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ECO Engineered Remedy for Water Pollution using Artificial Floating Island

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Abstract

In recent years, water pollution has become one of the most serious environmental problems. The Mula, Mutha and Pavana rivers, flowing through the Pune City and Pimpri-Chinchwad industrial area, are polluted with untreated domestic sewage and partially untreated industrial waste from nallas. The city is under continuous stress due to population growth, industrial growth and waste generation. The river water quality has deteriorated with respect to some of major water quality parameters like Dissolved Oxygen (DO), Biological Oxygen Demand (BOD) and phosphates levels. In account of Maharashtra Pollution Control Board (MPCB), all the pollution parameters are above permissible limits in Pune Rivers. Water pollution is caused mainly by the discharge of untreated or inadequately treated sewage, industrial effluent and waste-water runoff from households. Water pollution has its most immediate effect on human health, through water borne diseases also people living near the Pune Rivers and nallas suffer from bad odor, mosquito and other problems. Thus when highly polluted nalla water discharges to the river causes water pollution. Hence there is need to treat nalla water effectively so as to minimize this pollution. Artificial Floating Island is a cost effective and environment friendly method for removing pollutants from the water streams like river, lakes and nallas. Its core is utilizing aquatic plants and root's microbes to absorb nitrogen and phosphorus elements, degrade organic matter. AFI has been applied to some water pollution control projects and has got several achievements. In this study, AFI has been proposed for treating nalla water from PCMC area. Various parameters like BOD, COD, TS, and pH is to be analyzed.
Keyword- Artificial Floating Island (AFI), Nutrient Removal, Wastewater, Wetland

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I. INTRODUCTION

According to Environmental Status Report, Pune city generates around 451 MLD of wastewater. About 265 MLD sewage is still carried through open gutters and nallas for the want of adequate conveyance system. It has led to an adverse impact on the environment in the surrounding areas through which they flow. The effluents in the nallas and rivers are affecting the ecological balance of the city. This review is to study present scenario for the treatment of nalla water and to suggest eco engineered and cost effective remedy. Artificial Floating Island is nothing but a type of wetland which consist of free-floating aquatic plant systems.

II. AVAILABLE WETLAND TREATMENTS FOR TREATING WASTEWATER

The high cost of some conventional treatment processes has produced economic pressures and has caused engineers to search for creative, cost effective and environmentally sound ways to control water pollution. Application of ecological principles are found to be effective in treatment of wastewater. One technical approach is to construct artificial ecosystems as a functional part of wastewater treatment. There are three categories of aquatic treatment systems:
1) Natural Wetlands
2) Constructed Wetlands
3) Artificial Floating Island

Among these three types, Constructed wetland has been used for grey water and domestic wastewater treatment in Pune city. Most of the treatment units are maintained by Ecosan services Foundation. It utilize wetland plants, soils, and their associated micro-organisms to mimic natural wetland ecosystems processes for the treatment of wastewater. As the wastewater flows through the bed, it gets treated through natural process; pollutants in the wastewater are mechanically filtered, chemically transformed, and biologically consumed. Constructed wetlands are divided according to direction of wastewater flow (i.e. horizontal or vertical flow) into reed beds, also known as horizontal flow constructed wetlands (HFCW), and vertical flow planted gravel filters (VFPGF), also referred to as vertical flow constructed wetlands (VFCW).

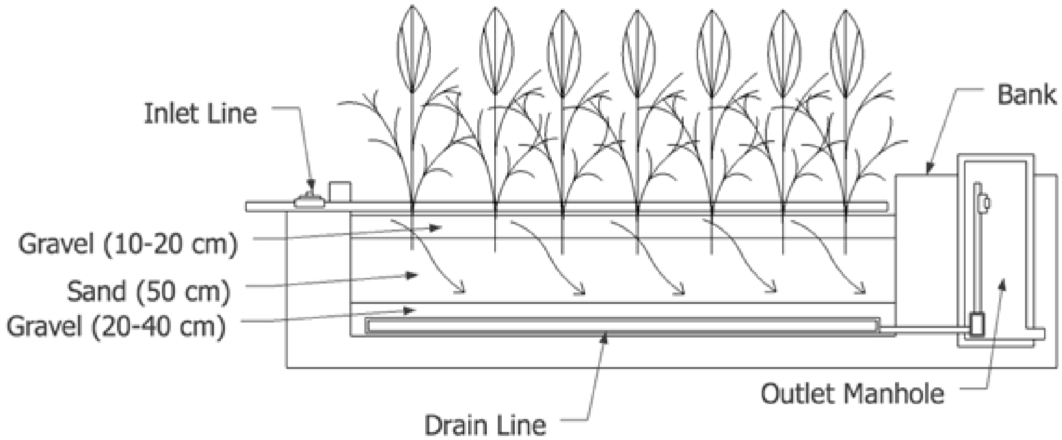

Fig. 1: Diagram showing Vertical Flow Constructed Wetland

III. ARTIFICIAL FLOATING ISLAND

Artificial Floating Island (AFI) is a soilless planting structure constructed with floating mats, floating aquatic plants, sediment-rooted emergent wetland plants and related ecological communities like algae, biofilms, zooplankton, and small invertebrates. As Shown in Figure 1, it basically involves the growth of emergent wetland plants on a structure that floats over a water surface. Water receives treatment as it passes through the root mass that develops beneath the floating wetland. Fine particles may potentially become entrapped within this hanging root mat and associated biofilms.

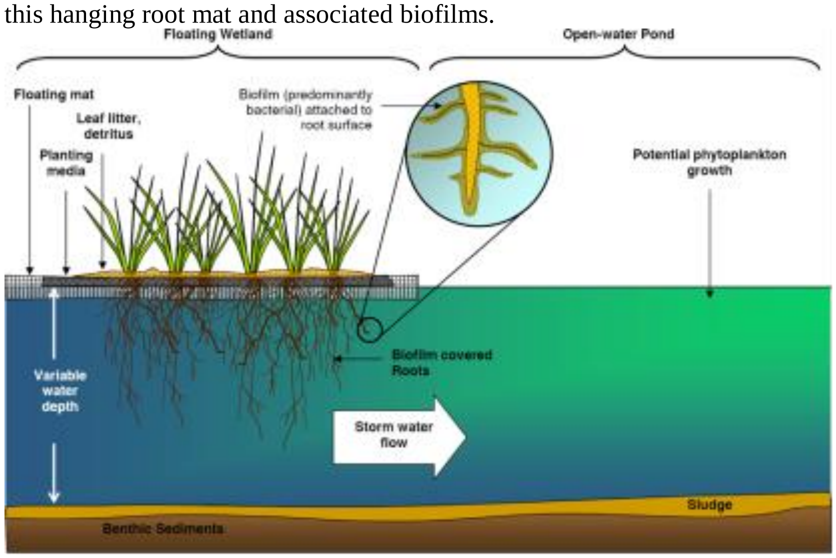

Fig. III2: Artificial Floating Island

Source: N. Yeh et al. / Renewable and Sustainable Energy Reviews 47 (2015) 616–622

Floating treatment wetlands have been used for a number of applications world-wide, including treatment of airport de-icing runoff and acid mine drainage. Over 5,000 floating islands have been installed around the world in the past decade. Island sizes range from small decorative units to larger than football fields, and can be made in any shape or buoyancy. Islands have withstood numerous freeze/thaw cycles, as well as typhoons, tornadoes, hurricanes and major snowfalls. Primary uses for AFI's include water quality improvement; fishery enhancement; de-stratification and dissolved oxygen addition; and creation of waterfowl and riparian edge wildlife habitat. The typical duty of AFI technology is to rapidly cycle nutrients into appropriate biota within target waterways. Secondary uses for AFIs include erosion control, wave dampening. Removal rates have been developed in field-scale applications for contaminants such as ammonia, nitrate, phosphorus, metals, and total suspended solids (TSS) and biochemical oxygen demand (BOD).

A significant amount of research work on various aspects of Treatment of wastewater by using Artificial Floating Island has been carried out by many investigators. Applications for landfill leachate and metals removal have also been explored.

The inspiration for using artificial floating structures for water quality improvements appears to have arisen in South East Asia where floating plants such as Azolla and water hyacinth Eichhornia Crassipes have been used to remove nutrients from water for centuries (Whitton & Potts ibid).

The concept of constructing a floating platform on which plants could be grown to improve water quality originated in China, Japan and Taiwan in the 1990s. Floating beds of Canna Cana Generalis were placed on fish ponds and their biomass production was measured (Wu et al. 2000). Similar soil-less floating beds planted with Canna were also used to control eutrophic water, with coverage of 20% recommended to significantly improve water quality (Bing & Chen 2001). In 1984, Heathrow Airport in London, U.K., installed floating reed beds to remove glycol, used to de-ice runways and other surfaces, from storm water (Revitt et al. 1997; Chong et al. 1999; Richter et al. 2003).

Trials in the USA in 1987 using the floating plant Pennywort Hydroctyle Umbellate successfully improved domestic sewage water quality (DeBusk et al. 1989). In 1998, AFIs were placed in Lake Mead, Nevada, to evaluate their nutrient removing ability while also assessing the structural durability of the islands and aspects of the plants growing on the islands (Boutell 2002). Yu Deng and Fuquan Ni in China worked on various factors influenced on the removal rate of pollutants, including plants, temperature, seasons, processing time, coverage, and initial concentration of pollutants. AFI's were tested in Pasco Country Florida as a method of reducing total nitrogen (James bays et al.2013).

Most studies focused on the ability of plants grown on the AFIs to remove nutrients (Bureau of Reclamation 2002, Hubbard et al. 2004, Yao et al. 2011), and attributed the water quality improvements entirely to the plants' uptake of nutrients. Credit must go to Bruce Kania of Floating Island International LLC (FII) for the first commercialisation of AFIs. Starting in 2000, Kania began experimenting with different designs and construction materials for floating islands, initiating extensive laboratory research (Stewart 2005; Stewart et al. 2008), with commercial island production beginning in 2005.

Kamble R , Patil D studied Artificial Floating Islands, in context with restoration of Mula Mutha River. According to this study, with proper selection of Plants and site, AFI can reduce BOD and COD by 80 and 60 percent respectively. (Rashmi Kamble et al. 2012) further research by Chandak A and his team on the similar project at College Of Engineering, Pune showed about 42% removal efficiency for nitrate and 21% efficiency for phosphate removal at a plant age of 53 days.(Chandak A.et al)
World-wide, a number of companies and individuals supply a range of floating island products. These products vary from islands whose buoyancy is derived from naturally buoyant bamboo onto which wetland plants are tied, through to sophisticated molded plastic designs which interlock together to create virtually unlimited island sizes and shapes.

IV. CONCLUSION

- It is eco-friendly and economical, locally manageable technology that treats nalla water.
- As climate of Pune is suitable for use of AFI, the temperature and atmosphere can accelerate the process of conversion of complex matter in simpler form.
- AFI Eliminate the need for additional land to be dedicated to treatment, Adjust to fluctuating water levels and creating habitat for aquatic life.
- There is a scope of further research regarding use of more than one species of plant
- This paper is an attempt to show that AFIs and other buoyant structures in wetlands are a logical and effective improvement to existing accepted practices.

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