TREATMENT OF INDUSTRIAL WASTEWATER

POULTRY AUTOMATIC SLAUGHTER HOUSE WASTES

A Thesis Presented

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APPROVAL SHEET

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INTRODUCTION

There is need for an understanding of the industrial processes, water demands, and waste discharges of many smaller types of manufactories. This need will grow as the practice of waste treatment is intensified for protection of available water resources.

The slaughtering and dressing of poultry is one of the smaller industries but nevertheless a very important one. Modern development has been towards centralization of poultry plants.

Poultry are processed in every state. The six states of **Kalubia (33%), Sharkia (20%), Giza (13%), Dakahlia (7%), Minofia (5%) and Esmaillia (2%)** produced approximately 80 percent of all chickens in the **A.R.E.** for the year 1985.

The poultry industry has taken tremendous strides over the last few years processing plants have become larger and more centralized and rely on newer and faster equipment to provide a high degree of automation. Major attention is given to the raising of frozen and broilers poultry, since birds can be fully grown and ready for processing within seven to nine weeks.

In certain areas of the country where poultry processing establishments have concentrated the problem of waste disposal is critical. Even one plant of average size or greater may pose a serious waste problem in a small town. Their huge resultant wastes are discharged into municipal sewerage systems; when available. Dificulties frequently result at the sewage works or treatment plants for their distinguished strength. In other cases, they are directly released to nearby streams. PORGES AND STRUZESKI (1962) reported that untreated poultry wastes have the following pollutional effects upon receiving streams; reduction of available oxygen, deposition of solids, addition of floating matter, and increase of coliform, color and inorganic mineral content.

Acts of 93/1962 and 48/1982 as well as Ministerial Decrees 649/1962 and 8/1983 are amongst other Egyptian regulations specifying the strength and conditions of industrial wastes disposal. Aside from these regulations, the day in and day out reiterated warnings of environmental pollution, have motivated some few Egyptian researcher to deal with such effluents as a challenging problem **EL-KHOULY (1970)**, revealed the characterization and treatability of wastes produced from iron and steel works. **EBIED (1970)** dealt with the characterization and treatability of wastes from onion drying industry. **WASSEL (1984)** revealed the characterization and treatability of dairy wastes.

In spite of the well recognized particular consideration of poultry processing wastes amongst other wastes, no attention has been paid yet to them by any national investigator. What are their chemical and biochemical characteristics defining them? What are the factors affecting on the load and volume of waste? What are the rates of inter-relationships governing and influencing these characteristics with each other? What is the contribution of every major process in poultry to the whole strength? Must they be treated in the factory before release? To any rate will be the suggested treatment (if necessary) effective? All of these enquiries and others are still waiting for replies.

The work reported herein, is a pioneering attempt to answer these above questions. The approach taken was implemented as follows:

PART (I)

This part was assigned to introduce exhaustive analytical data on the evaluation of poultry processing wastes quality. It was divided into two sections. The former, revealed the chemical and biochemical characteristics of these wastes. They included the estimations of total solids, suspended solids, dissolved solids, fixed solids, volatial solids, pH, grease, total nitrogen, total phosphorus, biochemical oxygen demand

and chemical oxygen demand. The second is applied In-process waste control (process upgrading, water use reduction, and waste segregation).

PART (II)

This part was conducted in the light of **Part (I)** obtained results. It concerned with wastes treatment to reduce their strength before departure. The activated sludge method was the base of study underlying the design of a proposed system for wastes cure.

PART I

Characterization of Poultry Processing Wastewaters

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CHARACTERIZATION OF POULTRY PROCESSING WASTEWATERS

LITERATURE REVIEW

PORGES. R. and STRUZESKI. E.J. (1962) reported that poultry establishments without flow-away facilities discharge about 4500 gals of processing water per 1000 birds handled. With reasonable blood recovery BOD and suspended solids values per 1000 birds are approximately 23 lbs and 12 lbs respectively. When all blood is flushed to the sewer, the unit BOD and suspended solids loads increase to 35 lbs and 21 lbs respectively.

The normal ranges in the composition of poultry plant wastes are compiled as (150 to 2400) mg/L BOD_5, (200 to 3200) mg/L COD, (100 to 1500) mg/L suspended solids, (200 to 2000) mg/L dissolved solids, (250 to 2700) mg/L volatile solids, (350 to 3200) mg/L total solids, (1 to 20) mg/L settleable solids, (40 to 350) mg/L total alkalinity, (15 to 300) mg/L total nitrogen, (6.5 to 9) pH.

MORRIS. GROVER L. and ROBERT A. (1965) stated that two duck-processing plants located on long Island were studied to obtain waste load and water use data for comparison with chicken processing data. Weighted average for both plants studied indicate water use of 23.6 gallons and waste loads of 0.0419 pound BOD and 0.0289 pound of suspended solids per duck processed. Similar values for chicken processing are 8 gallons of water, 0.025 pound of BOD, and 0.013 pound of suspended solids per bird. Comparisons between duck and chicken processing of the basis of 1,000 pounds of live birds indicate water usage is 3,600 gallons for duck and 2,300 gallons for chicken; BOD values are 6.4 pounds for duck and 7.18 pounds for chicken ; and suspended solids values are 28.9 pounds for duck and 13 pounds for chicken . Wastewater coliform values were 56,800 per 100 milliliter in plant A and 49,200 per 100 milliliter in plant B.

ECKENFELDER (1966), stated that depending on the nature of the industry and the projected uses of the water of the receiving stream, various waste constituents may have to be removed before discharge. Soluble organics causing depletion of dissolved oxygen. Since most receiving waters requires maintenance of minimum dissolved oxygen the quantity of soluble organics is correspondingly restricted to the capacity of the receiving waters for assimilation.

SMITH, RAYMOND C. (1970), reported that data on processes that contribute to wastewater pollution were obtained from five of the six poultry processing plants in Delaware. BOD, COD, and suspended solids tests were run on samples of wastewater from various locations within the plants. A regression analysis of COD and BOD in poultry processing wastewater indicated a fairly good approximation of BOD values can be estimated from COD values. For the various plants, BOD values averaged between 0.9 and 2.3 lbs/1,000 birds for the scalding operation, between 0.2 and 7.8 lbs/1,000 birds for the dressing operation, 0.4 to 13.4 lbs/1,000 birds for the eviscerating operation, and 0.4 to 4.6 lbs/1,000 birds for the chilling operation. It appears that most poultry processing plants could reduce the volume and strength of their wastewater.

ESKENFELDER and FORD (1970), reported that the chemical oxygen demand (COD) parameter has been used for over a quarter of a century in estimating the organic content of wastewaters. However, correct interpretation of COD values is still a problem and one must understand those variables which affect the COD value of the sample in question. Generally, one would expect the ultimate BOD of a waste-water to approximate the COD. There are many factors which would negate this statement, however, especially when determining the BOD and COD for complex industrial wastes.

R.L. WESLEY, et al (1971). reported that the effluent from poultry processing plants contains the proper bacterial flora. In this plant about 100,000 gallon perday of waste is being handled which contains almost 1200 pounds of BOD.

K.J. PLATT (1971). mentioned that the waste going to the treatment plant would initially amount to about 500,000 Imperial gallons per day, with about 1,900 pounds **BOD** content (455.5 mg.L) and ultimately the plant should be capable of treating 733,000 Imperial gallons per day having a BOD content of about 2,565 pounds (419.6 mg/L).

SUMMERS T.H. (1972). stated that the discharge wastes from poultry processing varies significantly during the production day and clean down times, the total weight of BOD in the effluent is directly proportional to the number of birds processed and the extent to which measures are taken to prevent unnecessary ingress of contaminants, particularly blood recovery is pratised, processing of small poultry can result in an effluent BOD load equivalent to 25 to 30 lbs per thousand birds through the plant, the load increasing with size of bird processed. Poor blood recovery can in crease this amount by at least 40%.

Water used per bird processed varies greatly from one plant to another, and in the proportions of the total usage for process and for cleandown. Thus the average strength of the discharges is largely dependent on the water usage.

At these plants variations of from 2.5 gallons to 12.5 gallons per bird resulted in effluent strengths varing from 850 mg/Litre BOD, to 250 mg/litre. On average values, the processing of small poultry requires of about 7 gallons per bird, this resulting in an effluent having a BOD value of around 450 mg/Litre.

In cases where erisceration is not practised the BOD load produced per bird processed approximates to 70% of that mentioned above but, due to the substantial drop in water usage the strength of the discharge will rise by up to 30%.

The major proportion of the BOD load is derived from soluble and suspended proteinaceous materials and grease the soluble component making the larger contribution.

Wide variations obtain in the quantites of suspended setteable and total solids, grease etc. in effluent from different plants, and at different times of the day at the same plant.

Some indication of the spread of values can be seen from the variations value of BOD from 150 to 2400 mg/L, COD from 200 to 3200 mg/L, suspended solids from 100 to 1500 mg/L, total solids from 350 to 3200 mg/L and total Nitrogen from 15 - 300 mg/L.

WOODARD et al. (1972). evaluated the waste water contents of a poultry products plant as 0.860 mgd (3255.1 m^3/d) in flow, 2850 lb/day (400 mg.L) BOD, 2410 lb/day (336 mg/L) suspended solids, 1640 lb/day (228 mg/L) Grease.

CLISE, J.D. (1974). extensive study was made of poultry processing raw waste characteristics and proportions of wastes generated during processing and plant cleanup a raw waste water characteristics (mean value) 453 mg/L BOD, 863 mg/L COD, 831 mg/L suspended solids, 403 mg/L Grease.

Wastes generated during processing

398 mg/L (5.6 Kg/1000 Kg LWK) BOD_5

. 675 mg/L (9.5 Kg/1000 Kg LWK) Grease

. 1330 mg/L (18.7 Kg/1000 Kg LWK) Total solids

. 740 mg/L (10.4 Kg/1000 Kg LWK) Suspended solids

. 548 mg/L (7.7 Kg/1000 Kg LWK) Dissolved solids

Wastes generated during clean up

64 mg/L [0.9 Kg/1000 Kg LWK] BOD_5

, 71 mg/L [1.0 Kg/1000 Kg LWK] Grease

, 377 mg/L [5.3 Kg/1000 Kg LWK] Total solids

, 135 mg/L [1.9 Kg/1000 Kg LWK] Suspended solids

, 285 mg/L [4.0 Kg/1000 Kg LWK] Dissolved solids.

DART, M.C. [1974] evaluated the waste water contents of a poultry products plants as 1900 mg/L BOD, 350 mg/L suspended solids.

NEMEROW [1978] stated that the total liquid waste from the poultry-dressing process contains varying amounts of blood, feathers, fleshings, fats washings from evisceration, digested and undigested foods, manure, and dirt. The manure from receiving and feeding stations and blood from the killing and sticking operation contribute the largest amount of pollution from the process. The composition of poultry-plant wastes is given as:

3.26 gallon/bird in volume, 26.6 lb/1000 birds

[978.8 mg/L] Total solids, 15.3 lb/1000 birds

[563 mg/L] Suspended solids, 9.4 lb/1000 birds

[236 mg/L] Settleable solids, 1.3 lb/1000 birds

[48 mg/L] Grease, 30.0 lb/1000 birds [1104 mg/L] BOD, 5-day.

STANLEY ASSOC. [1979] evaluated the waste water contents of apoultry processes plants as 750 mg/L BOD, 500 mg/L suspended solids.

SHIH, J.C. and KOZINK, M.B. [1980]. reported that the water samples of the original waste water and concentrate were analyzed of their total solids [TS] 1276 $\pm$ 67 mg/Litre, chemical oxygen demand [COD] 1968 $\pm$ 111 mg/Litre, Ash 104 $\pm$ 18 mg/Litre, Total Kjeldahl nitrogen [TKN] 82 $\pm$ 2 mg/Litre and true protein 492 $\pm$ 17 mg/Litre. Analyses were carried out according to published standard procedures **[American public Health Association, 1975; the Association of Official Agricultrual Chemists, 1965; Lowry et al., 1951].**