CHAPTER 4

LITERATURE REVIEW

Wastes from Soft Drink Bottling Industry.

PORGES AND STRUZESKI (1961) reported that most of the waste load came from the continuous rinses of the bottle washing machine. The average values of 5 day BOD was 3.08 lb, Suspended solids 24.1 lb, pH 11.0, total alkalinity 290 mg/l and the volume of 10700 gallons per 100 standard cases.

Sludge Reaeration in the Activated Sludge Process - A Survey.

HASELTINE (1961) reported that the average BOD input should not exceed 50 lb/day/100 lb activated sludge solids under aeration for maximum efficiency and the avoidance of low sludge density indexes. By changing from conventional operation to one of the various sludge reaeration procedures, the capacity of the existing plants increased without loss of efficiency. In some instances, the increase was as much as two - to four - fold which indicated the possibility of effecting substantial savings in the cost of new plants by providing for sludge reaeration. He also reported that sludge reaeration procedures resulted in a higher sludge density index.

Some studies on Aerobic Digestion.

COACKLEY (1955)

carried out a series of experiments to determine the extent of aerobic digestion of sludge previously subjected to anaerobic digestion. In one series, the anaerobically

digested sludge was aerated without inoculation by aerobic organisms. Another series was inoculated with aerobic organisms found in a compost heap. The third series continued the anaerobic digestion of the sludge. The three series were carried on up to 71 days of digestion with temperatures of 18°C and 37°C.

Although Coackley was primarily interested in dewatering characteristics of the sludge, he also observed the reduction of solids and organic nitrogen. At a temperature of 18°C, the reduction of volatile solids after 48 days of digestion was not appreciable, even in the inoculated series. In the 37°C non-inoculated series, the volatile solids were reduced from 2.98 per cent to 1.08 per cent after 47 days, while in the inoculated series, they were reduced from 2.66 per cent to 1.52 per cent. A decrease in organic nitrogen was also noted in the aerobic units which did not occur in the anaerobic series. The aerobic series produced a stable sludge which showed no signs of decomposition when left without aeration. Anaerobic digestion could not be initiated in this series even after the digesters were inoculated with anaerobic organisms.

ECKENFELDER (1956) studied aerobic digestion using waste activated sludge from a conventional activated sludge plant. Four-liter digesters were aerated for a period of 7 days with the temperature maintained at 25°C. At the end of the 7-day period of aeration, his data showed a reduction in C.O.D. of 48.5 per cent, a reduction in suspended volatile solids of 38.2 per cent, and a decrease in volatile solids content from 76.5 per cent

to 63.5 per cent. The soluble nitrogen increased from 46 ppm to 94 ppm in the 7 days of aeration.

MORIARTY (1958) has reported that raw primary sludge can be digested under aerobic conditions and that the digested sludge had no objectionable odor. His data indicated that the decomposition of volatile solids in aerobic digestion was more complete than in anaerobic digestion as shown by the amount of CO_2 produced per gram of solids added to the two digesters.

MURPHY (1959) studied the effects of aeration on the filterability and the settleability of sewage sludges. He used primary and waste-activated sludges, mixed at a ratio of 1:1 by volume, and aerated the sludges for various lengths of time at controlled temperatures. Most of his work was done at 15° C. He concluded that the reduction of volatile solids at 15° C with digestion times up to 6 days was not appreciable.

AKERS (1959) investigated some of the factors that may influence the auto-oxidation (endogenous respiration) rate of biological sludge. Two primary factors were considered in his study:

(1) the effect of auto-oxidation rate on the mean sludge age (pounds of suspended volatile solids in the system divided by the pounds of suspended volatile soilds into the system daily)

(2) the effect of separate aeration (aerobic digestion) of the mixed liquor without additional substrate being added during the aeration period.

In his study the average reduction in volatile solids in

8 days at 23°C was greater than 20 per cent. The corresponding reductions in suspended volatile solids, B.O.D. and C.O.D. were 30 per cent, 60 per cent and 35 per cent, respectively.

His study also indicated that the rate of change of auto-oxidation is considerably less than the rate of change of the sludge age.

WOODLY (1961) has concluded that primary sewage sludge can be destroyed under mesophilic (35°C) or thermophilic (52°C) conditions and that the percentage reduction in volatile solids was higher in the mesophilic than in the thermophilic range. His study indicated that the mesophilic oxidized sludge settled readily and gave a clear supernatant whereas thermophilic oxidation is more efficient in the reduction of ether solubles and in the destruction of nitrogenous material.

BARNHART (1961) studying the application of aerobic digestion to industrial waste concluded that the solids reductions obtained were comparable to anaerobic digestion and that temperatures below 20°C were significantly retardant to aerobic digestion. Fifteen days detention time was sufficient to accomplish accep table digestion in all cases.

JAWORSKI, LAWTON and ROHLICH (1961) described laboratory studies using both batch and continuous feeding systems. With an air flow rate of 23 $l/m^3 s$. COD reductions after 6 days at 20°C were, 50 percent for a sludge with 0.75 percent initial solids and 12 percent for a sludge with 3.06 percent initial solids. It was concluded that aeration periods longer than 15 days gave little

further improvement. There was a greater reduction of volatile solids at higher temperatures. The settling characteristics of sludges digested for less than 30 days were poorer than the undigested samples.

However sludges digested for more than 5 days showed satisfactory drainage and separated liquors had relatively low BOD values compared with those from anaerobic digestion.

KEHR (1966) outlined the operation of full-scale aerobic sludge stabilization plants in Germany and stated that the total oxygen requirement for aerobic sludge stabilization was about 1 m^3/kg volatile solids. Stabilization periods of 5-10 days were quoted and the estimated energy consumption was about 0.30 kWh/kg volatile solids. Aerobic sludge stabilization was stated to be in use for populations of up to 10,000 but no data were given for the composition of the stabilized sludge.

Studies by RANDALL and KOCH (1969) on twelve contact stabilization plants in Texas, which utilized aerobic digestion for the stabilization of waste sludge, indicated that aerobically digested sludges generally had good dewatering characteristics. The sludge supernatants contained large concentrations of inorganic matter but had low BOD values. Thus return of supernatant to the aeration unit did not significantly increase the organic loading but did cause a buildup of minerals which on occasion had toxic effects on the micro-organisms.

REYES and KRUSE (1962) have reported volatile matter reduction of 43.5 % at 27°C and 53.4 % at 35°C after 20 days of aerobic batch digestion of night soil at 3 % total solids. The values at 6 % total solids were found to be 43.4 % and 45.9 % respectively .