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Correlation studies in model waste stabilisation tanks

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Abstract

Two aquarium model waste stabilization tanks made up of plexiglass of size 45 x 30 x 30 cm with 6 cm free board were used for the investigation. One was kept in the laboratory and the other on the terrace (field). The holding capacity of each tank was 32.4 litres. For inlet a separate over head plastic tank (20L) was used, the outlet was fixed at a height of 24 cm from the bottom. The effluent samples were analysed for physico-chemical parameters such as light, temperature, pH, Dissolved oxygen (DO), alkalinity, carbon dioxide (CO_2), nitrate (NO_3) and phosphate (PO_4) and biological parameters, especially chlorophyll-a,b,c and qualitative and quantitative analysis of phytoplankton and zooplankton, and the correlation studies was carried out by SQUANA based on C++ and the results were discussed.

Keywords: effluent, physico chemical parameters, phytoplankton, waste stabilization tanks, zooplankton.

INTRODUCTION

Pollution may be natural or artificial. Natural drainages from adjoining lands flowing into the river or lake may bring various substances in suspended and dissolved forms. Industrial and other human activities in the vicinity of a water body may introduce yet more organics and inorganics which could be included under artificial sources of pollutants. The increase in nutrient load leads to a culturally determined eutrophication of lakes all over the world. Eutrophication refers to the addition of nutrients such as nitrogen and phosphorus in various forms which increase the productivity of water and bring about consequent changes in plant and animal life in the body of water, perhaps reducing its utility and aesthetics, and threatening its very existence in the course of time.

Eutrophication is the direct result of human interference with water shed ecosystem. It is a threat to the conservation of natural communities since it reduces diversity of freshwater ecosystems, Zutshi *et al.*, (1980) and leading to the production of large quantities of malodorous gases, In addition, untreated wastewater usually contains numerous pathogenic or disease causing microorganisms that dwell in the human intestinal tract. It also contains nutrients, which stimulate the growth of aquatic plants. For these reasons, the immediate and nuisance-free removal of wastewater from its site of generation, followed by suitable treatment and disposal is not only desirable but also inevitable in the modern society. Wastewater treatment, although important from public health, ecological, aesthetic and other points of view, is generally given a low priority. The treatment methods which are technologically sound, economically feasible and operationally capable of meeting effluent quality requirements are preferred. Waste stabilization ponds are large shallow man-made earthen basins in which the aerobic bacteria convert the complex insoluble substances to simple forms which are in turn utilized by algae during photosynthesis under natural conditions without the necessity for any man-made accelerating devices.

Study on the performance of three stabilization ponds at Bhandesvadi, Nagpur and found that the ponds were efficient in removing 87.2% - 90.9% of organics at a loading rate of 0.33 – 0.65 kg d^{-1} and detention period ranging from 4.5 to 10 days (Sinha *et al.*, 2002). Generally, the deeper the pond, the longer the detention time, the more stable is the performance in terms of BOD removal, nutrient removal and microorganism kill throughout the year despite diurnal and seasonal variations in temperature (Arceivala, 1981) and degradation experiments with different sewage effluents proved that the solar irradiation was highly essential in the degradation processes (Pratap *et al.*, 2002).

Correlation studies between TP and chlorophyll-a concentration was carried out in which chlorophyll-a recorded was below 0.07 mg/l and the TP influenced the growth of blue- green algae (Harry and Vanhuet, 1992). The chlorophyll-a content of the phytoplankton decreased with temperature and increased with degree of light intensity (Riegman, 1985). The change in

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planktonic dynamics depends on the climatic stability, geological age, habitat heterogeneity, productivity, predator- prey relationships and comparative interactions (Pianko, 1994). A multiple correlation analysis involving primary production with mean depth, acid KMnO4 value, phosphate, silicate and alkalinity was carried out and proved to be efficient (Bharati and Krishnamurthy, 1990).

MATERIALS AND METHODS

Two aquarium model waste stabilization tanks made up of plexiglass of size 45 x 30 x 30 cm with 6 cm free board were used for the investigation. One was kept in the laboratory and the other on the terrace (field). The holding capacity of each tank was 32.4 litres. For inlet a separate over head plastic tank (20L) was used, the outlet was fixed at a height of 24 cm from the bottom.

The model waste stabilization tanks were fed with 3 litres of well settled sludge and filled with algae laden waste stabilization pond effluent collected from field. The waste stabilization tank kept on the terrace was exposed to natural sun light and the tank kept in the laboratory was exposed to artificial light (12 hour light period followed by 12 hour dark period). The artificial wastewater prepared by dissolving different nutrients (Sinka and Mathur, 1981) was used to feed the tanks continuously at the rate of 6 litres per day and was left undistributed for acclimatization. The waste stabilization tanks reached a steady state condition after about 45 days. The tanks were designed for the organic loading rate of 53.3 kg/ha/day with a detention time of 5 days. The evaporation loss from the waste stabilization tanks during the period of investigation was made up with tap water and the entry of rain water was totally prevented.

The effluent samples were collected periodically every week for a period of one year from both the tanks (one at laboratory condition and another at field condition) fed with artificial wastewater. These samples were analysed for physico-chemical parameters such as light, temperature, pH, Dissolved oxygen (DO), alkalinity, carbon dioxide (CO_2), nitrate (NO_3) and phosphate (PO_4) and biological parameters, especially chlorophyll-a,b,c and qualitative and quantitative analysis of phytoplankton and zooplankton, (APHA, 1985) and the correlation studies was carried out by SQUANA based on C++ and the results were discussed.

RESULTS AND DISCUSSION

The light intensity during the period of study ranged from 2,890 to 5,231 lux in the lab tank and from 23,391 to 57,725 lux in the field tank. The lowest intensity (23,391 lux) in the field tank was recorded during November and the highest intensity was recorded during the month of May (57,725 lux), obviously during summer season. The low ranges of light intensities were recorded during the months of October and November (26,913 and 23,391 lux) which represent the rainy season. In the case of lab tank there was not much variation in the intensity and the mean value varied from 2,890 to 5,231 lux during the period of study which may be due to direct and indirect or scattered diffuse light.

Temperature is responsible for the zonation and stratification of microorganisms in water bodies. During investigation the lab tank registered the lowest temperature of 26.5^{0}C in the month of December and the highest temperature of 31.4^{0}C in the month of May with annual average of 27.8^{0}C. The standard deviation was 1.46 in the lab tank and 1.93 in the field tank. The field tank showed much variation due to direct sunlight exposure, (Ahlgren, 1990).

The pH of the lab tank varied from 7.32 to 8.43 with the mean of 7.9 and SD of 0.34, and the field tank from 7.32 to 9.40 with the mean of 8.0 and SD of 0.53. A mean pH of 9.4 registered in the field tank during the month of May showed that this tank had exhibited a very high photosynthetic activity as evidenced by maximum mean

Table 1. Correlation (v) between the physico-chemical and biological parameters in the waste stabilization tanks kept at laboratory

S. No.	Parameter	Light	Temperature	pH	DO	Algae	Zooplankton
1	Zooplankton	0.31	0.39	-0.01	0.33	0.32	-
2	Algae	0.49	0.52	0.35	0.31	-	0.32
3	Chlorophyll –a	0.32	0.42	0.41	0.48	0.19	-0.41
4	CO_2	0.39	0.47	0.42	0.39	0.39	0.15
5	NO_3	0.28	0.41	0.38	0.12	0.03	-0.35
6	PO_4	-0.16	-0.28	-0.07	-0.03	-0.10	-0.78
7	Alkalinity	0.29	0.79	0.52	0.34		
8	DO	0.53	0.40	0.48			
9	pH	-0.04	0.69				
10	Temperature	0.05					