REQUIREMENTS FOR SUCCESSFUL FORCED-AIR COOLING

James Thompson, P.E.
Biological and Agricultural Engineering Dept., UC Davis
Davis, CA 95616

jfthompson@ucdavis.edu

Palletized boxes of warm fruit placed in a cold room cool very slowly. Wrapped Anjou pears in boxes vented only with hand holes may take 45 days to reach storage temperatures. The slowest cooling fruit in the center of the pallet are dramatically softer than the faster cooling fruit near the outside edges. Properly managed forced-air cooling can reduce cooling time to less than six hours.

The essential concept behind forced-air cooling is to provide a flow of cold air past each piece of fruit in a box. This requires three elements: (1) a dedicated airflow system in a cold room, (2) packaging that allows good airflow through boxes, and (3) adequate refrigeration capacity to handle the heat load from the fruit.

The most common airflow system is called a 'tunnel cooler'. A lane of pallets is placed on either side of an exhaust fan and a reinforced tarp is unfurled over the gap between the two lanes. The fan pulls air from the cold room through the boxes and directs the warmed air past refrigeration coils for re-cooling. Fans provide about 1 cubic feet per minute (cfm) per pound of product on the cooler and generally provide this airflow at about 1 inch of water column static pressure. Actual static pressure for a particular product package depends on product size, master container air vent area and the use of interior packaging materials. The distance between the pallets and between neighboring cooling positions is selected to keep air speeds below 1500 feet per minute. Short distances cause uneven fruit cooling.

Forced-air cooling requires specially designed produce boxes. The master container should have at least 5% of the sidewall area devoted to air vents and vent holes should align with vents in neighboring boxes on a pallet. Clamshell containers inside the master container should have about 10% vent area. Paper wraps and plastic box liners retard airflow and slow cooling. Consider eliminating paper wraps and adding vent holes to liners. Vented liners are nearly as effective in reducing moisture loss as non-vented liners, but can significantly increase air flow past fruit.

Adequate refrigeration capacity allows room air temperature to remain constant during the cooling process. Refrigeration capacity for your specific cooler should be calculated by your refrigeration contractor. But as a rule of thumb, product entering and exiting the cooler at a rate of a ton per hour and at an initial temperature of 80 °F requires about 5 tons of refrigeration capacity. Refrigeration levels much below this allow air temperature to rise during cooling and reduce cooling capacity. Relative humidity in the cold room is usually not controlled. As long as it is above about 80% it will not contribute to excess moisture loss from the product.

Measure and record fruit temperature before it leaves the cooler. The warmest fruit is located near the surfaces of the boxes facing the return air channel, under the tarp in a tunnel cooler.

This fruit should reach desired temperature before the process is stopped. If cooling times are longer than expected, measure air temperature during cooling to determine if the refrigeration system is able to maintain temperature. If this is not a problem the slow cooling may be caused by air bypassing produce through pallet bases or through a poorly sealed tarp. A change in packaging can also affect cooling time.

A well-designed and well-operated forced air cooler is a dependable and effective method of rapidly cooling fruit and maximizing fruit quality.