II. LITERATURE REVIEW ON FISH CANNERY WASTES

2.1 Fish cannery wastes

2.1.1 Manufacturing Process

Raw fish are brought into the factory and kept frozen at the fish storage area. The thawing ice together with blood run to the floor drain and then to the sump of the factory. After the head and gut of the fish are removed, the deheaded and degutted fish are rinsed in a running rinse bath. The rinse water runs to floor drain and then to the sump of the factory. These fish are then placed in precookers for approximately 1 hour, after which they are removed from the cookers and transported to the cleaning are for further cleaning. The tables and the floor in the cleaning area are generally dry swept and the solid wasted is disposed of separately. The cleaned, cooked fish pass to the cannery line and, after the canning process is completed, cans are washed by continuously running rinsing water, then loaded into retorts. The retort condensate and colling water pass to floor drain and are discharged directly to the sewer at the rear of the factory. Cans are removed from the retort and then packed for transportation. At the end of each day, the processing area as well as the floor drains are washed for a period of approximatly $\frac{1}{2}$ hour.

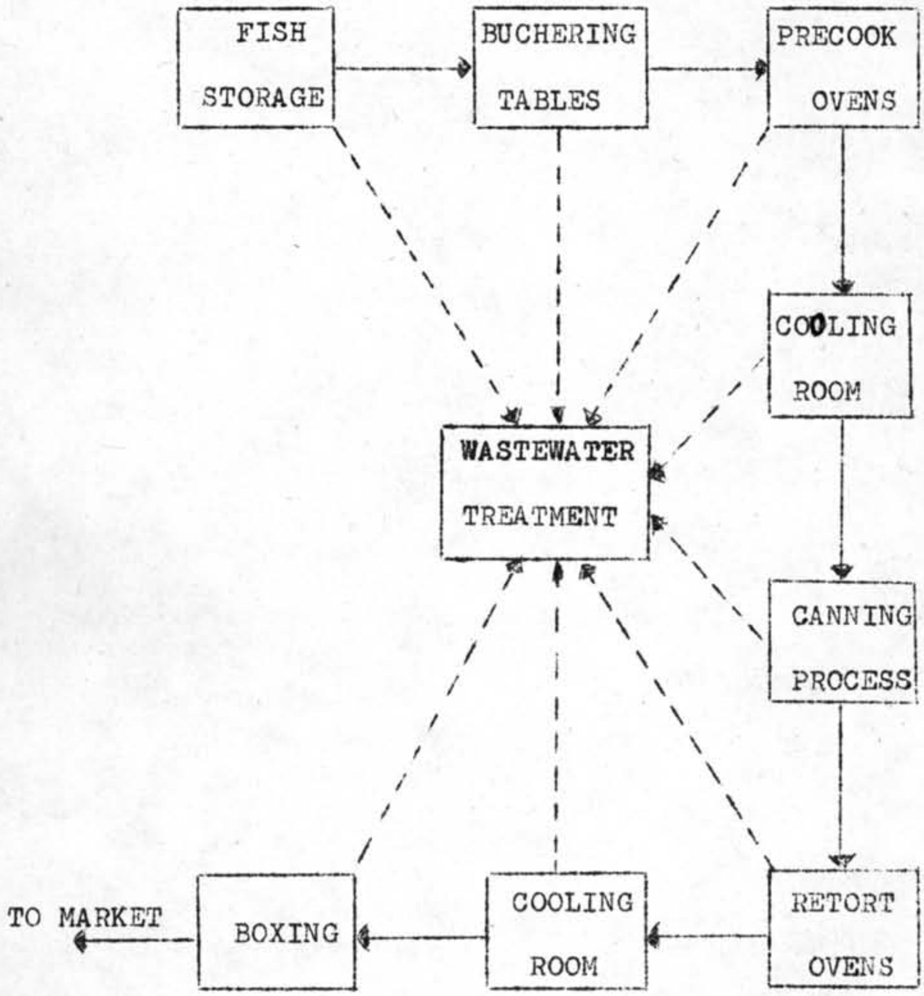

Figure 2.1 FISH CANNING PROCESS AND WASTEWATER GENERATION.

2.1.2 Characteristics of the wastewater

Table 2.1 shows the physical and chemical characteristic of Fish Canning Factory waste from SAFCOL (THAILAND) Fish Canning Factory.

TABLE 2.1

CHARACTERISTICS OF FISH CANNERY WASTE*

BOD	4,400-5,600 mg/l
COD	6,170-8,000 mg/l
Total Nitrogen	642 mg/l
Phosphorus	88 mg/l
Suspended Solids	660-700 mg/l
Total solids	6,500-7,500 mg/l
Chlorides	1,200-1,500 mg/l
Grease & oil	180-220 mg/l

*SAFCOL (THAILAND) CO.LTD. BANGKOK.

Composite Sample

TABLE 2.2[2]

WASTE CHARACTERISTICS FROM TUNA CANNERIES IN AMERICAN SAMOA

	Cannery 1		Cannery II	
	Composite	Washdown	Composite	Washdown
pH	6.56	9.95	6.13	6.18
Suspended Solids mg/l	1765	897	1700	2500
Volatile Suspended Solids, Percent	82	89	88	92
Grease, mg/l	3840	520	7930	13700
Five-Day BOD, mg/l	6200	1250	4100	5960

2.2 Treatment of Fish Canning Wastes

Banhanek investigated the composition of fish-processing waste.[3] Typical average valves were as follows: pH, 8.4; COD, 54,836 mg/l, SS; 20,781 mg/l; total nitrogen, 1,456 mg/l; and fatty substances, 6,169 mg/l. Sedimentation for 2 hr followed by mechanical cleaning reduced the SS concentrations in wastes from all product lines except that producing COD liver oil where a high content of emulsified fat was present.

Claggett and Wong studied screening with both rotary and tangential screens and flocculation for primary treatment of wastes from salmon-canning plants.[3] Two flocculating agents, aluminum hydroxide (Al $(OH)_3$) and F-Flok-98 gave the best results. When the solids were fed to poultry, the results were equal to or better than those obtained with control diets.

According to Liao the filter backwash and raceway cleaning water in salmonid fish hatcheries are similar in pollution potential to domestic wastewater.[3] In unstable stabilization ponds, BOD removals were less than 50 percent and SS removals varied from 40 to 50 percent. When the ponds were stabilized, removals of BOD and SS were in the range of 55 to 70 percent. The BOD removal in an aerated system with a detention time of 10 hr was 80 percent.

Dazai et al. reported that treatment of wastes from fish meat paste processing with an activated sludge acclimatized in the waste for 1 week significantly reduced its BOD.[3] The crude protein and phosphorus contents (expressed as P_2O_5) of the precipitated sludge were 57 and 5 percent, respectively.

Tsuchiya also investigated activated sludge treatment of wastes from fish - and meat-processing plants.[3] A combined aeration and sedimentation. A combined aeration and sedimentation system gave BOD and SS removals of greater than 95 and 90 percent, respectively, at a loading of 0.3 Kg BOD/cu.m/day.

Borchardt and Pohland found in laboratory-scale studieds that two-stage anaerobic digestion could be useded for treating alewife-processing stick liqour alone or in combination with fresh primary domestic wastewater sludge if the volatile solids loading rates did not exceed 0.05 lb/day/cu.ft. (0.8 Kg/day/cu.m) of digester capacity with respective first-or second-stage retention times of 10 to 15 days.[3]

Kato and Ishikawa described a treatment system for recovery of protein and oil from fish processing plant effluents.[3] The recovery operations included flotation, heating, and centrifugation for oil recovery, and coagulation, flotation, and dewatering by filtration for protein recovery.

According to Soderquist et al., Dungeness crab wastewater is characterized by nitrogen and phosphorus contents that are 10 times those of fruit and vegetable processing wastes.[4] The results of a survey showed that brining gave the highest contribution of COD, TSS, SS, total nitrogen, and total phosphorus of any step in the process, followed by cooling operations. The replacement of flumes with dry capture systems, and segregation and separate treatment of brining and cooking waste streams to reduce total waste loads were recommended.

Claggett presented details of the design and operation of a chemical treatment and air flotation system for treating fish processing wastes at Steveston, D.C., Canada.[4] Lignosulfounic acid treatment gave a floc that was fragile and not easily removed, but alum-caustic ($Al_2\ (SO_4)_3$ NaOH) treatment at pH 9.2

gave a suitable floc. Adjustment of pH to 5.2 resulted in a curdy floc that floated readily. The COD, protein, insoluble solids, and soluble solids removals were 84 ± 6, 61 ± 1.7, 92 ± 5, and 28 ± 16 percent, respectively.

In the treatment of fish canning wastes, Shifrin reported that impeller agitation and pressure flotation were effective in removing fat.(4) Under optimum conditions, COD, suspended matter, and fat removals were 45 to 55, 75 to 80, and 95 to 99 percent, respectively.

According to Defalco, odor problems from fish wastes were solved by spray irrigation over a 14-acre (5.67-ha) black and pin oak wooded area having the top foot of soil consisting of loamy sand and vegetative litter. The application rate was 12,000 gpd/acre (112.2 cum/day/ha).(4)

Kawashima et al. reported that filtration of fish processing wastes through activated coal, made by treating low-grade coal with mineral acid and a nonionic surfactant, reduced COD and BOD values 64 and 97 percent, respectively.(4)

Oshima et al. achieved 85 to 95 percent reduction in BOD and COD of fish processing waste by coagulation at pH 5 and flocculation with $FeCl_3$, $CaSO_4$, and polyacrylamide.(4)

Tarkey et al. conducted laboratory scale studies on the revocery of wastes from English sole filleting operations by enzyme hydrolysis using pepsin.(4) A 2:1 fish wastewater mixture was treated with 0.2 percent pepsin and centrifuged at 12,000 gravity for 10 min. The supernatant was heated to 80°C to inactivate the anzyme, neutralized with 30 percent NaOH, filtered, concentrated to 30 percent TS, and sprayedy to yield a fish protein concentrate containing 80 percent protein and 22 percent ash.

Knickle investigated the treatment of fish and shellfish processing wastewater by using filtration, reverse osmosis, adsorption, and chemical precipitation processes.(5) Dilution and chemical precipitation were the most effective and economical treatment methods for wastes from an operating shellfish processing plant.

In a study of wastewater from a fish oil and meal processing plant, Stuiber and Quigley developed a process consisting of heating the effluent to 185 °F (85°C) centrifuging to remove oil, adding 0.1 percent glutaraldehyde at pH 5, and filtering to remove solids.(5) The solids were recycled to a fish kiln, and the filtrate was treated in anaerobic and aerobic lagoons to give final COD and SS values of 250 and 50 mg/l, respectively.

The characteristics of fish processing waste-waters from salting, smoking, canning, and waste processing operations in the U.S.S.R. studied by Pesenon et al. were as follows:

temperature, 19 °C (summer) and 13.5 °C (winter); pH 6.6 to 8.4; COD, 500 to 5,000 gm/l; BOD, 1,600 to 2,000 mg/l; SS, 200 to 2,000 gm/l (87 percent organic materials); and phenols (in wastes from smoking), 50 to 500 mg/l. The most concentrated wastewaters were diluted and disposed.(5)

Riddle and Shinkaze presented a survey of the characteristics and treatment of fish processing effluent in Canada, including wastes from the precessing of groundfish, salmon, herring, shellfish, and fish meal.(5) Treatment methods reviewed included screening with tangential screens dissolved air flotation, and biological treatment. Estimated capital for treatment by fine screening combined with air flotation ranged from $3,000 to $12,000/100 gal./min of flow ($790 to $3,170/100 l/min.) and for lagoons, $48,000 to $240,000/100 gal/min of flow ($12,680 to $60,410/100 l/min.)

Electrochemical coagulation has been applied to fish processing waste treatment by Tamoto et al.(5) Wastes from fish meat and fish organ processing were mixed with $Al_2(SO_4)_3$ or $KBrO_3$, the pH adjusted to 4.5 to 5.5, and the wastes electrolytically treated at 50 V and 8.5 amps for 10 min followed by pH adjustment to 5.5 and the addition of 0.1 percent sodium polyacrylate recover the floc. The BOD and COD reductions were 88.7 and 87.2 percent, respectively.

Chawla described a spray irrigation system for the treatment of perch and smelt processing wastes at Wheatley, Ont, Can., in which the effluent from an aerated lagoon was applied at an optimum rate of 0.25 ft/week/acre (0.0188 m/week/ha) to sandy loam. The percolate contained BOD, COD, and NO_3-N concentrations of 14, 41, and 5 mg/l, respectively, and BOD, COD, and NH_3- N reductions were 96, 94, and 80 percent, respectively.(5)

DeFalco described the correction of an odor problem in a spray irrigation system for treating vegetable and fish processing waste by chlorination of the effluent and raising the soil pH by hydrated lime application to ionize H_2S.(5) The importance of controlling the pH of the final effluent, maintaining aerobic conditions in the soil, avoiding the use of boron-containing detergents, and maintaining a uniform application of waste by using revolving sprinklers was emphasized.

Sakaguchi et al. found that floc formation and sludge bulking in the AS treatment of fish meat processing waste were affected by pH; temperature; oxygen supply; and the presence of high BOD and COD and Spherotilus spp. Bacillus spp., and Escherichia species in the effluent.(5) A sucrose concentration of 0.5 percent in the waste caused bulking, and fish oil concentrations of 0.05 and 0.1 percent inhibited AS treatment.

Imamura described a patented process in which fish waste was adjusted to pH 7 to 8 with alkali, heated to 55° to 60°C, treated with alkali, heated to 55° to 60°C, and treated with proteolytic enzyme for 4 hr followed by pH adjustment to 5.2 and filtration to separate a protein solution and oil from sludge.[5] The protein and oil were separated by dissolved air flotation and centrifugation to give recoveries of protein and oil of 80 and 82 percent, respectively. In a similar process, Sato et al. adjusted the pH of the froth of pollack processing wastewater to 5.0, added sodium polyacrylate, treated the waste with pressurized water, adjusted the pH to 8.5 with NaOH, and then added a protease. After incubation at 50° C for 3 hr, the waste was heated for 20 min and centrifuged to separate the oil and protein.[5]