meantly caused an explosion and evaporation at the temperature corresponding to the vacuum inside the tube.

After a thorough investigation with the pilot plant, an evaporator was designed containing a multiplicity of reasonably large tubes, in which the juice was sprayed into the top and descended to the bottom, the tube being large enough to carry away the product of evaporation at the very low vacuums which were obtainable at that time. Using three jets with suitable intercondensers, vacuums were obtained within .35" of the barometer. About a year was consumed in making such an evaporator commercially practical, and among other difficulties, the problem of cutting evaporation off at the one to ten limit, without going further and forming a solid so-called, "candy," since very little moisture could be removed from the 10 to 1 product without the material solidifying.

As a break in the serious dissertation above, we might say that the first few times the evaporator was opened for cleaning after a run, the various operators who were attending to the job made the mistake of eating handfuls of this so-called, "candy." Since each handful was equivalent to 20 or 30 oranges, a certain effect was had on the digestive apparatus of the operators, which prevented them from coming to work for two or three days.

After the product had been made in such a manner for a considerable length of time, a sales organization was formed to sell the product and the 10 to 1 concentrate was made fairly salable over certain parts of the country and the process began showing a profit.

World War II came on about this time and the Government took over the process, and products of the plant, and insisted on receiving for export a thinner liquid than the 10 to 1 concentrate, which was about the consistency of very cold molasses and was dissolved with difficulty. The trouble, of course, with the 8 to 1 concentrate which was demanded, was the fact that it had to be sterilized, which again tended to deteriorate the flavor.

From the beginning of our operation, we had recommended to our customers that a small percentage of freshly squeezed whole juice be added back to the reconstituted concentrate. It was therefore but a simple step to add whole juice to our low temperature concentrate and freeze.

Therefore, the first commercial production of frozen concentrate was made by us for Knight & Middleton, which was dispensed through the Peoples Drug Stores in Washington, D. C. The rest of the story is well known to everyone and there is no use in going further with it. It is only fitting, however, that after discussing our early efforts in this matter, we call attention to the capable technical work done by the staff of the Minute Maid Corporation and of Joe Cross of the Majonner Corporation in achieving similar results through different methods. We also wish to mention the work done by Dr. E. L. Moore and Dr. C. D. Atkins of the Citrus Experiment Station in their development of a low temperature evaporator.

In concluding, we wish to call attention again to the point which was known to all of us, which is that if enough capable and technical heads are used in the solution of any problem, results can be obtained which forward the whole progress of science.

CONCENTRATE PLANT ARRANGEMENT FOR LOW COST EXPANSION

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This paper will deal with original citrus concentrate plant design as this design allows for controlled and preplanned low cost expansion. It is probably most appropriate at this time to note that any expansion in the 1951-52 season, regardless of economical design, is costly. Continually increasing labor costs and high material and equipment costs coupled with the many shortages due to the war economy are all not conducive to specific low cost expansion. Reasonable recognition of the economics brings forcibly to the fore-front the absolute necessity of lower cost expansion and an absolute need of machinery and equipment selec-
tion that will result in the lowest possible parts maintenance and upkeep all coupled with a permanence that will prevent early replacement of a specific tool.

All production facilities must be examined with an eye towards ample elbow room for production cycle changes, and specific machines should incorporate features which adapt themselves to as many different purposes as possible.

In summary, the low value dollar must be spread over the production requirement to allow a maximum of use and reuse for as many end-products as possible. In a growth industry, such use of a low dollar value will prevent future expenditures in a continuing high cost economy. As our competition increases for the citrus consumer dollar it is of utmost importance that designs allow a minimum of operation cost; the investment dollar must be spread over as many products and by-products as possible; and equal to all, any investment must allow an unrelated control and effort to maintain top quality. In most cases in our industry and in spite of its major importance, detailed examination will usually reveal that quality control and product development represents the minimum cost in investment and operation dollars when compared to actual product investment and labor cost dollars. This is a most desirable condition and is certainly an excellent insurance policy against consumer refusal of the higher cost production product.

SITE AND PLOT PLAN LOCATION

The Fosgate Citrus Concentrate Plant was conceived for construction during the summer of 1950. Construction was started December 1, 1950.

In the planning stages a considerable amount of time was expended in attempting to link the canning plant with existing structures and properties which would considerably handicap the plant from an expansion standpoint as well as from a waste disposal stand-point.

The economics to be effected and first cost saving in such combinations with existing equipment are readily seen by a new group entering the canning business; however, the future high cost problems are not seen and it is often difficult to realize the extent of these high cost future problems. After much detailed consideration the Board of Directors realized the necessity of locating the canning plant in the middle of a large unobstructed area served by rail on one side and highway on the other with ample property between the two transportation facilities. A large twenty acre tract of land was acquired adjacent to existing properties and the canning plant was plot-planned in this newly acquired property.

FIGURE NO. 1 will indicate the original plot plan as selected. The principal functions of fruit storage, juice extraction, packaging, cold storage, laboratory, filling and blend room, refrigeration compressors, evaporation, steam power, and fuel storage are all as shown. The existing fertilizer plant, paint shop, and garage are all in evidence at the left of the figure. The basic plant group is designed in a "U" shape arrangement allowing a court yard in the middle.

FIGURE NO. 2 exhibits a complete blow up of the production unit and shows clearly the basic reasoning behind the original construction plot plan. It should be noted that all functions have at least one mode of expansion and some functions deemed most important have two modes of expansion. As is readily noted, the fruit bin area and cold room area are allowed two avenues of expansion.

FIGURE NO. 3 is an elaboration of figures 1 and 2 and goes further to exhibit the eventual enlargement of the plant function to include extensive dry-goods warehouses for single strength products and a by-products plant (feed mill). The waste bed area has been incorporated in the original construction and was placed at inception to allow expansion. The feed mill was located as shown to give ample distance from the canning plant and assure dust-free premises. It is also located adjacent to the waste bed for easy handling of waste residue.

FIGURE NO. 4 exhibits the original 1950-51 operation unit completed for operation on Feb. 15, 1951. Due to fruit supply and late maturity of the Valencia crop there was only limited operation until the latter part of April.

The plant as shown in Figure 4 is a single line 10,000/hr. producing unit for orange concentrate only in 6 oz. cans. Eight juicers of the FMC In-Line Type were employed; one set of fruit bins (14 truck loads); a Carrier-Howard Steam Evaporator; a Carrier 90 Ton Centrifugal Compressor; an FMC immersion freezer; and a single 16 pocket filler was also used. Cold wall tanks were employed for pre-refrigeration prior to filling.
FIGURE NO. 5 will reveal the same plot plan as in Figure 4. The basic identical buildings have been used to increase production capacity to an evaporation rate of 20,000/hr. and also add a third complete line of single strength equipment for 55 gallons per minute output. Fruit bins have been doubled and twenty FMC In-Line machines are installed instead of the original eight units. Two of the FMC In-Line machines are capable of grapefruit extraction and the original cannery sizer was elongated to accommodate a third size instead of two sizes originally used. The second Carrier-Howard Evaporator was designed in place to equal, but opposite hand to the original unit. Considerable economy was effected in this design in that original hot well and waste water piping from the barometric condenser was used as originally installed inasmuch as both condensor discharges were adjacent to each other. Water supply to the evaporator was easily at hand and panel-board cover was made available from previous construction.

Leaving Figure 5, for a brief moment, Figure No. 6 will exhibit the evaporator structure placed outside (upper left corner). Every effort has been made to place equipment and operation outside of building cover. Where block, mortar, and structural steel can be eliminated such has been done. Both the original and new evaporator have been exposed to the elements in every way. Only the instrument control panel (Figure 7) has been placed under cover. Operations to date have proved the economy of this move.

Returning to FIGURE NO. 5, the only courtyard equipment under cover is the centrifugal compressor. The refrigeration supply tank, pumps, and immersion freezer are all exposed with no permanent cover. A second freezer has been added in the form of an alcohol flood type unit of the Barry-Wehmiller design. This unit requires more space per unit of production, but places the investment dollar in a very flexible position. Cans of extreme diameter and height range can be frozen by this investment dollar. The basic 6 oz. requirement is serviced by immersion type unit, while odd size 12 oz., 4 oz., 27 oz., and 32 oz., are handled on the flood unit. Room is available for duplication of the latest freezer addition if ever found necessary.

Cold wall tanks have been added and two additional concentrate fillers have been added to cover sizes from 4 oz. to 32 oz. if required.

A single strength filler with room for a second has been placed adjacent to single strength blend tanks. Sugar supply is afforded from the sugar room by means of a worm feed.

Filled single strength cans are immediately removed from the building and are handled outside until they reach the casing operation. An approximate 25 second holding time is available immediately out of the single strength filler before cooling. The can coolers are elevated without the use of a full can elevator and placed outside with no cover and parallel the future dry-goods warehouse addition. Doubling boxes and cooler feeds are mounted on the roof of a lift truck service room. The coolers are maintained at elevated height to eliminate costly full can elevators and their attendant high cost of operation and maintenance.

The original dry-goods warehouse is employed, in part, for the casing and labeling operation.

All trucks are of electric type to spread the investment dollar over both frozen and dry-goods handling.

Concentrate packaging operation consists of two FMC new type non shock casers. Here again the investment dollar allows duplicity of use. Each caser can be used on any size can (4 oz. to 32 oz.) or eventual single strength operation if required.

GENERAL EQUIPMENT VIEWS

The following figures present some of the highlights of the equipment and building design.

FIGURE NO. 8 exhibits the previous discussion of outside placed refrigeration equipment. All of the piping, pumps, and refrigeration tanks are in the open air with water proof insulation (cork).

FIGURE NO. 9 is the immersion freezer which is open except for a cheap transite cover which is placed low over the top can intake and discharge. This roof is to prevent icing of the can intake and discharge during operation in heavy rain. The elevator in the foreground is a freezer by-pass in case of a freezer can jam.

FIGURE NO. 10 exhibits the only car height platform in the plant. This arrangement of a two sided car ramp allows the plant to be placed at the most economical grade; thus
omitting costly fill. Outside empty can lines are shown here for access to the blend room and filling room.

FIGURE NO. 11 shows the primary weir for lagooning beds. FIGURE NO. 12 also shows the primary weir with a secondary weir on the same lagooning beds for contaminated waste water. Experience during the past season indicated ample capacity in these beds for future expansion. At best, such beds are often unreliable in rainy weather and could create serious trouble. Operation in July rains of the 1951 season gave encouragement in that peak capacity for sustained periods was handled easily.

Finally, FIGURE 13 exhibits a commodity—not a facility—which requires an investment in time if not in actual dollars. The increase in defense work and the attendant high wages and salaries involved are making themselves felt in the labor market for canning plant operation. As a result we have prepared a text book and training program which we hope will allow us to operate efficiently as we expand. The figure shows a group attending our foreman's school for the daily one hour class. These men are trained in quality control procedure and plant production and maintenance procedure. The men are selected from routine operating groups and are trained for eventual formancies. The success of this step is not yet proven in the industry. The canning season 1951-52 should indicate the wisdom of the move.

Summary

Even in the event of a Korean Truce, it is quite apparent that war preparation and the resulting shortages and inflation will continue at a very high rate.

If expansion is to be carried on in such a period, it is necessary that the facilities dollar be expended on reasonably substantial equipment to eliminate early replacement or heavy maintenance. Also the investment dollar should be hog-tied and kept away from non-producing brick, mortar, and buildings wherever possible. It is surprising to evaluate how much paint and weatherproof insulation can be obtained for the price of one roof truss of structural steel (assuming you could buy the steel). In addition to the above, facilities to be purchased should be reviewed with a critical eye toward multiplicity of end use. A quick change to another product type, or size, or equivalent, might often allow continued operation where a less flexible facility will necessitate a shut-down.

The original 1950-51 producing facility shown in FIGURE 1 has been approximately trebled for the 1951-52 season. The building addition of only a shipping platform and a small battery room has allowed the original design of approximately one million boxes per year capacity to be increased to three million boxes per year total processing.

Cost figures indicate the two million box capacity per year addition to be procurred at a cost not to exceed 60% of the original one million capacity. In simplified terms: if the first million boxes of capacity cost one dollar, the second and third million boxes capacity will not exceed 30 cents per million. Actually, all prices have increased over the 1950-51 season and an equal price basis would indicate even further lower unit expansion costs.

Finally, the quality control investment dollars can and will guide the production investment dollar to a product accepted by the customer and returned for the customer. Without the proper end product to give the customer acceptance and repeat sales, the production facility becomes a great white elephant who gobbles the interest on investment with an insatiable appetite.

EFFECT OF INSOLUBLE SOLIDS AND PARTICLE SIZE OF PULP ON THE PECTINESTERASE ACTIVITY IN ORANGE JUICE

A. H. Rouse

Florida Citrus Experiment Station
Lake Alfred

Florida Agricultural Experiment Station Journal Series, No. 37.

Clarification and gelation, two undesirable characteristics sometimes found in processed citrus juices, are known to be associated with

---Cooperative research by the Florida Citrus Experiment Station and Florida Citrus Commission, aided by a grant from the American Can Company.