities must receive refrigeration in transit and, in most cases, this is accomplished by placing a refrigerant in the package. Water ice, dry ice and certain proprietary refrigerants are used. Because any method of transit refrigeration available is incapable of economically cooling a warm commodity to its desired transit temperature, all perishable items must be precooled to this level before shipment if transit losses are to be avoided. Flowers generally are wrapped in several layers of newspaper or lightweight insulating material and kept cool by water ice. The ice (solid, chopped or flake) is placed in a plastic bag or wrapped in many layers of paper and tied to one of the cleats of the container. In some instances, the block of ice may be chilled to 0 F in a freezer before putting it in the package, thereby obtaining a slightly greater refrigeration capacity. Newspapers are sometimes wadded up and thoroughly wetted and then frozen to 0 F or lower. In all cases the paper helps absorb the ice meltage water and reduces the chances for leakage into the cargo space.

It is important to leave some voids in the containers to permit air circulation, otherwise cooling will not be uniform. Boxes should be sealed to prevent air exchange. Placing the ice or water for freezing in sealed plastic bags eliminates the problem of drippage, but melting ice in open containers increases humidity within the package which is desirable, particularly for cut flowers. A packaged refrigerant which has no escape of free liquid must be used with commodities which would be damaged by water. Water ice acts as refrigerant in special type blood containers.

Dry ice is used extensively with frozen products, the amount depending on the type of container and the length of the journey. Sometimes it is placed in with water ice, not only for its own refrigerating value, but also to slow down meltage of the water ice and extend its value to the end of the transit period. Dry ice alone is seldom used for flowers because its very low temperature may result in freezing damage to adjacent blooms if not properly spaced or insulated. Some danger may also exist from a build-up of carbon dioxide.

For insulated shipping containers when the thermal conductance of the box is known, the amount of refrigeration required can be calculated if transit conditions for the trip can be estimated with reasonable accuracy. For example, the small insulated container previously described, C = 2.8 Btu per (hr) (F deg), will hold 15 standard strawberry trays, each holding approximately 13 lb of berries. Total weight of fruit is 195 lb. Assume fruit precooled to and carried at 35 F, an average ambient of 75 F (Δt = 40 F) and a transit time of 24 hours. The refrigeration load due to heat transmission through the container is expressed by $Q = C\ (\Delta t)$ (Time) or 2.8 × 40 × 24 = 2688 Btu. The ice required to absorb this heat is 2688/144 = 18.6 lb. The vital heat generated by the berries during transit would be 3990 Btu per (ton) (24 hr) at 35 F × 195/2000 = 389 Btu. This would require an additional 2.7 lb of ice or a total of 21.3 lb to maintain the desired 35 F in transit. The amount of dry ice required would be about 11.8 lb. These simple calculations can be made only when the thermal conductance or heat transfer rate of the container is known. It would therefore be of considerable value to all concerned, shipper, carrier and receivers, to have this factor determined for all insulated shipping containers and clearly displayed thereon. Such ratings are currently being made on truck-trailer bodies as discussed in Chapter 55.

When package refrigeration is not available, rapid warm-up of commodities can be retarded by the use of insulated containers or blanket insulation over stacks or pallet loads. This has been satisfactory with some of the less perishable fruits such as peaches. Varying layers of blanket insulation are used depending on the duration of the flight and weather conditions expected. Temperatures can be maintained for several hours in flight with the proper use of these blankets. Care must be exercised in loading to insure that insulating material is wrapped completely around the cargo and that no containers are in direct contact with hot or cold surfaces. Some cargo compartments on passenger aircraft may be cooled somewhat by the air conditioning system, but as previously stated, the temperature will not be in the optimum range for most perishable commodities. Many aircraft carrying cargo are equipped with thermostatically controlled heaters which serve to protect the lading from low temperatures. Special procedures and equipment are required for the transport of live animals and vary with the species.

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