e-ISSN: 2347-7830
p-ISSN: 2347-7822

Research and Reviews: Journal of Ecology and Environmental Sciences

Oxidation Pond: A Tool for Wastewater Treatment.

NC Tharavathy, M Krishnamoorthy, and BB Hosetti*.

Department of Post-Graduate and Research in Biosciences, Mangalore University, Mangalore – 574199, Karnataka, India.
*Department of Applied Zoology, Kuvempu University, BR. Project, Shimoga – 577115, Karnataka, India.

Short Communication

Received: 14/07/2013
Revised: 30/09/2013
Accepted: 10/10/2013

***For Correspondence**

Department of Applied Zoology, Kuvempu University, BR. Project, Shimoga – 577115, Karnataka, India.

Keywords: Oxidation pond, BOD, wastewater, bacteria, algae, protozoa.

ABSTRACT

Oxidation pond is one of the biological systems which are used for the treatment of wastewater. It is considered as the secondary treatment method by which natural purification and stabilization of wastewaters like domestic sewage, trade waste and industrial effluents is accelerated. The biological treatment process in oxidation pond mainly involves an interaction between bacteria, algae and other organisms. It efficiently removes bacteria, biodegradable organics, phosphorous and nitrogen present in the wastewater which is going to be discharged to the receiving streams. In this method, 98% to 99% of BOD reduction in wastewater is often possible.

INTRODUCTION

Oxidation (stabilization) pond is a simple scientifically designed pond with 2-6 feet depth, where BOD reduction of a wastewater takes place by supporting algal-bacterial growth [1]. These ponds are effective, low-cost and simple technology for the treatment of wastewater before it is discharged to an aquatic ecosystem [2] and are commonly used in warm climates to purify wastewater. The performance of pond depends on climatological conditions like light, temperature, rain, wind and also the wastewater quality. Primarily these are used as tertiary treatment facilities specially to polish the effluents from conventional treatment plants [3]. These ponds are also used to treat the raw sewage, settled sewage and industrial effluents [4].

Oxidation pond typically operate in an extended aeration mode with long detention and solids retention time [5] and is a widely adopted technique for the treatment of domestic and trade wastes. It is one of the methods used extensively in the tropical areas of the world for treating the wastewater [6]. The first oxidation pond "The San Antanio pond" or Mitchell Lake arose due to the practice of land disposal of sewage and industrial effluents for irrigation in large areas of deficient rainfall in the USA [7]. Hospital wastewaters have been reported to be best treated in the oxidation pond [8]. This method would also have disadvantages that it requires extensive land area, potential odour problem, mosquito menace, little control over the effectiveness of the treatment process and the main disadvantage is seepage of effluents into soil which may also lead to ground water pollution. Still, oxidation ponds have proved to be one of the most significant devices of economical waste treatment for small communities and isolated industrial units in Tunisia [9].

The occurrence of several species of bacteria [10], fungi [11], algae [12,13], protozoa [14,15] and viruses [16] in the oxidation pond has been reported. In the earlier years (1946-1964) it was believed that the symbiotic activity of bacteria and algae alone was responsible for the treatment of wastes in oxidation ponds. However, Gloyna [9] has reported many species of fungi which are involved in the function of waste purification.

Principles involved in oxidation pond functioning

Oxidation pond comprises different groups of organisms such as bacteria, algae, protozoa, fungi, viruses, rotifers, nematodes, insects and crustacean larvae etc. These organisms coexist and compete with each other[15]. The bacteria present in the pond decompose the biodegradable organic matter and release carbon dioxide, ammonia and nitrates [18]. These compounds are utilized by the algae, which together with sunlight and photosynthetic process releases oxygen, enabling the bacteria to breakdown more waste and accomplish reduction in BOD levels [19]. Weidemann and Bold [20] included fungi in the symbiotic cycle and explained that the nutritional aspects of bacteria, algae and fungi are interrelated. These ponds often harbor aquatic weeds and are termed as macrophyte ponds. Initial research on oxidation ponds (1946 to 1960) describes pond activity in terms of mutualistic behaviour of algae and protozoa through photosynthesis [15].

Review of Literature

Studies on the physico-chemical characteristics and the seasonal periodicity of plankton in Indian sewage and treatment of wastewater in oxidation ponds started six decades ago. Studies on microbial succession [21] and biochemical stratification [22,23,24] have already been carried out. The earlier reports on oxidation ponds have emphasized upon the removal of BOD, bacteria and nutrients [25,26,38].

Intensive work has been carried out on few species of bacteria, fungi, algae and protozoa individually in response to changes in environmental factors like light intensity, temperature and pH [27,39]. Koppen [28] showed that retardation in the rate of catalytic decomposition of hydrogen peroxide in the presence of catalase may be used for the detection of compounds toxic to aerobes in the biological systems. The analysis of enzyme activity was used to investigate the process of self purification in polluted rivers [29,30].

The bacterial genera commonly present in the oxidation ponds are *Achromobacter*, *Proteus alkaligens*, *Chromomonas*, *Zoogloea*, *Pseudomonas*, *Chromatium*, *Thiospirillum*, *Thiopedia* and *Rhodothecae* [31]. According to the conditions of the oxidation pond aerobic, facultative and anaerobic bacteria grow and stabilize the organic substances present in the wastes through biological processes [32].

About 15,000 species of algae have been recorded in nature; only few of them are functionally useful in the oxidation process [33]. The algal species belong to the genera *Chlorella*, *Scenedesmus, Euglena* [12,21, 26] and *Microcystis* [34] were shown to be the dominant algae in the oxidation pond because of their high tolerance capacity to extreme environmental conditions. Euglenoids depicted a great deal of adaptability to changes in environmental conditions in ponds [35].

Protozoans such as microflagellates and ciliates appear during prestabilization phases. Among ciliates, Holotrichales are the most predominant forms [36], which mainly feed on bacteria and suspended solids [15]. Ganapati and Amin [37] reported the presence of *Vorticella*, *Macrostoma*, *Paramecium* and *Podophrya* in the scum formed at the surface of oxidation pond, during prestabilization and overloading conditions. Patil *et al.,* [21] recorded 12 species of protozoa from oxidation pond samples belonging to various genera such as *Paramecium*, *Vorticella*, *Colpodium*, *Stylonychia*, *Perispira* and *Caenomorpha*. Nair [15]) reported 46 species of protozoa from sewage.

In addition to bacteria, algae and protozoa, there are also other organisms such as crustacean larvae, insects, viruses, rotifers, nematodes which interact and compete with each other for food and convert the organic materials of the sewage into simple products in the oxidation ponds. The Tunisian government has laid guidelines for safe reuse of effluents for agriculture with respect to the presence of helminthes and fecal coliforms [9].

CONCLUSION

In India and in most of the tropical parts of the world where sufficient sunlight and temperature are available, oxidation pond system is found to be most suitable for the treatment of domestic sewage and trade waste containing nutrients. During the recent past, improved life style and activities like urbanization, industrialization and technology have lead to the enrichment of various pollutants, which may affect the treatment efficiency of oxidation pond. When these pollutants are accumulated in the sediments of oxidation pond, they become toxic to the entire oxidation pond community. In addition, these pollutants circulate in a pathway similar to nutrient cycles in the oxidation pond medium. If the pollutants are over loaded in the sewage, they cause shock loads and degrade the effluent quality.

ACKNOWLEDGEMENT

The authors are thankful to the authorities of Mangalore University for providing laboratory facilities.

REFERENCES

1. Hosetti BB, Rodgi SS. Influence of depth on the efficiency of oxidation ponds for wastewater treatment. Environ Ecol. 1985;3: 324-326.

2. Mahajan CS, Narkhade SD, Khatik VA, Jadhav RN, Attarde SB. Wastewater treatment at winery industry, Asian J Environ. Sci. 2010;4(2):258-265.
3. Sarner E. Oxidation ponds as polishing process of the wastewater treatment plant in Lund, Vatten. 1985; 41: 186-192.
4. Abeliovich A. Biological treatment of chemical industry effluents by stabilization ponds. Water Res.1985;19:1497-1503.
5. Sperling VM, Lemos DC. 2005, Biological wastewater treatment in warm climate regions, IWA Publishing, London.
6. Mara DD, Pearson H. Artificial freshwater environment: Waste stabilization ponds. Biotechnology. 1986; 8: 177-206.
7. Caldwell DH. Sewage oxidation ponds-performance, operation and design. Sew Works J. 1946;3: 433-458.
8. Hosetti BB, Patil HS. Influence of Lemna minor on the performance of sewage stabilization pond. Geobios. 1986.13:244-247.
9. Ghrabi A, Ferchichi M, Drakides C. Treatment of wastewater by stabilization ponds-Application to Tunisian conditions. Wat Sci Tech. 1993.28(10):193-199.
10. Marais GVR. Fecal bacterial kinetics in stabilization ponds. J Environ Eng. 1974;100:119.
11. Ahmed K. Role of fungi in oxidation ponds. Biol Abstra. 1980;70: 7104.
12. Kawai H, Grieco VM, Juredini PA. Study of the treatability of pollutants in high rate photosynthetic ponds and the utilization of the proteic potential of algae which proliferate in the ponds. Environ Tech Lett. 1984; 5: 505-516.
13. Henry JG,Prasad D. Microbial aspects of the inuvik sewage lagoon. Wat Sci Tech. 1986;18:177.
14. Rivera F, Lergo A, Ponnce J, Lares F, Ortiz R. Zooflagellates in an anaerobic waste stabilization pond system in Mexico. Wat Air Soil Poll. 1986;27:199.
15. Nair G. Role of organisms in sewage treatment I: Types of organisms. Proc Acad Environ Biol. 1997; 6(1): 19-26.
16. Bausum HT, Schaub SA, Rose WE, Gibbs PH. 1983, Enteric virus removal in wastewater treatment lagoon system, Environmental Protection Agency, Virginia.
17. Gloyna EF. 1971, Waste stabilization ponds, W.H.O. Monogr., Ser. No. 60. Geneva.
18. Tharavathy NC, Hosetti BB. Biodiversity of algae and protozoa in a natural waste stabilization pond: A field study. J Environ Biol. 2003;24(2): 193-199.
19. Pearson HW, Mara DD, Mills SW, Smallman DJ. Factors determining algal population in waste stabilization ponds and the influence of algae on pond performance. Wat Sci Tech. 1987;19:131-140.
20. Weidemann VE, Bold EC. Heterotrophic growth of selected waste stabilization pond algae. J Phycol. 1965; 1: 66.
21. Patil HS, Dodakundi GB, Rodgi SS. Succession of phyto and zooplankton in sewage stabilization pond. Hydrobiologia. 1975;47: 253-264.
22. Dodakundi GB, Rodgi SS. Stratification of catalase and protease in a sewage stabilization pond. J Karn Univ Sci. 1974;19: 63-68.
23. Hosetti BB, Patil HS, Rodgi SS. Vertical distribution of microbes in oxidation ponds in relation to changes in the physico-chemical parameters. Enviro Ecol. 1984;2: 159-161.
24. Chaudhari PR, Rao AV, J Kotungale JP, Krishnamoorthi KP. Studies on diurnal and vertical distribution of phytoplankton in wastewater stabilization pond. Bull Bot Soc. 1985;32: 197-203.
25. Rao AV. Studies on stabilization ponds for domestic sewage in India. Hydrobilogia. 1983;68: 411-434.
26. Somiya I, Fujii S. Material balances of organics and nutrients in an oxidation pond, Wat Res. 1984;18: 325.
27. Gaddad SM, Nimbaragi PM, Rodgi SS. Ecological studies on two polluted bodies of water at Gulbarga, Poll Res. 1983;2:49.
28. Koppen R. Characterization of wastewater with the help of enzymes. Hydrobiologia. 1955;76: 147.
29. Parthasarathy UR, Prasad DY, Pankhapekasan B, Shankar GV, Raju N. Catalase activity measurement: Self purification capability of a river receiving Kraft mill effluents. Ind J Environ Health. 1982;24: 303-307.
30. Hosetti BB, Birasal NR. Catalase activity: An indicator of self purification in River Kali. J Nat Conser. 1989; 1: 123-126.
31. Sletten O, Singer RM. Sulphur bacteria in red lagoons. J Wat Pollut Cont Fed. 1971;43: 2118.
32. Hosetti BB, Frost S. A review of the sustainable value of effluents and sludges from wastewater stabilization ponds. Ecol Eng. 1995;28:421-431.
33. Palmer CM, Tarzwell CM. Algae of importance in water suppliers. Publ Woks J. 1955;86:107.
34. Hosetti BB, Patil HS, Rodgi SS, Gaddad SM. Effect of detention period on the biochemical activities of sewage stabilization ponds: A laboratory study. J Environ Biol. 1985;6:1-6.
35. Patil HS, Dodakundi GB, Rodgi SS. Succession and stratification of organisms in sewage oxidation ponds. Ind J Expt Biol. 1973;11: 318.
36. Curds CR, Cockburn A. Protozoa in biological treatment processes-II. Protozoa as indicators in activated sludge process. Wat Res. 1970;4: 237.
37. Ganapathi SV, Amin PM. Microbiology of scum formed at the surface of the lagooned wastewater. J Wat Poll

Cont Fed. 1972;44:769-784.
38. Mara DD, deSilva SA. Removal of intestinal nematode eggs in tropical waste stabilization ponds. J Trop Med Hyg. 1986;89:71-74.
39. Patil HS, Dodakundi GB, Rodgi SS. Ecology of sewage pond stabilization. Curr Sci. 1972;41:615.