creased and sodium hydroxide-soluble pectin remained constant during processing and storage.

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# A CITRUS PLANT ELIMINATES WASTE

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The control or treatment of citrus waste has occupied the time and attention of a number of people in recent years. Many have made valuable contributions to the industry but there is still much remaining to be done. It appears that a majority of the attention has been directed towards the treatment of waste. This paper will not discuss the merits of the various approaches to treatment but instead presents a plan to avoid the creation of a waste problem which has been accomplished at the Dunedin Plant of Clinton Foods Inc.

This plant is situated near one of the better residential areas of Dunedin and is within two blocks of Clearwater Bay—a sizable body of salt water. As is too often the case little or no planning was given to the proper treatment of plant waste when the plant was built in 1941. The accepted method of disposing of citrus plant waste was to take the peel and dump it in some suitably distant swamp or to wash it into some convenient stream. The citrus pulp and molasses business was just a dream or beginning to be a reality and was totally untested. Therefore, we had no feed mill or molasses evaporators and all plant wastes with the exception of what peel could be handily collected were pumped into a pond close to the plant, which discharged directly into the bay. It was not long before the residents of this area began to complain bitterly about the odors and debris collecting along the shore line. The small creek which emptied this pond near the plant was filled to a depth of five to six feet with rotting peel and pulp. The odor in that area was extremely unpleasant and the situation rapidly became untenable. In fact the problem became so serious that the local courts ruled to close the plant because it was becoming a public health hazard.

The emergency of the situation forced a decision to install facilities for the manufacture of citrus feed and molasses. This was done at a time when the economy of citrus feed manufacture was doubtful. If, however, the operation broke even, it was a very excellent way of eliminating the waste from the plant and also any court trouble. In addition to the feed mill, Mr. Bristow, our research director, developed a very effective method for treating waste waters which could not be economically converted into molasses.

This treatment consisted of passing waste liquors containing sugars over a screen to remove the solids and through a series of aeration tanks. Six tanks each with a capacity of 25,000 gallons afforded approximately a 60 hour lag. With sufficient air being supplied to the bottom of each tank, a satisfactory fermentation or conversion of sugars to nitrogenous material was accomplished. The effluent from the tank was pumped to the bay where fish and shell life fed on the uncontrolled yeast production.

This setup appeared to work very well with the plant set up as it was with two evaporators. Shortly after this the plant was expanded with the addition of three more evaporators which increased the fruit load terrifically. The situation was soon out of hand again.

In 1949 the State Board of Health conducted a series of tests on the effectiveness of this treatment at our plant. They were not nearly as well satisfied with the results of the treatment as we were. A volume of 150 gallons per minute from the aeration tanks with a B.O.D. of 3000-4000 p.p.m. was considered entirely unsatisfactory by this group. This gave a B.O.D. of 2700 for the total plant effluent with a flow of 2500 gallons of water per minute, and at the outfall in the harbor, 1000 to 1500 B.O.D. The figure of 3000-4000 p.p.m. for the outflow from the aeration tanks would rise to 8000 to 10,000 p.p.m. at cleanup time. A large amount of this trouble was due to speed ups in the plant, more fruit processed and more evaporators; all of which reduced the hold up time in the aeration tanks to 10 hours as contrasted to approximately 60 hours when the tanks were installed.

This then was the problem that presented itself to the plant staff in 1949. It was absolutely mandatory to cut down this amount of B.O.D. entering the bay, and it was necessary to reduce this B.O.D. at a reasonable cost to the company.

A plan first considered was to add nutrients and adjust the pH in the aeration tanks and to increase the hold up time so that an effective yeast fermentation could be accomplished. The estimated cost of such a program was absolutely prohibitive so a treatment plant was considered. This too was found to be prohibitive in cost. The only other answer to this problem was to eliminate the waste. With the waste eliminated no treatment would be necessary. This then was the plan decided upon and carried out.

The first step in such a program was a survey of where leakage and waste streams occurred. The following was found:

1. In the fruit receiving bin, split fruit, culls, leakage from conveyors, etc. amounted to 60 gallons an hour;

2. The grinding of culled fruit in conveyors and resultant leaks amounted to 50 gallons an hour;

3. Peel storage bins which were wooden leaked a constant stream of peel juice amounting to 300 gallons an hour;

4. In clean-outs approximately 300 gallons of juice were lost each time the evaporators were cleaned;

5. The filling machine operation was responsible for a loss of about 5 gallons per hour;

6. Due to the lack of capacity of the molasses evaporator an average of approximately 1000 gallons of press liquor per hour had to be dumped into the waste flow;

7. Centrifuged effluent from the peel oil extraction amounted to about 100 gallons per hour;

8. Three to four gallons per hour of peel oil distillate were lost with the condensate water from the molasses evaporators.

The figures obtained from this survey were very impressive. We had no idea of the extent of our losses through negligence which had been accepted as inherent in processing operation. We realized the first step which had to be taken would be to increase the capacity of our molasses evaporators. This was necessary anyway because the old evaporators needed complete retubing and were of too small capacity for the present operation. Therefore, these were replaced by larger capacity evaporators with proper stainless steel tubes and of adequate capacity for all operations at this plant.

The next step was to work on the fruit bins. From the fruit bins all leakage from conveyors, receiving bins, etc. was either stopped or collected. The collected liquor was diverted into the pipes that led into the press liquor tanks in the feed mill. The old pond which was still in use, was by-passed and all solids from the fruit bins, leaves, branches, etc., were removed and disposed of by means of a sanitary fill instead of being allowed to collect in the pond.

A new piping system was installed to carry all the liquid wastes to the press liquor storage tanks. Conveyors and cull screws were repaired or replaced to eliminate leaks. Wooden hoppers for peel storage were replaced with stainless steel ones. Piping manifolds were installed so that all clean-out water from evaporators, tanks, homogenizers, etc., could be pumped directly to press liquor storage tanks.

After the fruit bins were revamped, every process leak was stopped where at all practical. In conjunction with this a general plant educational program was embarked upon emphasiz-

ing the elimination and reporting of leaks in process equipment and also emphasizing the conservation of water.

An in-plant chlorination plant program was adopted–running chlorine to 600 p.p.m. to try to burn up the excess B.O.D. that was in clean-up water, etc. This caused a very bad corrosion problem and was soon abandoned.

Settling tanks were installed in the condensate lines from the molasses evaporators to remove condensed orange oil. This has since become a rather valuable by-product and this step has paid for itself very well. This one step of removing 3 to 4 gallons of peel oil distillate per hour was a major factor in reducing the odor in the bay. In addition to this settling tank other wastes such as paint spray, oil, grease and spent carbides from the shops are either collected separately or in traps provided for such wastes. All sugar-containing wash water was conveyed to the press liquor tanks to go into the molasses manufacture.

There were still some bad features, however. The solids from the juice presses and conveyors still went to the aeration tanks and made B.O.D. Therefore a shaker screen was installed, 24 x 36 mesh, and this stream was diverted through it, all solids being strained out and sent to the feed mill, and the liquid being poured into our effluent line. This one step reduced the B.O.D. in our effluent water a great deal.

Due to this clean-up program we were able to throw away the aeration tanks. If necessary the B.O.D. in our effluent water can be further reduced by chlorination. This is possible without excessive cost due to the low amount of B.O.D. to which the effluent water had been reduced.

**TABLE No. 1**
**Florida State Board of Health**
**Pollution Survey**
**Clinton Foods Inc., Dunedin, Fla.**

| Sampling Station | Date | Time | BOD ppm | Est. Flow | Comments |
|---|---|---|---|---|---|
| Total Plant Effluent before entering Harbor (at garage) | 4/21/53 | 1200-1630 | 60 ppm | | 1st Day of operation following shut-down. |
| | 4/22/53 | 0900-1600 | 126 ppm | 2,500-4,000 g.p.m. | Normal Operation. |
| Fruit Wash Water containing Cl. | 4/21/53 | 1330 | 63 ppm | | Catch sample from under wash bins |
| Fruit Wash Water containing detergent | 4/21/53 | 1630 | 133 ppm | | Catch sample from under wash bins. |
| Composite of Fruit Wash Water, Cl. and detergent | 4/21/53 | 1000-1600 | 66 ppm | | Composite. |
| | 4/22/53 | 1330-1630 | 65 ppm | | Composite. |
| Barometric Condenser Water | 4/22/53 | 1330-1630 | 573 ppm | | 1st Day of operation following shut-down. |
| Shaker-screen effluent | 4/21/53 | 0900-1600 | 728 ppm | 55-75 g.p.m. | Normal Operation. |
| At plant outfall 1200' from shore | 4/22/53 | 1300 | 53 ppm | | In bay, some salt water dilution. |
| 200 yds. downwind S.E. of outfall | 4/22/53 | 1400 | 4.4 ppm | | In bay, seeds, cells, observed. |
| 500 yds. downwind, S.E. of outfall | 4/22/53 | 1430 | 1.7 ppm | | In bay. |

These changes and repairs have been costly. However, we feel they have been justified. We have not stopped at this point but have extended the program as follows. Due to our location we have water problems. Therefore, we are emphasizing water conservation. We intend to use low B.O.D. condenser water to flume our fruit in. This is one of the few plants in operation that uses the fluming system to bring the fruit in from the trucks to the fruit bins. At the present time we re-use all our cooling water by use of a spray pond. The discovery and elimination of new waste streams is also being pushed. However, this looks as if it has reached the point of diminishing returns. This whole program has been very hard to sell to Management. However, a return on the investment involved appeared likely and this has proved itself in increased molasses production, increased utilization of total amount of solids coming into the plant, and the by-product d-Limonene from the feed mill. In effect this program instead of becoming a liability, as a treatment plant would have been, has actually become an asset in improving the income from the plant and in the long run will show a profit.

We have worked very closely with both the County and State Health Departments in eliminating our waste disposal problem. We wish