Ecotechnological Applications for the Control of Lake Pollution

Sayali Joshi and Sandeep Joshi
Shrishti Eco-Research Institute, B-106, Devgiri, Opp. P. L. Deshpande Garden, Near Ganesh Mala, Sinhagad Road, Pune – 411 030. INDIA.
Email: sayali.joshi@yahoo.co.in; seriworld@seriecotech.com, sandeepjoshi-IP@eth.net

ABSTRACT

National Environment Policy 2006 of India directs to use wetlands - natural powers of ecosystem to curb the pollution generated by human settlements. It’s a welcome shift from the stance of vehemently insisting mechanical waste treatment systems which are energy intensive and need skilled careful operations. The conventional aerobic and anaerobic treatment systems developed from about 150 years are yet to get acceptance worldwide since they are cost intensive also. The application of ecological principles harnessing the living components of detritus food chain – bacteria, fungi, micro-invertebrates are found to be effective in the treatment of wastes. The waste generated through anthropogenic activities is consumed by the living components of ecotechnological treatment units. Ecotechnological treatment units such as Soil Scape Filter (vertical filtration), Hydrasch Succession Pond, and Green Channel are found to be effective for the treatment of pollution from point sources. The operational costs is reduced to 10 -20% that of conventional aerobic – anaerobic treatment systems. Innovative horizontal filtration system – Green Bridge is found to be promising technology to treat the pollution from non – point sources flowing through the natural drains / streams. Green Bridge is supported by Green Lake Systems. For the aeration purpose, the gradient of the drain is used to splash, cascade and fall from some height to increase the concentration of dissolved oxygen in the flowing wastewater – Stream Ecosystem technology. The erosion control is possible by using contour plantation of some grasses – Green Contour technology. All these technologies can be effectively used to control the pollution and sediment ingress from the catchment area of the lake. Practical applications of all these ecotechnologies are found to be economical and simple as far as operations are concerned because their source of energy is sun and they require least machinery for the routine process maintenance.

Keywords: ecotechnology, ecosystem, ecoremediation, ecotransformation, pollution control

INTRODUCTION

Ever-increasing population, urbanization and modernisation are posing problems of sewage disposal and contamination of surface waters – lakes and rivers (Mehata et al, 1994; Mehata, 1995). The outbreaks epidemics of Delhi, Mumbai, Karad, Surat (Agarwal, 1996; Joshi, 1989) which claimed hundreds of victims were due to improper disposal of sewage. It has been observed that in many cities, sewerage systems are incomplete. In the holy cities like Nashik, Allahabad untreated sewage is released into the rivers where millions of people bathe in Kumbhamela like gathering. In the lake cities like Hyderabad and Bhopal, lakes have become receivers of pollution from non-point and point sources in densely populated areas (Joshi, 2005).

It has been estimated that a city like Pune would require at least 350 crores to take away sewage from the city to centralized treatment facility. Depending on the technology adapted, the treatment cost may vary from Rs. 240 crores to Rs. 500 crores. It is estimated that about 40,000 crores will be required to treat sewage in India before it enters into the rivers, streams, lakes or seawater.

Failures of the mechanical equipments at the treatment facilities may add to the operational costs inclusive of chemicals, electricity and man-power. At the same time conventional systems are found to be very sensitive to variations hydraulic as well as pollutants loading. These numerous problems triggered to adapt simple, cost effective and result - oriented ecological treatment systems – vertical and horizontal filtration systems. Soil Scape Process (Joshi, 1998; Joshi, 1999) is the application of ecological principles to remove pollutants from liquid wastes and bioconvert, bioprocess for the bioutilization and eco - assimilation into natural cycles again.

Ecotechnologies

Engineering applications of ecological principles and succession of biological communities is very useful to consume organic and inorganic pollutants from the water and bioconvert them into non-toxic form. The consortia of organisms at different trophic levels utilize pollutants as nutrients. These eco-transformations, eco-conversions and degradation or bio-utilization of pollutants - nutrients are the part of ecological cycles - biogeochemical cycles. The
attempt has been made to apply natural flora and fauna in well-designed manner to develop technologies like Green Bridge, Green Lake Eco-Systems, Green channel, biox (biological oxidation) and Stream Eco-Systems.

**Soil Scape Filter**

It is the simulation of natural filtration of water or wastewater through the well developed soils and fragmented rock materials below which give purified water in the form of groundwater. Soil filter contains layers of bio-active (i.e. biologically activated) soil - ECOFERT - developed from non-toxic and non-hazardous wastes (fig. 1). The process harnesses ecological principles of interactions and interrelationships of biota with their environment and eco-transformations of substrates into assimilable form by treating, transforming and detoxifying the pollutants using solar energy (Fig. 2).

![Figure 1: Soil Scape Filter](image1)

![Figure 2: Hydrasch Succession Pond](image2)

**Hydrasch Succession Pond**

It is an application of ecological succession of aquatic plants depending on characteristics of incoming effluents (Fig. 3). Various green plants including invasive species are successfully employed in these phytofiltration and phytoremediation processes with ecoremediation to treat organic and inorganic pollution. It is open water system, confined by rooting plants, surface covered by floating plants establishing a detritus food as a major component with various trophic levels flourishing depending on the limiting factor of incoming nutrients (Fig. 4).

![Figure 3: Hydrasch Succession Pond](image3)

![Figure 4: Stream Ecosystem](image4)

**Stream Ecosystem**

It involves the use of the natural slopes of the polluted drains, beds, banks of streams or ponds to enhance the aerobic activity in water by generating turbulence and providing shallow depths to allow sun – light to reach the bottom (fig. 5). This is the simulation of the stream flow in the wilderness. It ensures the free flowing water splashed by stones and cascades. It is observed that the dissolved oxygen in the water increases multifold – in some already installed systems it is observed that this increase is upto 90 – 120 times i.e. (from 0.1 to 8 – 12 ppm) (Joshi et al, 2007).

![Figure 5: Stream Ecosystem](image5)
Natural streams, rivers and lakes have their own in-built purification system, the winds, natural slopes, stones, sand, biological growth and complex food web help in the purification process. The basis of food web is nothing but utilization of one's waste by another as it's food. Nature has her own living machinery of detritivorous microbes and other living species to consume wastes. These principles have been harnessed in the Stream Eco-System Technology.

Phytofiltration and Biox Process

It involves the use of plant fibres, roots to remove suspended solids from wastewater effectively in a well designed tank. In this technique normally the floating plants are used to facilitate the removal of solids by biosorption methods (Fig. 6). Biological oxygenation process is defined as the transfer and dissolution of oxygen with the help of certain green plants and algae. It has been observed that in the unpolluted mountain streams the oxygen content in the water rises up to 19 ppm. The effect can be achieved in polluted drains using certain algal species in combination with stream ecosystem techniques.

Green Bridge Technology

Green Bridge technology uses filtration power of biologically originated cellulose / fibrous material in combination with sand and gravels and root systems of green plants. It's an innovative approach to minimize the cost of pollution treatment when the cellulose / fibrous materials like coconut coir or dried water hyacinth or aquatic grasses are compacted and woven to form a bridge / porous wall like structure strengthened by stones and sand. All the floatable and suspended solids are trapped in this biological bridge and the turbidity of flowing water is reduced substantially. The green plants growing there help in absorption of soluble substances including heavy metals.

Green Lake Technologies

Green Lake system uses floating, submerged or emergent aquatic plant species. These can be termed as macrophyte ponds also. Macrophytes are capable to absorb large amounts of inorganic nutrients such as N and P, and heavy metals such as Cd, Cu, Hg and Zn etc and to engineer the growth microbes to facilitate the degradation of organic matter and toxicants. Green plants detoxify the pollutants and make them suitable for other organisms.

Examples of Ecotechnological Applications

A number of ecotechnological wastewater treatment systems have been employed to treat domestic and industrial wastewaters. Some of the installations are listed below in the table no. 1 and 2.

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Industry/Organization</th>
<th>What was expected?</th>
<th>Observed Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Satish Solvent Extraction, Dhule (1995)</td>
<td>Removal of COD &amp; BOD</td>
<td>90%</td>
</tr>
<tr>
<td>2</td>
<td>Bosch Chassis Systems India Ltd., Pune &amp; Jalgaon (1996)</td>
<td>Metal removal</td>
<td>70 – 90%</td>
</tr>
<tr>
<td>4</td>
<td>Technova Imaging Systems, Taloja (2000)</td>
<td>Neutralization of acidity</td>
<td>Saving lakhs per month</td>
</tr>
<tr>
<td>5</td>
<td>Morde Foods, Manchar (2002)</td>
<td>Removal of COD &amp; BOD</td>
<td>95%</td>
</tr>
<tr>
<td>6</td>
<td>Sandvik Asia, Pune (2001)</td>
<td>Removal of Oil &amp; Grease</td>
<td>98%</td>
</tr>
<tr>
<td>7</td>
<td>Parshwanath Electroplaters, Pune (2001)</td>
<td>Removal of Cyanide</td>
<td>98%</td>
</tr>
<tr>
<td>8</td>
<td>P &amp; MS, textile unit, Baroda (2005)</td>
<td>Removal of COD &amp; colour</td>
<td>80 – 96%</td>
</tr>
</tbody>
</table>

Table 2. Some of the ecotechnological installations on polluted drains
The observed efficiency of horizontal filtration systems installed on the locations given in table no. 2 is listed in table no.3.

Table 3. Efficacy of Green Bridge and Green Lake treatment systems

<table>
<thead>
<tr>
<th>% Reduction in Key Chemical and Biological Parameters</th>
<th>82 - 88 %</th>
<th>90 - 95 %</th>
<th>85 - 95 %</th>
<th>40 - 60 %</th>
<th>70 - 90 %</th>
<th>65 - 75 %</th>
<th>40 - 60 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Suspended Solids</td>
<td>Chemical Oxygen Demand</td>
<td>Biological Oxygen Demand</td>
<td>Iron</td>
<td>Zinc</td>
<td>Copper</td>
<td>Nickel</td>
<td></td>
</tr>
<tr>
<td>Dissolved Oxygen</td>
<td>10 - 120 times</td>
<td>Algal biodiversity</td>
<td>4 - 18 times</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Application of ecotechnological treatment systems

1. It can be applied to any size of the stream from 0.7 MLD to 200 MLD.
2. It can be used on any type of terrain or in geographical conditions, urban and rural areas.
3. The pollution load can be in the range of COD – 300 – 100000 mg/L and BOD 200 – 60000 mg/L.

Potential and Scope of Ecotechnology

Shrishti Eco-Research Institute (SERI) is working on social, health, economic and environmental impacts of the water pollution in the cities of Western Maharashtra. From last three years, we examined the pollution of water bodies in 10 corporation areas – viz. Ulhasnagar, Kolhapur, Pune, Nashik, Sangali – Miraj, Pimpri Chinchwad, Dhule, Jalgaon, Malegaon and Ahmednagar. We found that the rivers flowing through all these cities are severely polluted. Indian scenario is not much different: 233 class I cities in 14 major river basins of India having population about 105 crores. 76% untreated sewage from these cities reaches to freshwater bodies mainly rivers and lakes. Class II cities don’t have sewerage systems for the collection of sewage. Natural drains in the cities are serving as sewer lines.

All these growing cities need cost effective and less energy intensive treatment methodology to control their pollution emanating from point and non-point sources. The ecotechnological treatment systems vertical filtration systems for point sources and horizontal filtration systems promise the result with minimal electricity as compared to conventional aerobic or anaerobic treatment systems.

REFERENCES


Joshi, Sandeep (1989) Pollution its Control today and tomorrow. Journal of IAEM


