

Figure 2. Forced-air tunnel with portable exhaust fan.

also circulates the air over the cooling surface and returns it to the cold room (Figure 3).

Cold wall

This is a permanently constructed air plenum equipped with an exhaust fan. It is often located at one end or side of a cold room, with the exhaust fan designed to move air over the cooling surface. Openings are located along the room side of the plenum against which stacks on pallet loads of containers can be placed. Various damper designs have been developed so that air flow is blocked except when a pallet is in place. Each pallet will start cooling as soon as it is in place; thus there is no need to await deliveries to complete a tunnel. Shelves are often built so that multi-layers of pallets can be cooled with this system. Different

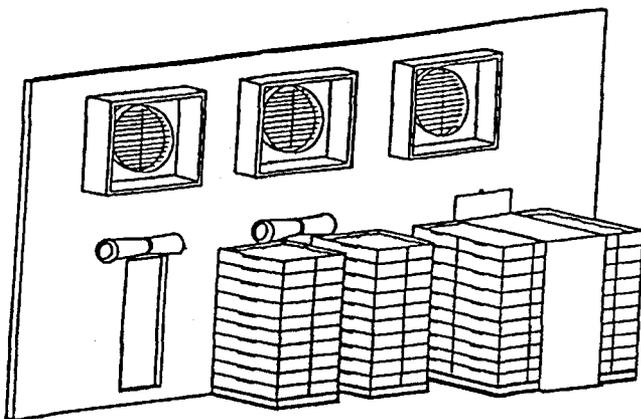


Figure 3. Forced-air cooler with permanent constructed air plenum.

packages, and even partial pallets, can be accommodated by proper design of the damper system. This is a benefit in some operations where a range of commodities or varieties is handled. Each pallet must be promptly moved from the cooler as soon as it is cooled in order to avoid unnecessary desiccation from continued rapid air flow over the product.

The usual design air flow rate for blueberry cooling is 2.1×10^{-3} m³/s per kg (2 ft³/min per lb) of fruit with the air temperature at -0.5 to 0°C (31 to 32°F) [8]. The cooling time varies from 1.5 to 2.5 hours depending on initial temperature of the fruit. In practice, air flow rate generally varies from 1.0×10^{-3} to 4.2×10^{-3} m³/s per kg (1 to 4 ft³/min per lb) of fruit.

Blueberries are usually pre-cooled at the packing-house in pallets consisting of 96 open-top fiber-board, single-layer tray cartons containing 12 200 or 400 gram (1/2 or 1-pint) containers, weighing approximately 454 kg (1,000 pounds). The pallet is usually 3 cartons deep, 2 cartons wide, and 16 cartons high. Most boxes are constructed in such a manner that tray cartons are connected together with wires and each carton is connected to the carton below with tabs protruding up into the carton above for load stability. The cartons have enough open area to allow for passage of cooling air. Cold air is forced through the pallet and recycled through a refrigeration unit.

Fresh market packaging

A considerable amount of information is available on the effect of package type on blueberries [4, 5, 6, 10, 11]. All of these studies have shown the importance of a good packaging system maintaining the quality of blueberries. The traditional molded pint pulp carton covered with cellophane wrap is being replaced by new packages which lend themselves to mechanized forming, filling, and closing, are easy to handle and transport, are attractive and convenient to the consumer, increase shelf life, and reduce water loss. New flat-top containers (Figure 4) have shown a high degree of approval and acceptance by marketers and consumers. These containers eliminate the 20% overfill normally associated with the traditional pulp containers to compensate for their high rate of water loss. New film wrappings are being developed which are superior to cellophane overwrap in terms of reduced moisture loss, decay and condensation.

Effective carton venting is essential for forced-air cooling to work efficiently. Cold air must be able to