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Full Length Research Paper

Treatment efficiency and economic benefit of Zartech poultry slaughter house waste water treatment plant, Ibadan, Nigeria

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The efficiency of the poultry wastewater treatment plant of Zartech Limited, Ibadan, Nigeria, was assessed based on percentage reduction of the various water contaminants while the unit cost of treated water was compared with that supplied through tankers. Wastewater and treated water samples were respectively collected from the points of generation and release after treatment for laboratory analysis for biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), oil and grease, nitrate, phosphate and pH. The values for BOD, COD, TSS, oil and grease, nitrate and phosphate obtained for the wastewater were 1680, 5199, 7125, 1266, 70.0 and 6.8 mg/l, as against 22.8, 15.6, 0, 15.2, 0 and 0 mg/l, respectively, for the treated water. This translates to treatment efficiencies in percentages of 98.7, 99.7, 100.0, 98.8, 100.0 and 100.0 for BOD, COD, TSS, oil and grease, nitrate and phosphate, respectively. The pH of the wastewater was 6.7 as against 7.2 for the treated water. Based on the results obtained, the plant was adjudged efficient for the treatment of poultry wastewater. The cost of treated water was ₦0.18/l compared with ₦0.50/l for that supplied through tankers, resulting in a daily savings of about ₦120,506.95. Further cost reduction can be achieved through adjustment of dozing pumps.

Key words: Pollution, poultry, slaughter house, treatment, wastewater.

INTRODUCTION

The desired qualities of water depend on the purpose for which it is to be used. These water qualities are measured by a number of parameters which include biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), oil and grease, nitrate, phosphate and pH.

The term wastewater (WW), is defined as the spent or used water of a community or industry which contains dissolved and suspended matter, and about 99% of which is liquid while the remaining 1% is solid waste (FAO, 1991). The composition of WW depends on the source of generation (Marka et al., 1987). Poultry slaughter houses produce substantial amounts of WW containing high amounts of biodegradable organic matter, suspended and colloidal matter such as fats, proteins and Cellulose (Caixeta et al., 2002). The WW is generated from various operations such as chicken cutting, scalding, de-feathering, eviscerating, chilling, packaging and plant cleanup. Slaughter house WW has a complex composition and is very harmful to the environment (Polprasert et al., 1992). It has high organic concentration compared to domestic WW. After the initial screening of coarse solids, slaughter house WW is mainly composed of diluted blood, fat, and SS. It may also contain some manure (Masse et al., 2000), while pathogens, including salmonella and shigella bacterial, parasite eggs and anaerobic cysts may also be present. Typical characteristics of slaughter house WW in Ibadan, Nigeria, are detailed in Sangodoyin and Agbawhe (1992).

WW must be treated before it is either discharged onto water courses or open field in order to reduce its potential environmental hazards. Where there is a need for it to be reused, the treatment becomes even more essential. The clean water act prohibits the discharge of toxic pollutants in large amounts into water courses or open lands (Nayef and Al-Mutairi, 2005).

The biological method of treatment involves the use of bio-organisms either in the presence (aerobic) or other-

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wise (anaerobic) of oxygen to reduce the pathogenic loads. The chemical method involves the use of chemicals in different forms and means in the treatment of the WW. The choice of an appropriate biological treatment system is influenced by a number of factors, including WW load and the need to minimize odors. The removal efficiencies of the various WW components depend on the method used and amounts of SS that can be removed in the primary treatment phase. Sand filtration system has been reported to achieve over 95% removal of BOD and COD (Kang et al., 2003). Al-Mutairi et al. (2004) investigated the use of the coagulation/flocculation process to remove organic matter from slaughter house WW by adding aluminum salts and polymer compounds. The COD removal efficiency was reported to be in the range of 45-75%.

The objective of the work reported here was undertaken to assess the efficiency of the Zartech Limited, Ibadan, Nigeria, poultry WW treatment plant on the basis of percentage reduction of the various water contaminants, and to compare the cost of treated water with that supplied through water tankers.

MATERIALS AND METHODS

Study location and treatment plant

Zartech Limited, which WW - treatment plant was used for this study is one of the leading agricultural establishments in Southwestern Nigeria. The headquarters is located in Ibadan, while other farms owned by the establishment are located in various parts of Nigeria. Its primary activities are animal and plant production especially poultry, fisheries, livestock, horticulture and animal feeds. The poultry slaughter house plant located in Ibadan, has a design capacity of 24,000 chickens per day and produces approximately 0.38 ML of WW daily.

A schematic diagram of the WW - treatment plant (Figure 1) indicates the following components: screens, flow equalization tanks, skimming spades, chemical dosing systems, sedimentation tanks, carbon filter, sand filters, bag filters, and UV - light. The treatment process consists of about nine stages the sequence of which is as follows:

Screening

Screens are placed at the WW - outlet and at various points along the water channel to remove the SS which include feathers, some intestinal content, some fats, oils and grease from the WW.

Skimming

This is done with the use of long spades to remove fat and grease that may still be present at the free surface of the WW.

Primary clarification

This involves separation of the sludge from the inflowing liquid.

Chemical coagulation

The addition of aluminum sulphate: This precipitates the organic materials from the WW stream. Flow equalization tanks equipped with mechanical agitators and chemical dosing pumps are used at this stage.

Chlorination

Disinfection of the water stream so that bacteria and other pathogens are eliminated.

Neutralization

Correction of treated water pH by the injection of milk lime or citric acid depending on the resulting pH of water.

Sedimentation

Four sedimentation tanks connected in series are used to remove settled material. The sludge is then driven to an outlet where it is removed using scrapers.

Carbon, sand and bag filtration

These are used to control odors, remove nutrients such as phosphorus, sulphide, SS, remaining BOD as well as pathogens.

UV light purification

The final treatment stage after which the treated water (TW) is transferred to storage tanks or for immediate reuse. It is done to kill resistant bacteria and pathogens.

Sampling and analysis

The distance between the point of discharge of the WW from the slaughter house and its entry to the treatment plant is about 700 m. WW samples were collected at three points along the flow line. Operation shift takes place at 2.00 pm during which the plant is washed and the water in the chiller is changed. In order to ensure that the WW tested was devoid of any wash water which might dilute the level of contamination, the WW samples were collected between 11.00 am and 12.30 pm daily for five consecutive slaughtering days using 50 ml round bottom flasks. The detention time within the treatment plant is about 8 hours and in order to ensure that the treated sample obtained was a product of the WW from which samples were collected, TW samples were collected between 7.00 and 9.00 pm on same days that the WW samples were collected.

The samples were taken to the Zartech Water laboratory for analysis. Tests were carried out for BOD, COD, TSS, Oil and grease, Nitrate, Phosphate and Hydrogen potential for both the WW and TW samples. Experimental procedures were in accordance with the Standard Methods for the Examination of Water and Wastewater (APHA, 1995).

RESULTS AND DISCUSSION

Plant efficiency

The mean values of the results obtained from the laboratory analysis for the raw WW and TW are presented in Table 1. The efficiency of the plant in removing each of the contaminants is also indicated. The treatment pro-

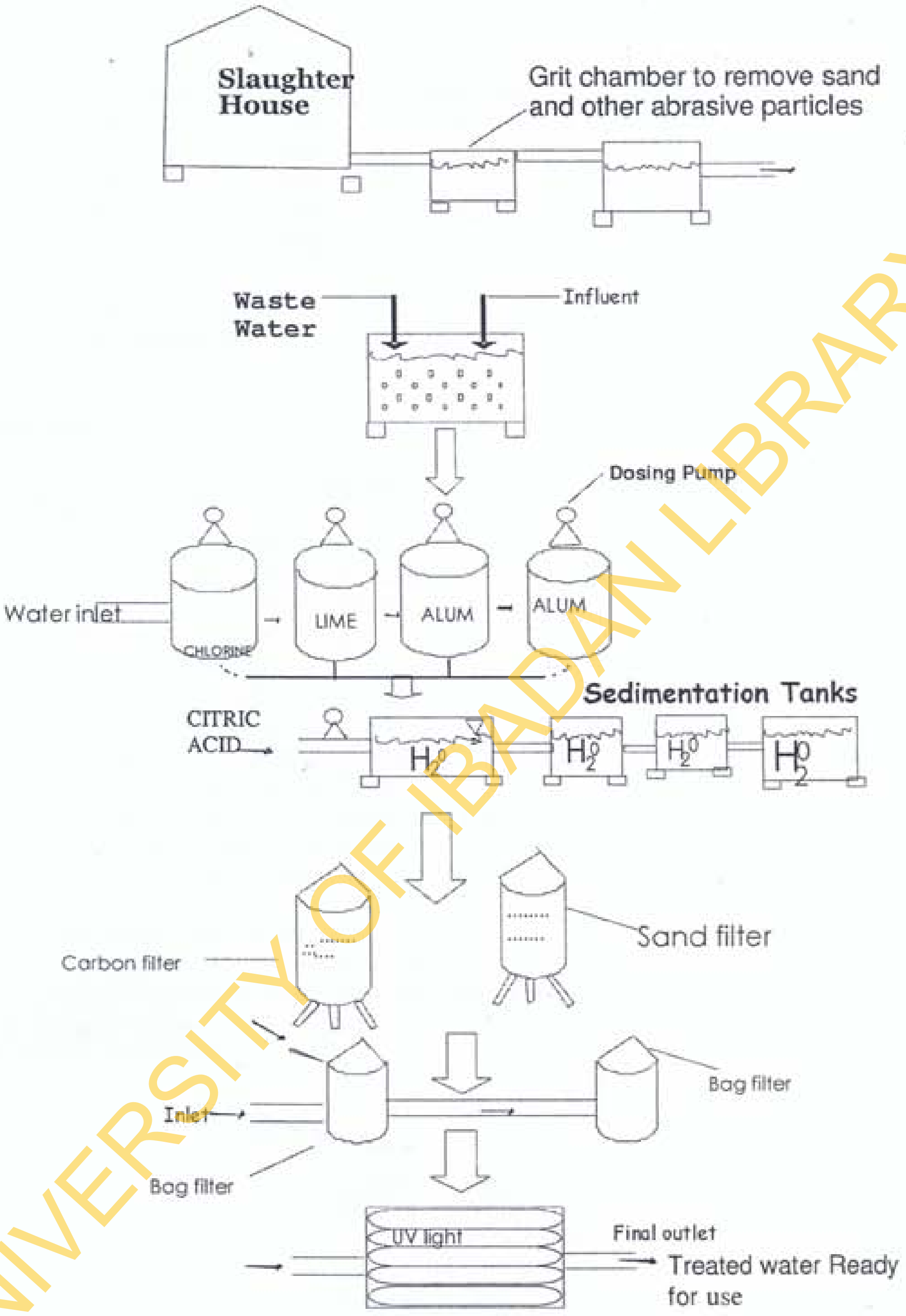

Figure 1. Wastewater treatment operations.

cess completely removed the SS, nitrate and phosphate in the WW while for the BOD, COD and the oil and grease, removal were constantly above 95%. A pH value of 7.2 was obtained for the TW sample as against a value of 6.7 for the untreated WW sample. The implication of this is that the slightly acidic WW has achieved a near neutral value following treatment thus enabling its discharge into nearest watercourse without serious disturbance or impact on the environment. The physical examination of the TW indicated that it was colourless but with a mild taste and odour associated with overdose of chlorine. Relatively high level of chlorine makes the water

Table 1. Treatment efficiency of the Zartech Limited wastewater treatment plant*.

Parameter	Wastewater	Treated water	Treatment efficiency
BOD	1680	22.8	98.7
COD	5199	15.6	99.7
TSS	7125	-	100.0
Oil/Grease	1266	15.2	98.8
Nitrate	70.0	-	100.0
Phosphate	6.8	-	100.0
pH	6.7	7.2	-

*All values expressed in mg/l except pH.

Table 2. Running cost of the Zartech Limited WasteWater Treatment Plant*.

S/N	Description	Cost in Naira (₦)
1	Labour	
	a) Monthly salary of one Biochemist	29,650.00
	b) Monthly salary of one Chemical Engineer	32,866.00
	c) Monthly salaries of three Technicians @ N18,600.00	55,800.00
	d) Monthly salary of one Plumber	14,860.00
		133,176.00
2	Chemical and Test kits	
	a) Chlorine: 42.75kg/day @ N400.00/kg	17,100.00
	b) Hydrated lime: 47.5kg/day @ N65.00/kg	3,087.50
	c) Alum: 31.35kg/day @ N65.00/kg	2,037.75
	d) Sodium Thiosulphate : 11.4kg/day @ N3,000.00/kg	34,200.00
	e) Citric Acid : 1.66kg/day @ 250/kg	415.00
	f) Chlorine Test kit (Cost/day)	2,080.00
		58,920.25
3	Daily cost of fuel for generator	3,680.00
4	Cost of annual plant maintenance including dredging of reservoirs, pipe maintenance and pump repair and maintenance	56,300.00

*At an average of 240 working days per annum, the running cost of the plant treating 0.38 ML of waste water is about ₦69,493.63/day.

unsuitable for live vaccine administration to poultry birds as it renders the vaccine inefficient.

Cost implication

Saving in the cost of water supply is a major consideration for in-house treatment and reuse of WW. It was therefore considered necessary to compare the unit cost of TW with the cost of procurement through water tankers from sources such as the Eleyele Dam which is about 20 km away from the poultry slaughter house, being the nearest guaranteed source of water. The commercial and accounts departments provided relevant data for the preparation of Table 2. From Table 2, the unit cost of TW was ₦0.18/litre compared to ₦0.50/litre for water purchased. With the use of TW, the daily water requirement of the slaughter house was provided at a cost of ₦69,493.63 which would have risen to ₦190,000.00 if supplied through tankers. By the use of the plant, there was a daily savings of ₦120,506.37. The choice of in-house treatment and water reuse is therefore justified. By adopting a number of measures, it is possible to further reduce the cost of running the treatment plant. For example, the use of appropriate amount of chlorine will eliminate overdosing and reduce the amount expended on this chemical.

Conclusion and Recommendations

The poultry slaughter house WW treatment showed over 90% removal of BOD, COD, TSS, Oil grease, Nitrate and Phosphate. The pH was changed from acidic to neutral value. These high efficiency values are indicators of a satisfactory performance of the treatment plant. The cost of TW was ₦0.18/litre compared with ₦0.50/litre for purchased water. This cost of water treatment can further be reduced and the plant efficiency improved upon by adopting the following measures:

a) Reducing the chlorine used through dosage monitoring which can be achieved through regular adjustment of the dosing pumps to supply the amount of chlorine that is just enough for the organic load of the wastewater. A preliminary laboratory study to establish the level of overdosing should be carried out.
b) Reducing the liquid waste load by preventing all solid wastes and all concentrated liquids from entering the wastewater stream.
c) Equip the wastewater outlet channels with screens and fat traps to recover and reduce the concentration of coarse material and fat in the combined WW stream.

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