

Fork-lift type ripening rooms require steel racks for supporting carrier bars, each 4 in. x 4 in. wood carrier bar being 5 ft-2 in. long and having a capacity of four stems (four hooks). The racks are arranged in two tiers, the lower tier at an elevation of 5 ft-5 in. and the upper tier at an elevation of 10 ft-10 in. The longitudinal channels, or angles, running from front to rear of the room that support the carrier bars are normally spaced 4 ft-8 in. apart.

Banana ripening rooms should be designed for an average stem weight of 125 lb.

Ripening rooms designed for ripening stems of bananas can be used for ripening tropical boxed fruit. Rooms designed specifically for ripening tropical boxed fruit are similar to rooms designed for handling stems, the major difference being that the joists or racks for supporting the hanging stems are not required as the entire box load rests on the floor.

Board form insulation is recommended for optimum air tightness. Three inches of insulation are normally required for ceilings, self-sustaining walls and walls erected against interior building walls, and 4-in. thick insulation against exterior building walls. No insulation is required in concrete floors on fill.

The high relative humidities used for ripening bananas result in free moisture on the fruit and on all inside surfaces of the ripening rooms. Therefore, all materials of construction must be moisture resistant and floor drains are essential. These drains must be trapped to prevent the loss of ripening gases.

With the high humidities required, and because the temperatures are such that various molds grow profusely, sanitation is important. In the design of rooms, the use of pressure treated lumber, fungicidal paints and finishes that retard the growth of mold are recommended. The room walls and other surfaces should be washed as often as necessary with solutions of sodium hypochlorite and water. Various proportioning devices are available, the simplest of which utilizes city water and an ordinary hose connection. This is effective for cleaning the surfaces as well as retarding the growth of mold.

Refrigerating Systems

Refrigerant 12 is most commonly used for banana room systems, and direct expansion is preferred. The use of direct expansion ammonia is to be avoided because a leak in the system may destroy an entire room of fruit. In some instances, recirculated brine at 40 F is used.

Best results are possible where an independent refrigerating system is used solely for the banana ripening rooms. For economic or other reasons the banana room refrigerating system may be connected to other cold storage room systems but this practice is not recommended.

Most banana processing plants include a minimum of 3 ripening rooms. Regardless of the number of ripening rooms, it is unlikely that all rooms will be calling for refrigeration simultaneously. One or more rooms may require refrigeration, one or more rooms may require heat, while the fruit in other rooms may be awaiting delivery to retail stores. Further, the fruit in some ripening rooms may be at the stage where it is generating the maximum amount of heat, or it may be ripe and merely being held at minimum temperatures prior to shipment. Thus, the cooling load is not constant.

Many banana room installations include 2 or more condensing units connected for parallel operation. However, in spite of the greater initial cost, individual condensing units have shown economies of operation that are often justified. The most satisfactory installations are those which consist of a single condensing unit separately connected to each banana room.

Banana room air temperatures range from 55 to 70 F. As

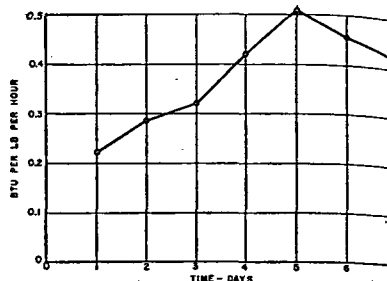


Fig. 1 . . . Heat of Respiration of Bananas Ripened at 70 F

mentioned above, direct expansion systems with Refrigerant 12 are preferred. The capacity is normally based on 40 F saturated suction gas. The 40 F refrigerant temperature provides a temperature difference of 25 F when the rooms are in normal operation for ripening bananas. Humidification systems are discussed in a later section.

Refrigeration load calculations are performed using the same methods employed for other fresh fruits. The maximum value for the heat of respiration should be used, 0.5 Btu per (lb) (hr), see Fig. 1. For the purpose of calculating cooling loads, use 0.9 Btu as the specific heat of bananas. It is considered good practice to use a pulldown rate of 1 deg per hr. The refrigeration requirements are affected only slightly by climatic conditions, and the heat leakage load is only a small part of the total load. The miscellaneous load would include only the unit cooler fan motors, as the lights are normally off and no workmen are in the rooms when fruit is ripening.

The cooling coils must be installed inside the ripening rooms to insure maximum room tightness. Disc fan or centrifugal blower units are satisfactory for banana rooms used for ripening stems, but centrifugal blower units are recommended for rooms designed for handling tropical boxed fruit. Air circulation equivalent to one air change per minute is desirable for boxed fruit.

Heating Systems

Bananas are usually carried at a pulp temperature of 56 F during shipment from the domestic port to the jobber's warehouse. General ripening procedure is to apply heat for the first 24 to 36 hr to raise the pulp temperature to the desired ripening temperature. After the initial heating period, the fruit starts to generate its own heat and refrigeration is required for controlling the temperature during the remainder of the ripening period.

The heating system should have a capacity sufficient to raise the temperature of the bananas at the rate of 2 F per hr. Use a specific heat for bananas of 0.9 Btu for calculating heating capacity.

There are several methods of providing heat, the most common and perhaps the most satisfactory being low pressure steam. Steam can be supplied most efficiently and economically by mounting steam coils in the unit cooler housing, or on the face of a standard unit cooler. The steam coils should be designed to offer a minimum amount of air restriction and should be specified to have a leaving air temperature of less than 110 F at the operating velocity of the cooling unit.

Storage of Apples, Pears, Grapes, and Bananas

A motorized control valve (that will close on current failure) is installed in the steam supply to each ripening room and connected to the heating thermostat in the control panel.

The banana room steam coils can be connected to the warehouse heating system, but heat is required in banana rooms during summer months when the warehouse heating boiler is shut down. Therefore, it is frequently good practice to install a low pressure steam boiler sized to take care of 60 to 70 percent of the total requirements of the ripening rooms.

Electric heaters are used in smaller plants and in lower power rate areas. All electric equipment must be corrosion resistant. The heater elements, in a corrosion resistant sheath and supplied with corrosion resistant terminal boxes, can be mounted in the unit cooler housing or on the face of a standard unit cooler. The surface temperature should not be greater than 800 F in dead still air. This limitation of surface temperature is partially a safety consideration necessary as a result of the proximity of the cooling coils. In the event of fan failure and a coincidental leak in the cooling coils, Refrigerant 12 could be broken down into its toxic components, thus an unfortunate chain of events could create a hazardous situation. As an added safety measure, a thermostat (open on rise) should be mounted on the outside of the unit cooler housing with a remote bulb mounted inside the housing over the heater elements. This safety thermostat is connected so that the heater circuit will open when the air temperature adjacent to the heater elements rises above 150 F.

Normal operation of the electric heater is controlled by a heating thermostat in a control panel.

Very few gas heaters are in use today and this type of heater is not recommended. Open flame gas heaters should not be installed in banana rooms under any circumstances because the oxygen will be consumed by the open flame, and the flame will be extinguished causing a hazardous situation and possible injury or loss of life to plant personnel.

Humidifying Systems

A humidifying system is required for ripening stem fruit. The most practical method of providing moisture is to install a copper waterline from the city water supply to each ripening room, terminating in mist nozzles, each nozzle having a rating of about 1 gph. These nozzles must be one of the types that provide a very fine mist. Approximately eight nozzles are required in a carlot capacity ripening room.

Moisture is controlled manually by means of a globe valve in the waterline to each room; automatic control of humidity is neither necessary nor desirable. Average shipments of bananas require almost 100 percent relative humidity when ripe, and about 85 percent relative humidity when green, however, each shipment of fruit differs and the moisture requirements must be determined by inspection.

A humidifying system is not required in rooms designed for ripening tropical boxed fruit.

Banana Room Controls

Banana room temperatures must be accurately controlled by remote bulb type thermostats, the instruments being mounted in a control panel on the outside front wall of each ripening room, and the remote bulbs located in the return air to the unit cooler. Two instruments are required, a heating and a cooling thermostat, each with a range of approximately 50 to 70 F, with 1 deg graduations and a 1½ or 2 deg differential. The cooling thermostat is connected to a solenoid valve in the refrigerant liquid line, and the heating thermostat to a motorized control valve in the steam supply, or to a heater contactor if an electric heater is used.

The control panel should also include a selector switch con-

nected in the control circuit to provide the following functions: (1) heating with continuous fan operation; (2) cooling with continuous fan operation (required when ripening tropical boxed fruit); (3) cooling with intermittent fan operation (fan operates only when thermostat is calling for refrigeration as required when ripening stems of fruit), and (4) fan operation only.

The control panel must also include a fan motor starter and a fused disconnect switch. When centrifugal blower units, electric heaters, or both are used, the panels must be wired for 220 volt, 3-phase, operation.

Packing and Shipping

Stems of bananas are removed from the ripening rooms at the completion of the ripening process and transported to the packing area which is usually adjacent to the banana rooms. Ripe fruit is extremely susceptible to bruising and scarring injury, therefore, the use of mechanized equipment is highly recommended for transferring ripe stems from the rooms to the packing location. Extreme care should be observed throughout the cutting and packing operation.

The hands are cut from the stalk, graded, and packed in containers (usually 40 lb net weight) for delivery to retail stores. Many wholesalers label or prepurchase the fruit in consumer size units. Representative labels include decals, gummed paper tape, cellophane tape, etc. The most commonly used packages are polyethylene bags and cellophane overwrapped trays.

The packing areas should be designed to protect the fruit against exposure to temperature extremes. These areas should never be permitted to drop below 56 F; a year round temperature of about 60 F would be considered satisfactory. A heating system may be required during winter months to prevent chilling, and it may be advisable to air condition the space during summer months.

The larger plants usually have holding rooms for the storage of packed box fruit where the fruit is held prior to delivery to the retail stores. These packed box storage rooms are designed to maintain a temperature of 55 to 56 F at a relative humidity of about 85 percent.

Tropical boxed bananas are, of course, transferred directly from the ripening rooms to trucks for delivery to retail stores. The fruit remains in the original container from the tropical boxing station to the retail store.

Protective measures must be taken when shipping bananas to retail stores to prevent exposure to excessively high or low temperatures for prolonged periods. It may be advisable to raise or lower pulp temperatures of the fruit prior to shipment from the warehouse depending upon weather conditions. If bananas are to be shipped in mixed loads with other produce and the trailer temperature is considerably below 55 F, the pulp temperatures of the bananas should be raised to 60 to 62 F before being loaded.

It will be evident that banana ripening and ripening room design are influenced by many factors, including the transportation period, frequency and size of fruit arrivals, and variations in the bananas themselves. These variables require interpretation by persons experienced in evaluating these factors. It is for this reason that major banana importers maintain an advisory engineering staff to assist wholesalers with the proper design of ripening and handling facilities.

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