TREATING AND MECHANICAL PACKAGING FOR THE
FRESH FRUIT PACKING HOUSE

By

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When an air conditioning engineer is asked to calculate the load for a room such as this, he must know how many people will occupy the room. He must know this because each one of us here is liberating about 400 BTU per hour of heat energy. That is, when we are at rest. If we dance or do some similar exercise, our heat rate goes up to as much as 700 BTU per hour.

The orange has many things in common with us. It is a living organism just like we are. It breathes in oxygen and breathes out carbon dioxide just like we do. An orange liberates heat just like we do. Of course, an orange cannot dance, but its heat rate varies, nevertheless. Its heat rate varies with its temperature. Calorimeter tests made at the Experiment Station at Gainesville by Messrs. Leggett and Sutton in 1951 show that the heat dissipation rate of oranges is 500% greater at 80°F than it is at 40°F. This is shown in Figure 1.

The heat rate of oranges is a direct indication of their deterioration rate. So we see that oranges deteriorate 500% faster at 80°F than they do at 40°F. The growth rate of spoilage causing microorganisms is also affected in about the same ratio. These data are substantiated by another series of tests where the respiration rate was studied by measuring the amount of carbon dioxide coming off the fruit. Also, there is a rule of thumb in chemistry that the reaction rate of most chemical reactions is doubled for each 10° centigrade rise in temperature.

Now, with this information at hand, it does not take a genius to figure out that the best one thing that the packer of fresh fruit can do to improve the quality of his product is to take the heat out of it as quickly and thoroughly as possible. The equipment used to do this, is what I will discuss at this time.

This machine is known as the Stericooler. It has been in production for about 20 years and is used on various types of fruit and vegetables. This machine has revolutionized the packing of
sweet corn and peaches. During the last decade, we have seen the peach packers go to 100% stericooled shipments.

The operating principle of the Stericooler is simple. Circulating ice water is pumped to the top of the machine where a weir box and suitable flood pans cause it to flow evenly over the fruit which is conveyed through the machine. Heat is removed from the water by adding ice or by using refrigerating equipment.

There were two Stericooler installations made in Florida this season for processing citrus fruit. One of these was made at Spada Fruit Sales Agency in Thonotosassa. The other machine is at Roper Groves in Winter Garden.

The peel of citrus fruit is a good insulator. This makes cooling more difficult than with peaches or other thin skinned fruit and vegetables. The equipment for cooling citrus fruit is necessarily large. The cooling load is no larger for citrus than any other fruit; it just takes longer to extract the heat through the thick peel.

In spite of its size, the Stericooler is an efficient piece of equipment. The Spada machine is 62 feet long overall. It is 88 inches wide inside. It has a capacity of 500 packed boxes per hour. It has two circulating water pumps that deliver a total of 8,000 gallons of water per minute. This figures out to be four million pounds of water per hour. Since this machine handles 45,000 pounds of fruit per hour, this means that there is 90 pounds of water circulated for each pound of fruit. Those of you who have done heat transfer work will recognize this as a very favorable ratio. The temperature drop of the water over the fruit is less than 1/2 degree F. The water temperature can be maintained within one degree of 32°F. This calls for considerable surface in the cooling coil to prevent icing. As can be seen from the cooling curve, Figure 2, this low water temperature is necessary to furnish the temperature difference to make rapid cooling possible.

The capacity of the Spada machine, Figures 3 and 4, can be doubled by adding another conveyor under the flood pans. This is called "double decking" and has been done to the Roper machine. This modification cuts the floor space requirements in half.

Tests have shown that cold fruit is more easily bruised than warm fruit. Therefore, it is important to reduce handling of the fruit to a minimum after chilling.

Experience has shown that shipments of Stericooler processed fruit can be made to all eastern and Midwestern points with initial icing only, during most of the season. This results in lower
Fig. 1. - Heat of respiration of oranges and grapefruit at 40°F and 80°F.

Fig. 2. - Stericooler cooling curve for 216 size oranges.
Fig. 3. - Stericooler installation at Spada Fruit Sales Agency, Thonotosassa, Florida.

Fig. 4. - Close-up of Stericooler discharge showing part of copious water flow.

Fig. 5. - Face of machine filled box shown after inverting the box.
shipping costs and eliminates the human element in enroute icing. Also Stericooler processed fruit brings a premium price in the market. These factors more than offset the cost of operating the Stericooler.

There is evidence of a phenomenon in fruit cooling that is referred to as "shock", or more accurately "thermal shock". Fruit that has once been chilled and allowed to warm up, has a shelf life far superior to samples of the same fruit that have not been chilled.

Now that we have a way to chill the fruit efficiently, it is important that it is packed and loaded into the car or truck promptly to avoid picking up heat. There have been two developments made recently to help the packing house get this job done. One is the mechanical box filler and the other is a bag filling machine.

Automatic packaging of manufactured products is the rule rather than the exception throughout industry. For example, no modern cannery is complete without a casing machine. There is an entire branch of industry, the packaging machinery industry, devoted to the packaging of manufactured products. It is not at all unusual to see machines that package packages. It seems paradoxical that so little of this vast store of experience and know-how has been applied to the packing of fresh fruit and vegetables.

Some items of produce are graded and packaged in one operation, but this is not the case in the citrus industry. Citrus fruit is delivered to the packing bins graded and accurately sized. These conditions are ideal for the application of mechanical packaging.

Since the packing operation in a citrus packing house represents a large portion of the total cost of packaging fruit, mechanical packing is very desirable from an economical standpoint. Mechanical packing is the last, and perhaps the most important stage in the complete automation of the packing house.

One of the first commercial operations of a mechanical citrus fruit packer was made in California several years ago. The need for mechanical packing was intensified in that area due to high labor rates in the post war period. The machines used there determined the volume of fruit in the shipping container by weight. This method of packing proved to be satisfactory for lemons because of their small size. These machines are still in use in California.

The shipping container used is 4/5 bushel corrugated paper carton which is equivalent in size to half of a Bruce box. The carton is filled in the upside-down position. The box is vibrated while it is being filled, which causes the first layer of fruit to
arrange itself in an orderly pattern. If filled properly, when the box is inverted and opened, the appearance is strikingly similar to that of a hand packed box, as can be seen in Figure 5.

One of these weight type box fillers, made by FMC Equipment Division of Food Machinery and Chemical Corporation, Riverside, California, was brought to Florida in 1955 by the Florida Division of FMC and was tested on Florida oranges. The pack was satisfactory in every way except that there was a slight variation in the number of fruit in each box. Citrus fruit has been sold by exact count for such a long period of time that there is a natural resistance to any pack other than exact count. At the conclusion of these tests, a decision was made by FMC to develop a packing machine that would actually count the exact number of fruit into each box.

It should be mentioned here that the requirement for exact count does not hold throughout all fresh fruit and vegetable operations. A battery of eight weight type FMC fillers is operating quite satisfactorily at Ruskin Tomato Growers Association, Ruskin, Florida. Direct labor costs were reduced 5¢ per 50 lb. box with this installation. The weight of the filled box is unbelievably accurate. The average weight is within the approximate weight of one fruit. This installation is shown in Figures 6 and 7.

The fruit counting machine developed by FMC is basically mechanical in operation. Fruit is passed through turnstiles and the count is monitored by a set of gears. This operating principle is similar to that used in the adding machine and is absolutely accurate. This mechanism, as well as the associated box handling mechanism, is controlled by electric circuits, but the actual counting is done mechanically. There are other counters on the market which use electric or electronic counters. The FMC counting box filler is shown in Figures 8 and 9.

From the standpoint of accuracy and trouble free operation, it is desirable to limit the number of fruit sizes handled by one counting head. The FMC orange counter is made in two sizes. The small orange counter handles 288's, 252's, and 216's. The large orange counter handles 176's, 150's and 126's. The only adjustment necessary to change size is to set the selector switch to the desired size. This division of sizes allows ample flexibility of operation to satisfy the needs of even the smallest packing house.

The greatest saving to the packing house using mechanical box fillers is the packing labor. The current piece work rate for filling oranges is 4-3/4¢ per 4/5 bu. carton. The rate is
Fig. 6. - FMC weight type carton fillers installed at Ruskin Tomato Growers Association, Ruskin, Florida.

Fig. 7. - Close-up of one filler shown in Fig. 6. Code stamping device and box switch can be seen.

Fig. 8. - FMC count type carton filler installation at Sniveley Groves, Eloise, Florida.
Fig. 9. - Close-up of FMC counting mechanism showing turnstiles and monitor gears.

Fig. 10. - FMC weight type bagger installation at Roper Groves showing run-around feed belt.

Fig. 11. - Side view of FMC bagger showing feed chute and shadograph scale dial.
6-3/4¢ for a 1-3/5 bu. Bruce box. Each box filler requires an operator. The filling rate of each filler depends on the size distribution of the crop being run and varies considerably. If we assume that the box fillers will average 3 boxes per minute, this would amount to 6/10 cents per box for packing labor at the rate of $1.10 per hour for the operator. So the net saving in packing labor is somewhere between 2-1/2¢ and 3-1/2¢ per carton depending on how the comparison is made.

The saving on the container is very small when two cartons are compared to one Bruce box. These items fluctuate through a narrow range. Usually there is an advantage of one to two cents in favor of the carton. There is a saving of about 14¢ when the carton is compared to the half Bruce box. The main objection to using cartons at present is because of their insulating properties. Fruit is more difficult to cool in cartons than it is in Bruce boxes. When the fruit is cooled and then put into cartons, the insulation is working for the packer, rather than against him.

There are several advantages in bagging sterically cooled fruit. First, there is a saving of nearly 3 cents per bag in bag costs when polyethylene bags are used. The polyethylene bag has some insulation value which is in the packer's favor when the bag is filled with cold fruit.

Also, these plastic bags can be used on bagging machines that increase the productivity of the packers. The machine operator is paid an hourly rate, whereas the hand packer is paid piece work rates. An experienced operator can average 6 bags per minute on a bagging machine. At $1.10 per hour, this direct labor cost is 3/10 cents for the bagging operation. The current piece work rate for this same operation is 9/10 cents, or 3 times the cost of machine filling.

The loss from over filling bags is sharply reduced with machine filling. Machine filled bags are held to 6 ounces overweight to allow for shrinkage. Whereas, hand filled bags that are filled by count, run as high as one pound overweight. Most packers are vaguely aware of this loss, but some of them are not fully aware of the staggering total it can add up to in the course of a season. A maximum 216 size orange is only 1/4" larger than a minimum 216 size. Yet a simple calculation shows that the larger fruit weighs 25% more than the smaller one. These values tend to balance out to an average, but the packer who fills bags by count must make a larger overweight allowance than is required for bags that are individually weighed. Since bags are sold by weight, it is logical that they should be filled by weight. Mixed sizes can be run by weight filling which may be desirable.

There is a 16 head FNC bagging unit in operation at Roper Groves. See Figures 10 and 11. This unit accommodates 8 workers. Each operator takes care of two bagging heads. The bag is changed on one head while the bag on the other head is being filled. Each
bag is weighed on a balance scale and the flow of fruit is cut off automatically when the proper weight is reached. The operator does not close the bag. It is placed on a conveyor belt and is transported through a closing machine on the way from the bagging machine. The bagging heads receive fruit from a run-around type of distributor belt. This makes a compact layout that conserves floor space compared to a packing bin operation.

The three items we have discussed, the Stericooler, the box filling machine, and the bagging machine together represent a new concept in packing house operation. Conceivably, these items could be installed and used separately, but to gain full advantage of these technological improvements, the three items should be installed as a unit.

The cost of this equipment represents an investment of considerable magnitude. The benefits to the packer that make such an investment worthwhile are:

Savings in packing labor costs.
Savings in shipping container costs.
Savings in shipping costs.
Premium price for fruit shipped.
Superior quality of fruit shipped.

These advantages should result in increased sales.

BIBLIOGRAPHY

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