Design and Laboratory modelling of Waste Stabilization Pond for Abattoir Wastewater Treatment.

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ABSTRACT

The discharge of untreated abattoir wastewater into water bodies results into water quality deterioration of the receiving water bodies. Treatment of abattoir waste using waste stabilization pond is one of such potential cheap and simplest methods of wastewater treatment. A field scale prototype pond which comprises of one anaerobic, facultative and maturation ponds were designed for wastewater treatment. The field scale prototype of waste stabilization pond was reduced to a laboratory-scale model using dimensional analysis. The abattoir wastewater was generated from kwata slaughterhouse and was fed from the equalization tank to the WSP. The results of physio-chemical and microbial parameter conducted show that a laboratory scale model of WSP reduced chemical oxygen demand, nitrate, total solids. total dissolved solids, total suspended solids, phosphate, total and fecal coliform to 10mg/l, 4.93mg/l, 250mg/l, 180mg/l, 70mg/l, 3.95mg/l, 4.04 cfu and 3.98cfu. respectively, the effluents are within the world health organization standard for effluent discharge. This research work is aim at modelling and fabricating a laboratory scale waste stabilization pond model which comprises of anaerobic, facultative and maturation pond, all in series for treatment of abattoir wastewater

KEYWORDS: Abattoir wastewater, Anaerobic pond, Facultative pond, Maturation pond.

1. INTRODUCTION

Abattoir wastewater are considered very harmful due to they are composed of Proteins, fats, high organic contents, pathogens. (Bustilo-Lecompte and Mehrvar, 2017). Abattoir effluent is characterized by the presence of high concentration of slaughtered animal's blood and high suspended solids from rumen and stomach content, undigested food, feathers, flesh pieces and pieces of bone making it very strong (Sunder and Satyanarayan, 2013). The discharge of raw abattoir wastewater to water bodies affects the quality of water particularly by causing a reduction of dissolved oxygen (DO), which may lead to the death of aquatic life (Bustilo-Lecompte and Mehrvar, 2017). The macronutrients, such as nitrogen and phosphorus nutrients might trigger an excessive algae growth and subsequent decay, thereby causing eutrophication when discharge directly to the water bodies without any form of treatment (Irshad et al, 2015). The mineralization of the algae may lead to the deterioration of aquatic life due to depletion of DO levels (Irshad et al, 2015). The numerous waste and microbial organisms obtained during abattoir operations pose a significant challenge to the effective environmental management and are also associated with decreased quality of life of human population residing close to these abattoirs (Abdullahi *et al.*, 2015; Dohare and Kowale, 2014). Because of the possible pollution of the environment, the efficient disposal of abattoir wastewater is of very important. To prevent degradation of the receiving environment, wastewater needs to be treated (Abrha and Tenalem, 2015).

Treatment of wastewater comprise the process and technology that is used to remove most of the contaminates that are found in wastewater and these play a vital role on human health (Amoatay and Bani, 2011; Sayad *et al*., 2012). Treatment of abattoir wastewater, before reuse is most important to avoid the excess load of contaminants such as solids, organic matter, nutrients and pathogens (Tjandraatmadja *et al.*,

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2012). The need to treat this wastewater for possible recycling is of paramount importance in providing healthy environment and eliminating the odor posed by this waste, in addition to its unaesthetic presentation (Lagasi *et al*., 2014). There are very different methods for wastewater treatment that mainly classify into two categories: conventional methods, and natural processes. Conventional treatment systems are including trickling filters, activated sludge, rotating biological contactors (RBC), and aeration lagoons (Al-Hashimi *et al.*, 2013). Developing countries prefer alternative systems that don't burden a remarkable cost, and provide an effective, reliable and sustainable way of treating wastewater. One of these alternatives can be waste stabilization ponds (WSPs).

Waste stabilization ponds are biological treatment systems, whose process and operations are highly dependent on the environmental conditions such as temperature, wind speeds and light intensity. They are simple earthen basins in which wastewater is treated by the removal of particulate matter and biological degradation of settled solids. Waste stabilization ponds rely on lengthy retention times and environmental factors (wind, solar, radiation) for treatment efficiency. Waste stabilization ponds (WSPs) are usually the most appropriate method of domestic and municipal wastewater treatment in tropical countries, where the climate is most favourable for their operation. WSPs are low-cost (usually least-cost), low-maintenance, highly efficient, entirely natural and highly sustainable. The only energy used is direct solar energy, not needing any electromechanical equipment, saving expenditure on electricity and more skilled operation. Anaerobic treatment is particularly well suited for high strength wastewater (Dehghani *et al*., 2014).

Various forms of wastewater treatment methods exist in Nigeria, however most of the research work have limited results on treatment of abattoir wastewater using waste stabilization pond Mohammed (2006), Sadegh *et al*., (2014), This research work is aim at modelling and fabricating a laboratory scale waste stabilization pond model which comprises of anaerobic, facultative and maturation pond, all in series for treatment of abattoir wastewater

2. MATERIALS AND METHOD.

2.1 Total BOD influent concentration (Li):

The total BOD concentration was calculated from the equation given by (Mara 1987;2001;2004), using Equation. (1).

$$Li = \frac{B}{Q} = \frac{2240.07}{3731.6} = 600.30mg/l \quad (1)$$

2.1.1 Design of anaerobic pond

An anaerobic pond was designed on the basis of the permissible volumetric organic loading λv which is related to (Q), influent BOD_5 (L_I) and pond volume (V). The volume of the anaerobic ponds (Va) in m^3 was computed by using the formula of Mara and Pearson (1986) and Hamzeh and Ponce (2007) expressed in Equation. (2).

$$\lambda V = \frac{L_i Q}{V_a} \quad (2)$$

Where V_a = Volume of Anaerobic pond

L_i = Influent BOD, Q = Wastewater flow rate, λv = Volumetric loading.

Substituting all the obtained values in Equation (2).

$$\frac{600.30\ x\ 3731.6}{350} = 6400.28m^2$$

The length (L), breadth (B) ration of Anaerobic pond is 3:1 (Egwuonwu *et al*., 2014; Mohammed 2006).

Area of the pond = $3B^2$ (3)

$914.32 = 3B^2$

B = 17.45 m, L = 3B = 52.35 m

Therefore, the dimension of the pond is Length(L) = 52.35 m, Breadth(B) = 17.45 m and Depth = 5 m.

2.1.2 Design of Facultative Pond

This pond was designed by considering the maximum BOD load per unit area at which the pond will still have a substantial aerobic zone. This is because biological activities are dependent on the temperature. Arthur (1983) used Equation (4) for hot climate which has been adopted in this design as

$$\lambda s = 20T - 80 \quad (4)$$

Putting the value of T as 30 °C we have

$\lambda s = 20(30) - 80 = 520$ kg/ha/day.

$L_i = 0.20 \times 600.30 = 120.07$ mg/l for minimum retention time.

The mid-depth area of the facultative ponds (A_f) in m^3 has been calculated by using Equation (5). (Mara and Pearson, 1987 and Mara, 2004).

$$A_F = \frac{(10\ X\ L_i Q)}{\lambda_S} \quad (5)$$

Where A_F = Area of facultative pond.

L_i = Influent BOD to facultative pond.

Q = Wastewater flow rate

λs = Surface BOD loading.

Substituting the values in equation (5).

$$\frac{10x120.07x3731.6}{520} = 8616.41\ m^2$$

Assuming that the mid-depth $d_f = 1.5$, then the volume of facultative pond.

$V_f = 8616 \times 1.5 = 12{,}924\ m^3$

The length (L) and breadth (B) of a facultative pond is usually 3:1 (Egwuonwu *et al*, 2014; Mohammed, 2006).

Area of the pond = 8616.41

$3X^2 = 8616.41$

X = 53.59 m

L = 3X =160.78 m

Length (L) = 160.78 m, Breadth (B) = 53.59 m and Depth (d) = 1.5 m (3:1).

2.1.3 Design of maturation pond

The main function of a maturation pond is to reduce the number of excreted pathogenic principally fecal, bacteria, and viruses, present in the effluent of facultative ponds to a level suitable for agricultural and for aqua-cultural reuse (Mara 2003). The number of faecal coliform bacteria per 100ml of the effluent can be calculated using equation (6)

$$B_e = \frac{B_i}{(1 + KB(T)t^*)} \tag{6}$$

Where B_i = Bacterial Concentration in no of FC 100ml of effluent.

t^* = Detention time.

KB(T) = First order FC removal rate constant in T °C/day and was computed in Equation (7)

$$KB(T) = 2.6(1.19)^{T-20} \tag{7}$$

Putting the value of T, in equation (7), the first order FC removal rate constant KB(T) is given as $KB(T) = 2.6(1.19)^{30-20} = 14.81d^{-1}$

The number of fecal coliform per 100ml can be calculated for the effluent from each pond in the series with equation (8). Also, the total number of faecal coliform in the effluent from the last pond of the series can be found from the Equation (8).

$$B_e = \frac{B_i}{\left(1 + K_{B(T)}t^*a\right)\left(1 + K_{B(T)}t^*f\right)\left(1 + K_{B(T)}t^*m\right)^n} \tag{8}$$

Where

t^*a, t^*f, and t^*m are the detention times of the anaerobic, facultative and maturation ponds respectively and n is the number of maturation units in the series.

Assuming a minimum of 5 days' retention time

t^*m = 5 days.

then the bacterial concentration in number of FC/100 ml of effluent can be calculated using Equation (9).

$$B_e = \frac{1x10^8}{(1 + 14.81x5)(1 + 14.81x5)(1 + 14.81x5)^1} \quad = 236.56FC/100ml$$

The value of B_e = 236.56FC/100ml signifies that the abattoir wastewater generated at Kwata slaughterhouse can be treated with one anaerobic pond, one facultative pond and one maturation and the effluent can be safely discharge into the environment (based on FEPA standard at 400fc/100ml).

Volume of the pond $V_m = Q \times t^{*}m$

$3731.6 \times 5 = 18658\ m^3$

Assuming depth of pond = 1.2 m

Area of maturation pond $= \frac{V_m}{d} = \frac{18658}{1.2} = 15{,}548.33m^3$

Length to width ratio =3:1

Area of the pond = $3X^2$ =15,548 m^3.

X = 71.99 m

3X = 215.97 m

The dimension of a pond is length (L) = 215.97 m, Width (B) = 71.99 m and depth (d)=1.2 m (3:1).

Probable cumulative BOD removal at higher temperature is 96% after maturation ponds, therefore effluent BOD

L_e = 4% of 600.30mg/l

L_e = 24.01mg/l which is lower than the required limit of 30mg/l.

For the best practice's scenario, it is the usual practices to have a parallel duplicate for the purpose of maintenance. The full-scale pond prototype that the anaerobic pond model represents is 52.35 m length, 17.45 m width, and 5 m depth with an estimated volume of 4567.54 m^3. The full scale prototype dimension of the facultative pond is 160.78 m length, 53.59 m width, 1.5 m depth with an estimated volume of 12,924 m^3 while the full prototype dimensions of maturation pond is 215.97 m length, 71.99 m width, and 1.2 m depth with an estimated volume of 18657 m^3. Table 1 shows the summary of the prototype ponds directions.

Table 1: Dimension of waste stabilization pond (prototype)

Description	Anaerobic pond	Facultative pond	Maturation pond
Volume (m^3)	4567.54	12924	18657
Area (m^2)	913.5	8616.2	15548
Length (m)	52.35	160.78	215.97
Width (m)	17.45	53.59	71.99
Depth, actual (m)	5	1.5	1.2
Depth + freeboard (m)	8	2.5	2

2.2 Design of the Laboratory-scale Plant Layout

In order to know the performance of the hydraulic structure before actually constructing or manufacturing them, their models are made and tested to get the required information. The experimental design of scale models requires applications of the principles of similarity and dimensional analysis if they are to yield meaningful results that are representative of full-scale systems (Shilton and Bailey, 2006). The model is the small scale replica of the actual structure while the prototype is the actual structure. Although it is recognized that the choice of scaling criteria is debatable, it was decided to design the laboratory model of the ponds based on Froude number. The existence of Froude number (Fr) similarity between the model and prototype ponds for WSPs has been used successfully by Shilton and Bailey (2006). The daily flows of wastewater and dimensions in/of the model were computed using dimensional analysis and Froude number method which was successfully used by (Egwuonwu *et al*., 2014 and Mohammed, 2006). The reactor length to width ratio adopted was understood to be cost effective and also for the purpose of arrangement in the available space in the laboratory. Length to width ratio for all the ponds was taken as 3:1 (|Mohammed 2006).

By equating Froude number F_r as expressed by Equation (9).

$$F_{rm} = F_{rp} \tag{9}$$

Where the subscripts m and p are models and prototype respectively

Equation (10) to (11) established the similarity using Froude number

$$F_r = {}^{V}\!\Big/\!\sqrt{Lg} \tag{10}$$

Where v = flow velocity, L = length, g = acceleration due to gravity.

$$\left[\frac{V}{\sqrt{Lg}}\right]_m = \left[\frac{V}{\sqrt{Lg}}\right]_p \tag{11}$$

Since g is constant

$$\frac{vm}{vp} = \left[\sqrt{\frac{Lm}{Lp}}\right] \tag{12}$$

Area – Length-scale ratio is given by:

$$\frac{Am}{Ap} = \left[\frac{Lm}{Lp}\right]^2 \tag{13}$$

Length – scale ratio is given by:

$$\frac{Am}{Ap} = \left[\frac{Lm}{Lp}\right] \tag{14}$$

Where Am, Lm, Bm = Area, length and breadth of model pond respectively and Ap, Lp, Bp = Area, Length and breadth of prototype pond respectively.

2.2.1 Modeling of Anaerobic Laboratory- scale pond

Assuming a length to width ratio of 3:1 as expressed above the dimension of the prototype pond becomes: Length =52.35 m; Width = 17.45 m and Depth = 5.0 m, using Equation (13 and 14)

$$\frac{Am}{Ap} = \left[\frac{1}{70}\right]^2 = \qquad A_m = A_p \left[\frac{1}{70}\right]^2 = 913.5\, x \left[\frac{1}{70}\right]^2$$

$A_m = 0.19\ m^2$ (Area of the model for Anaerobic pond.)

$$\frac{Lm}{Lp} = \left[\frac{1}{70}\right] = \qquad L_m = L_p \left[\frac{1}{70}\right] = 52.35\, x \left[\frac{1}{70}\right]$$

$L_m = 0.75$ m (Length of the model for Anaerobic pond.)

$$\frac{Bm}{Bp} = \left[\frac{1}{70}\right] = B_m = B_p \left[\frac{1}{70}\right] = 17.45\, x \left[\frac{1}{70}\right]$$

$B_m = 0.25$ m (Breadth of the model for Anaerobic pond)

$$\frac{Hm}{Hp} = \left[\frac{1}{6}\right] = H_m = H_p \left[\frac{1}{6}\right] = 5\, x \left[\frac{1}{6}\right]$$

$H_m = 0.83$ m (Height of the model for Anaerobic pond.)

2.2.2 Modeling of the Facultative Laboratory-Scale Pond

Assuming a length to width ratio of 3:1 as expressed above the dimensions of the prototype pond becomes Length = 160.78 m; Width = 53.59 m; and Depth = 1.5 m, Equation (13) and (14) was substituted

$$\frac{Am}{Ap} = \left[\frac{1}{155}\right]^2 = A_m = A_p \left[\frac{1}{155}\right]^2 = 8616.20\, x \left[\frac{1}{155}\right]^2$$

$A_m = 0.35\ m^2$ (Area of the model for Facultative pond.)

$$\frac{Lm}{Lp} = \left[\frac{1}{155}\right] = L_m = L_p \left[\frac{1}{155}\right] = 160.78\, x \left[\frac{1}{155}\right]$$

$L_m = 1.03$ m (Length of the model for Facultative pond.)

$$\frac{B_m}{B_p} = \left[\frac{1}{155}\right] = B_m = B_p \left[\frac{1}{155}\right] = 53.59\, X\, \frac{1}{155}$$

$B_m = 0.34$ m (Breadth of the model for Facultative pond.)

$$\frac{Hm}{Hp} = \left[\frac{1}{6}\right] = \qquad H_m = H_p \left[\frac{1}{6}\right] = 1.5\, x \left[\frac{1}{6}\right]$$

H_m = 0.25 m (Height of the model for Facultative pond.)

2.2.3 Modeling of the Maturation Laboratory- scale Pond

Assuming a length to width ratio of 3:1 as expressed above the dimension of the prototype pond becomes: Length = 215.97 m; Width = 71.99 m and Depth = 1.2 m, Substituting Equation (13) and (14)

$$\frac{Am}{Ap} = \left[\frac{1}{210}\right]^2 \quad = \quad A_p \left[\frac{1}{210}\right]^2 = 15548.33\ x \left[\frac{1}{210}\right]^2$$

A_m = 0.35 m^2 (Area of the model for Maturation pond.)

$$\frac{Lm}{Lp} = \left[\frac{1}{210}\right] \quad = \quad L_m = L_p \left[\frac{1}{210}\right] \quad = 215.97\ x \left[\frac{1}{210}\right]$$

L_m = 1.02 m (Length of the model for Maturation pond.)

$$\frac{Bm}{Bp} = \left[\frac{1}{210}\right] \quad = \quad B_m = B_p \left[\frac{1}{210}\right] = 71.99\ x \left[\frac{1}{210}\right]$$

B_m = 0.34 m (Breadth of the model for Maturation pond.)

$$\frac{Hm}{Hp} = \left[\frac{1}{6}\right] \quad = \quad H_m = H_p \left[\frac{1}{6}\right] = 1.2\ x \left[\frac{1}{6}\right]$$

H_m = 0.20 m (Height of the model for Maturation pond.).

There are three ponds in series namely anaerobic, facultative and maturation pond. Table 2, shows result obtained after scaling down the waste stabilization pond prototype in Table 1.

Table 2: Dimensions of Laboratory Scale Models of Waste Stabilization Pond.

Description	Anaerobic pond	Facultative pond	Maturation pond
Volume (m^3)	0.16	0.09	0.07
Area (m^2)	0.19	0.35	0.35
Length (m)	0.75	1.03	1.02
Width (m)	0.25	0.34	0.34
Depth, actual (m)	0.83	0.25	0.2
Depth + freeboard (m)	0.88	0.3	0.22

The dimensions of anaerobic pond models constructed are 0.75 m length, 0.25 m width, and 0.83 m depth with an estimated volume of 0.16 m^3. The dimensions of the facultative pond models are 1.03 m length, 0.34 m width, 0.25 m depth with an estimated volume of 0.09 m^3 while dimensions of maturation pond models are 1.02 m length, 0.34 m width, and 0.20 m depth with an estimated volume of 0.07 m^3. Anaerobic pond has a freeboard of 50 mm to allow a total water volume of 0.165 m^3, facultative pond has a freeboard of 50 mm to allow for a total water volume of 0.105m^3, while maturation pond has freeboard of 20 mm giving a total pond volume of 0.076 m^3.

2.3 Wastewater Generation:

The sample was collected from Kwata slaughter site located at Awka, Anambra state Nigeria. Awka is the capital of Anambra State, Nigeria. It has an estimated population of 301,657 as of 2006 Nigerian census, according Nigerian Bureau of Statics (NBS) and shares the latitude of 6.07^0N and 6.17^0N and longitude of 7.00^0E and 7.10^0E. The city is located about 500km east of Lagos in the center of the densely populated Igbo heartland in southeastern Nigeria.

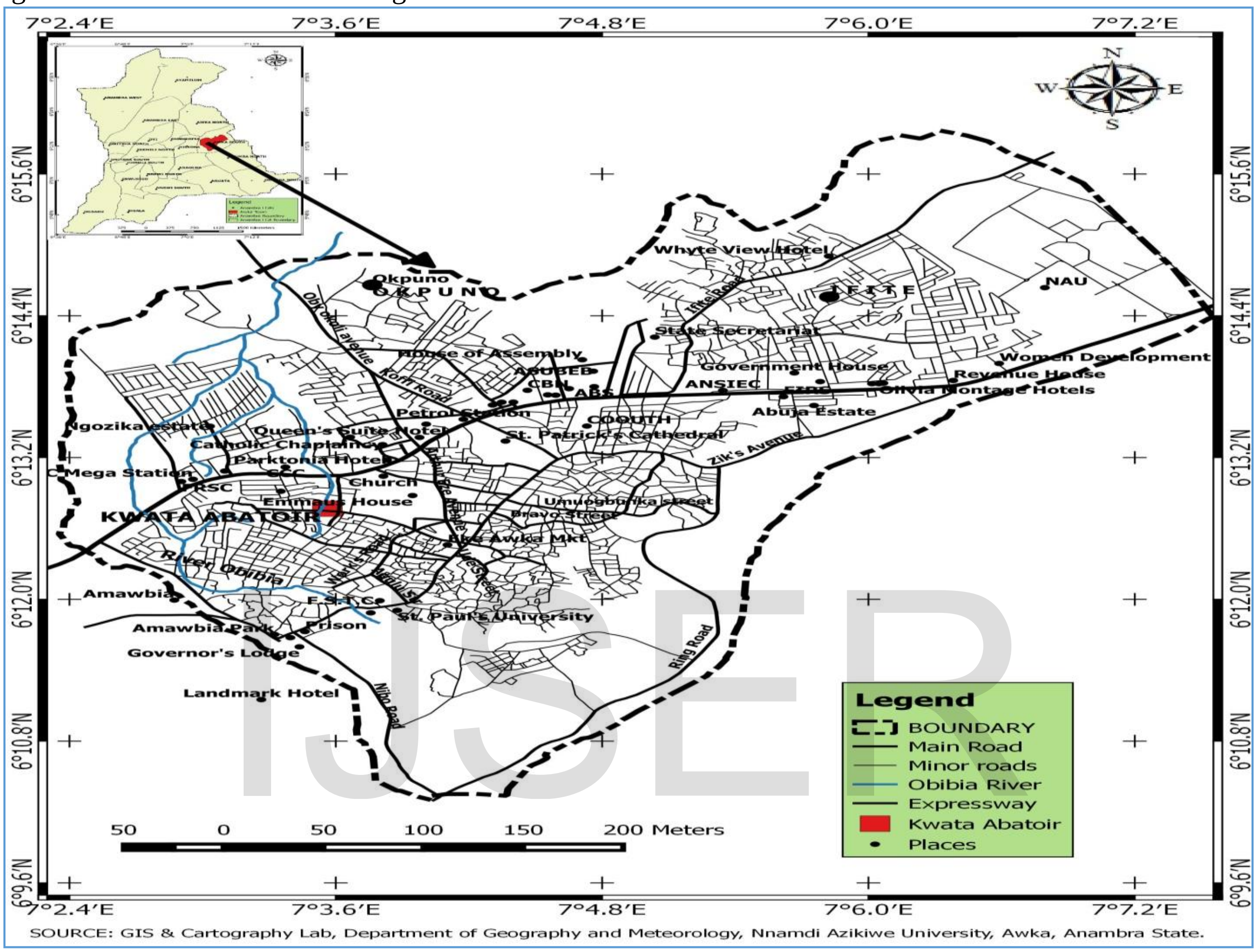

Fig. 1: Map of Awka

The Waste stabilization ponds were arranged serially in the Civil Engineering Departmental Workshop, with equalization tank designed to provide consistent influent flow to anaerobic pond by retaining high flow fluctuations, prevention of wastewater been septic and also maintain solids in suspension, positioned on a steel stand of 1.2m, the anaerobic pond was also positioned on a steel stand of 1.0m high to allow a free flow of abattoir wastewater by gravity to facultative pond while the two ponds, facultative and maturation pond were positioned on a laboratory work bench.

2.4 Wastewater characterization:

Table 3. Wastewater characteristics of Kwata slaughterhouse

Paramenters	Concentration (mg/l)
Chemical oxygen demand	1038.47
Conductivity	3394
Nitrate	35.35
Total solids	4470
Total Dissolved solids	3440
Total suspended solids	1030
pH	6.4
Temperature	35
Phosphate	7.11
Total coliform	7.39 (cfu)
Fecal coliform	7.1 (cfu)

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3. Results and Discussions:

The results of the physio-chemical and microbial parameters for the wastewater generated from kwata slaughterhouse, treated using waste stabilization pond are presented in table 4.

Table 4. Concentration of physio-chemical and microbial parameters of abattoir effluents in WSP

Paramenters	Concentration (mg/l)		
	Anaerobic	Facultative	Maturation
Chemical oxygen demand	178	125	10
Conductivity	1529	1171	961
Nitrate	9.79	5.6	4.93
Total solids	760	280	250
Total Dissolved solids	640	200	180
Total suspended solids	120	80	70
pH	7.5	8	8.41
Temperature	30	29	29
Phosphate	4.96	4.31	3.95
Total coliform	7.27 (cfu)	5.23 (cfu)	4.04 (cfu)
Fecal coliform	6.75 (cfu)	5.08 (cfu)	3.98 (cfu)

Solids in abattoir wastewater are mainly of animal matters and can cause many problems for stream health and aquatic life if in high concentration. The discharge of effluents with high solids concentrations can cause sludge depositions and anaerobic conditions in the receiving water body (Suglo and Bansah, 2016). The concentration of solids in abattoir wastewater generated at kwata slaughterhouse as presented in Table 3, shows that chemical oxygen demand, total solids, total suspended solids and total dissolved solids are 1038.47 mg/l. 4470 mg/l, 1030 mg/l and 3440 mg/l respectively. These are above the World health organization standard for effluent discharge in to the environment and as such requires a treatment before it can be safely discharge. The wastewater was passed through the waste stabilization pond for treatment and at the end of the treatment, the WSP reduced chemical oxygen demand, total solids, total suspended solids and total dissolved solids to 10 mg/l, 250mg/l, 180mg/l and 70mg/l respectively. The sharp decline of total suspended solids in facultative and maturation pond can be attributed to the agglomeration of the finer suspended particles into larger and hence heavier particles which were also pulled to the base as a sludge, this agglomeration effect are probably as a result of flocculation effects of bacterial discharge in the waste stabilization pond, the activities of algae in facultative and maturation pond, bacteria in the decomposition of suspended organic matter and the effect of time on settling of fine suspended particles by gravity. Removal of total solids during wastewater treatment is of great importance. This is due to high solid concentration in wastewater increases density of wastewater and reduces oxygen solubility which can affect growth of algae and other organism in ponds that aids in waste remediation processes. Suitable pH for the existence of biological life is quite narrow and critical and is typically 6 to 9 (Farzadkia et al., 2016). In low pH biological wastewater treatment is difficult and can have effects on hydrogen ion concentration of the receiving water. For the treated effluent discharge to the environment the allowable pH range varies from 6.5 to 8.5 (Metcalf, 2003). In anaerobic pond abattoir wastewater comprises of a wide range of chemicals and organic material which might have impacted on pH of pond making its pH to be low. Assimilation of nitrate by algae in facultative pond and further reduction of ammonia cell of algae leads to increase of pH in facultative pond (Ayre, 2013). The increased of pH value in maturation pond can be associated to rapid photosynthesis by the pond algae which consumes carbon dioxide (CO_2) faster that it can be replaced by bacterial respiration as a result carbonate and bicarbonate ions dissociate. Algae fix the resulting CO_2 from the dissociation while hydroxyl ions (OH) accumulate. The pH of the effluent at maturation pond is 8.41

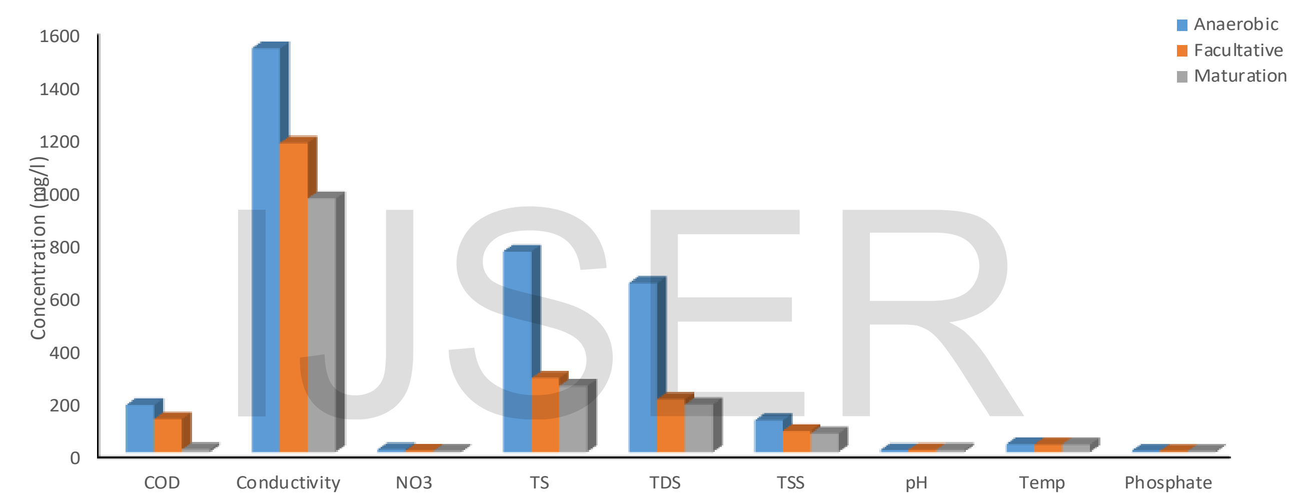

Fig.2 Concentration of abattoir effluent in WSP

Nitrate is a nitrogenous compound and that extremely soluble in water and can move easily through soil into the ground water (Ubwa et al., 2013; Jiban et al., 2016) when it is in excess in our drinking water can cause reduction of oxygen capacity of blood, shortness of breath and blueness of skin. Nitrate in waste stabilization pond was reduced to 4.93 mg/l, these can be attributed to the algae growth in the pond. A high concentration of nitrogen has been known to inhibit algae growth in waste stabilization pond and algae helps in nutrient removal. High phosphate levels result to eutrophication in the river. Growth of troublesome algae in the river will be supported by the phosphate, these algae die off and decomposed in river by micro-organism which consume the dissolved oxygen making the river unable to support aquatic life. These anaerobic conditions might have been responsible for having the water septic, changing the colour, reducing the stable minerals and producing oxides with offensive odours. The concentration of total phosphate in waste stabilization pond was reduced to 3.95 mg/l. The decline in concentration of total phosphate in waste stabilization pond can be attributed to removal of heterotrophic bacteria such as biological phosphorus removing bacteria in the anaerobic regions of the ponds. Total phosphate is removed in deep ponds due to better stratification and anaerobic processes of hydrolysis and fermentation.

Total and fecal coliform was reduced to 4.04 cfu and 3.98 cfu. Reduction of total and fecal coliform count in facultative and maturation ponds shows that waste stabilization pond system can treat abattoir wastewater with a high coliform count. The death and removal of indicator microorganisms is usually being affected by factors such as sedimentation, solar radiation, high pH, low CO_2 levels, high concentrations of dissolved O_2, algal toxins, presence of predators and retention time.

4. CONCLUSION

A field scale prototype pond which comprises of anaerobic, facultative and maturation pond were designed and reduced to a laboratory-scale model using dimensional analysis. Experiment ran on the waste stabilization pond model was able to reduce chemical oxygen demand, nitrate, total solids, total suspended solids, total dissolved solids, phosphate, total and fecal coliform to 10mg/l, 4.93mg/l, 250mg/l, 180mg/l, 70mg/l, 3.95mg/l, 4.04 cfu and 3.98cfu. the effluents are within the world health organization standard for effluent discharge. Abattoir wastewater system was designed, fabricated and operated under laboratory condition.

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