

Treatment of domestic sewage at Akuse (Ghana)

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Abstract

Waste stabilisation ponds are used to treat sewage from the Akuse township. Akuse is located in the Eastern Region of Ghana with a population of about 3 000 people. The whole township has been seweraged and the domestic sewage is treated in a series of four waste stabilisation ponds consisting of facultative and maturation processes.

The flow rates of both raw and final sewage effluents are about 570 m³/d. The weak raw sewage has a BOD and faecal coliform count per 100 ml of less than 100 mg/l and 5 900 000 counts per 100 ml respectively. The final effluent is discharged into the Lower Volta River. The ponds achieve BOD reduction of about 65% and the faecal coliform removal efficiency is about 99.99%. The reduction in suspended solids by the ponds is about 46%. The ammonia and phosphate concentrations of the raw effluent are reduced by about 92% and 94% respectively by the ponds.

Under Ghanaian tropical conditions the waste stabilisation ponds have been found to be more suitable and appropriate compared to conventional treatment systems, i.e. trickling filters and activated sludge, because of the ease of operation and maintenance and the high level of treatment efficiencies they are able to achieve.

The trend now is to adopt waste stabilisation ponds to replace conventional treatment facilities especially in localities where the cost of maintenance and operation of the conventional facilities seem to be excessive.

Introduction

Background

Usage of waste stabilisation ponds for treatment of seweraged wastewaters can be found in over fifty countries with very different climatic conditions ranging from tropical to temperate climates. A great number of these ponds can be found in Asia, Latin America and Africa (Arceivala, 1981).

In Ghana the common treatment technologies adopted for domestic sewage treatment are trickling filters, activated sludge and waste stabilisation ponds.

The waste stabilisation ponds installed in some of the towns and communities in Ghana have performed remarkably well. Some of the places where the waste stabilisation ponds can be found include Akuse, Akosombo and Kumasi.

Akuse is located in the Eastern Region of Ghana and has a population of about 3 000 people. It has a tropical climate with monthly average rainfall ranging from 13.7 mm to 195.9 mm with a mean of 95.7 mm. The monthly average temperatures are between 25.9°C and 29.1°C with a mean of 27.5°C, while the monthly average evaporation is between 4.9 and 6.6 mm with a mean of 5.1 mm.

Akosombo township is seweraged and waste stabilisation ponds are used to treat the sewage. The waste stabilisation ponds are managed by the Estate Department, Volta River Authority. The seweraged wastewater at Akuse is treated in a series of four waste stabilisation ponds consisting of a facultative and a maturation process. The surface area of the four ponds is in the region of 15 000 m² with a retention time of about 40 d. The discharge rate of the final effluent is about 570 m³/d. The final effluent is discharged into the lower Volta River. The ponds have high fish

proliferation which may be the cause of minimal mosquito or insect nuisance usually common with waste stabilisation ponds.

Objective of the study

The objective of the study is to investigate the treatment of domestic sewage and also evaluate the efficiencies of the treatment ponds at Akuse.

Methodology

Samples were taken of the raw sewage, Pond 1, Pond 2, Pond 3 and the final pond effluent. Samples were taken on six different days and seasons over a period of three years. Standard sampling methods were used. The temperature, pH and conductivity of the samples were measured *in situ*.

Standard methods for the examination of water and wastewater were followed (*Standard Methods*, 1995)

Results and discussions

The treatment performance of the ponds was assessed based on the following considerations, namely:

- suspended solids (SS) removal;
- organic matter removal (BOD);
- nutrient removal (ammonia, nitrate, phosphate); and
- micro-organisms removal.

The summary of the laboratory results is given in Table 1.

SS removal

The discharge of effluents with high SS concentrations can cause sludge depositions and anaerobic conditions in the receiving water body.

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The SS of the raw sewage ranged from 32 to 103 mg/l with a mean value of 53 mg/l. The SS of the final effluent were all less than 47 mg/l with a mean of 29 mg/l. The mean overall SS removal efficiency was calculated to be about 46%. The presence of high concentrations of algae in the final effluent may have influenced the SS removal results.

As expected no chlorophyll *a* was found in the raw sewage. The chlorophyll *a* concentrations in the final effluent ranged from 30 to 111 mg/l with a mean of 100 mg/l.

The SS concentration of the final effluent is satisfactory compared to the Ghana Environmental Protection Agency (GEPA) guideline value of 50 mg/l.

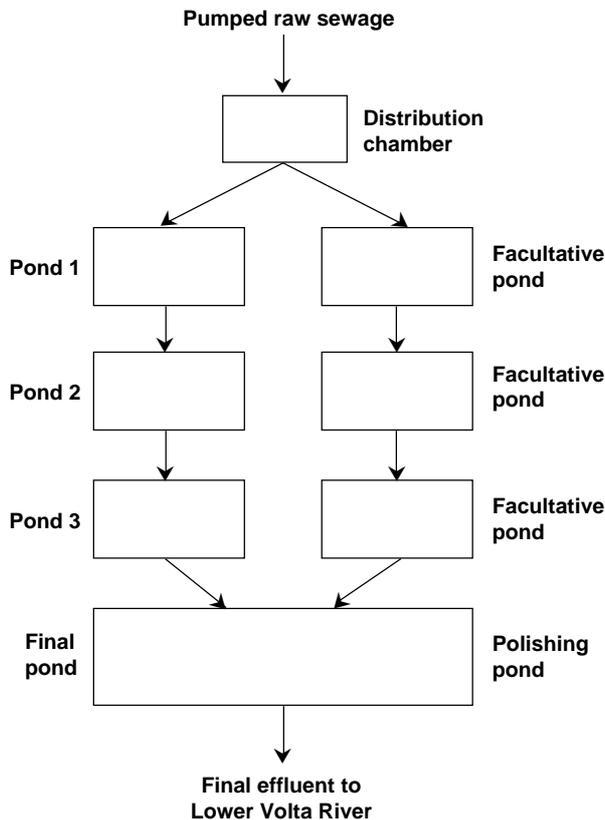


Figure 1
Akuse sewage points

BOD removal

Effluents with high concentrations of BOD can cause depletion of natural oxygen resources which may lead to the development of septic conditions.

The BOD of the raw sewage were between 42 to 96 mg/l with a mean of 66 mg/l. Since the BOD concentrations of the raw sewage were less than 200 mg/l the strength of sewage can be considered as weak (Mara, 1976).

The BOD of the final effluent ranged from 13 to 42 mg/l with a mean of 24 mg/l. The mean overall BOD removal efficiency of the treatment ponds is 64% which is low compared to other waste stabilisation ponds which give BOD removal efficiencies greater than 70% (Arceivala, 1981). The low BOD removal may be attributed to the weak raw sewage and algae.

The mean overall BOD of the final effluent is low and satisfactory compared to the guideline value of 50 mg/l.

Nutrients removal

Effluents with high concentrations of nutrients can cause undesirable phytoplankton growth in the receiving water body.

The ammonia concentrations of the raw sewage ranged from 7 to 47 mg/l with a mean value of 18 mg/l. The ammonia concentrations of the final effluent were between 0.1 and 6 mg/l with a mean of 1.5 mg/l. The mean ammonia removal efficiency of ammonia by the treatment ponds was calculated to be 92% which is appreciable.

The mean ammonia concentration of the final effluent is satisfactory compared to the GEPA guideline value of 1.5 mg/l.

The nitrate concentrations of the raw sewage and final effluent were between 3.74 mg/l and 29.0 mg/l, and 0 and 7.9 mg/l respectively. The means of the raw sewage and the final effluent nitrate concentrations were determined to be 4.3 mg/l and 2.2 mg/l respectively, giving the mean nitrate removal efficiency as 48.8%.

The phosphate concentration of the raw sewage ranged from 0.3 to 9 mg/l with a mean of 18 mg/l while that of the final effluent was between 0.1 and 0.4 mg/l with a mean of 0.2 mg/l. The mean phosphate removal efficiency was determined to be 94% which is appreciably high.

Compared to the GEPA guideline value of 2.0 mg/l all the phosphate levels obtained for the final effluents are acceptable.

Parameter	Raw sewage		Final effluent		% Reduction
	Range	Mean	Range	Mean	
SS	32 - 103	53	0.1 - 47	29	46
BOD	42 - 96	66	13 - 42	24	64
Ammonia	7 - 47	18	0.1 - 6	1.5	92
Phosphate	0.3 - 8.5	3.3	0.1 - 0.4	0.2	94
Total coliform counts/100 ml	800 000 - 10 600 000	9 040 000	0 - 27 000	5416	99.99
Faecal coliform counts/100 ml	20 000 - 10 000 000	5 804 000	0 - 90	28	99.99

Results are in mg/l unless otherwise stated.

Micro-organisms removal

The faecal coliform levels of the raw sewage were between 800 000 and 10 600 000 with a mean of 9 040 000 counts/100 ml while those of the final effluent were less than 90 counts /100 ml with a mean of 28 counts /100 ml. The mean faecal coliform removal efficiency was determined to be 99.99% which is significant. Waste stabilisation ponds usually give such high micro-organism removal efficiencies.

The faecal coliform level of the final effluent is low and acceptable compared to the recommended guideline value of 5 000 counts per 100 ml (Mara, 1976).

Conclusion and recommendation

The following conclusions were drawn from the study on the sewage treatment ponds at Akuse:

- The treated effluent from the waste stabilisation ponds at Akuse meets both the environmental and health criteria set by the GEPA.
- The raw sewage has BOD concentrations of less than 200 mg/l (< 100 mg/l) and therefore its can be classified as weak (Mara, 1976).

- The quality of the final effluent will not have any adverse effect on the Lower Volta River into which it is discharged.
- The treatment ponds are able to achieve mean SS (1), BOD (2), ammonia (3) and phosphate (4) removal efficiency of 46% (1), 64% (2), 92% (3), and 94%(4) respectively.
- A high algal activity is achieved in the final pond as indicated by pH values greater than 9 units during the day.
- A high coliform reduction of 99.99 % is achieved.
- The high fish proliferation has almost eliminated the mosquito nuisance.
- The health implications of consuming fish from the ponds need to be investigated.

References

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