CHAPTER - 8

WATER QUALITY RESTORATION
TECHNIQUES

8.1 General Introduction:

Water pollution as we know today began with the industrial revolution, advances in agricultural methods and development of factories. Continuous urbanization has also increased the human populations into the cities. The disposal of human wastes into the sewers improved living conditions but it led to foul conditions in rivers and streams. Since last 50 years, various processes have been developed to reduce the amount of organic pollution reaching fresh and marine waters. The processes generally used now are adaptable in large sewage treatment plants and involve two and sometimes three stages (Curd 1992). Primary treatment is purely physical and involves the removal of coarse and suspended solids. The secondary treatment is biological and rely on dissolved suspended materials. Tertiary treatment includes further removal of suspended particulate matter. It removes enteric bacteria or decreases nitrate or phosphate concentrations. It is a known fact that the pollutants in waste water are of organic and inorganic types. The organic matters can be controlled easily as compared to inorganic pollutants such as cyanides, heavy metals, fluoride etc. (Maikep, 1995). The Councils Biotechnology, Aquaculture Programme (2002) have described a few biofilter media available commercially with their advantages and disadvantages. For example, a very common “fixed-film” biofilter media is known by several names, “Bio-deck”, “Bio-block”. Biodeck is commonly used in wastewater treatment that can be used in a trickle down filter unit or in an upflow filter unit.
Meikap and Roy (1995) described some of the conventional bioreactors which are in use for the treatment of waste water. These are:

1. Aerated lagoon
2. Oxidation ditch
3. Activated sludge tank
4. Trickling filter
5. Anaerobic digestion tank
6. Oxidation pond and
7. Biochemical immobilized reactor

Among the novel immobilized bioreactors are:

(i) Rotating disc bioreactor
(ii) Basket type bioreactor
(iii) Hollow fiber bioreactor
(iv) Fluidized bed bioreactor
(v) Spouted bed bioreactor
(vi) Semi-fluidized bed bioreactor

Apart from these bioreactors, the surface aerators are in extensive use to activate sludge system for the purification of organic waste waters. Similarly pitch blade surface aerators are also used to facilitate waste water treatment.

During the present study at ten study sites of Sheonath river in Durg-Bhilai area, it has been noticed that the water quality has gradually deteriorated from site 1 to site 10 due to inflow of domestic and industrial wastes into it. It is, therefore, suggested that some remedial measures should
be taken so as to reduce the pollution load in the effluent of some nallahas before it is drained into the river. It may be mentioned here that, in the waste water of Kosa nallah, Bhilai nallah, Industrial nallah and Samoda nallah the pollution load is quite high. By installing the effluent treatment plants or under mentioned bioreactors near the nallahas will certainly improvise water quality.

1. Effluent treatment plant
2. Coconut coir filled bioreactor
3. Rotating disc bioreactor
4. Basket type bioreactor
5. Aerated lagoons

8.2 DEVELOPMENT OF AN EFFLUENT TREATMENT PLANT

The waste water from oxidation pond can be lifted through pumps in an overhead tank for storage and onward treatment. Alternatively, water can be stored in a sump which is subsequently pumped to the treatment tank.

The tanks are made of concrete having capacity of approximately 380 cft. The proposed diamensions are 6 feet (B) x 6 feet (H) x 10 feet (L). In side, it is provided with four vertical rods, one at each corner leaving a gap of 6 inches all around. On these rods are placed three horizontal meshes each of 5 feet x 9 feet size made of aluminum or PVC (Fig 8.1). These meshes are placed one above the other at a distance of 1½ feet. The bottom of the tank is given mild slope so that the effluent can be drained out from the bottom. The lowest mesh is placed one feet above the bottom. The second one at 2½ feet above from the bottom and the top most one at a height of 4½ feet from
the bottom, leaving nearly a free board of 2 feet above the top mesh. Over each of these meshes hydrophyte namely *Eichhornia* is placed at the top, *Hydrilla* and *Chara* in the middle and *Vallisnaria* at the bottom respectively. The effluent is made to enter the tank from the top inlet and when it gets filled, a retention time of 72 hrs. is allowed. During this period the water quality improvises which is subsequently drained out. The hydrophytes are then harvested by using cutters as they grow in size and accumulate pollutants within their tissues by uptake mechanism as already demonstrated by IAMB system. The meshes are again placed at their own positions containing cut hydrophytes. Now the tank is ready for the treatment of next quantity of untreated effluent. Similar sizes of 8 to 10 tanks in series can be constructed to treat larger quantity of water. When the first tank is filled with the effluent then it is switched over to the next one and so on. Tanks are filled using pumps of suitable capacity.

The outlet is kept at the bottom level which is used for draining the treated waste water. The 72 hrs. retention time is expected to improve the water quality in terms of BOD. However, if the improvement is not achieved upto the desirable limits then the detention time can be increased. Depending on the retention time in a tank and quantity of the effluent, the desired number of tanks can be used as per requirement. The treated water is then discharged into the river. As per the present study it is proposed to construct such tanks near the Dhamdha road bridge. The oxidation ponds to feed these tanks can be made adjacent to this area where water from Bhilai Nallah can be collected.
8.3 BIOREACTORS

Waste water contains Biodegradable organic matter in the form of settled, suspended, and dissolved solids. To remove BOD, different conventional bioreactors are being used for the last few years. Out of them few are given below.

8.3.1 Coconut Coir Filled Bioreactor

Biofilter is a fixed film biological reactor where the microbial growth takes place on a fixed rigid media like store plastic, ceramic materials, corrugated sheets rayon fibers etc. etc. Fang and Yang (1993) showed promising advantages of using fibrous packing materials in a reactor for the effective removal of COD and nitrogen from waste water. Khursheed Karim and Vaishya (1999) conducted experiments with coconut coir filled Bioreactors and found that by this system the COD and nitrogen removal was upto 90% and 70% respectively within 12 hours of effluent HRT.

In the present study also the coconut coir filled biofilter is being recommended for the effective removal of COD and nitrate at the site number 10, which is the most polluted one. There are certain advantages of this reactor for example; it has short hydraulic retention time without wash out of microbial pollution and without loss of treatment efficiency. It is simple to operate and has high reliability of results. Further, it is the most cost effective system for the biological treatment of water. Another advantage of this system is that it can regain its recovery efficiency even after a breakdown period of 5 days.
The proposed reactor for use can be made of plastic containers each having its height 150 cm, diameter 90 cm and capacity 1000 liters. The barrels are divided into 4-5 compartments with the help of circular PVC disc having holes in them. These disc are held in position at different heights by the stoppers. (Fig 8.2). These disc do not allow coir to settle down due their weight and obstruct the up flow of effluent. A number of such barrels can be used depending upon the quantity and quality of the effluent to be treated. To start the reactor it has to be seeded with sludge collected from oxidation pond and a start up time of nearly 20 days has to be given to grow the biomass. The reactor is to be uniformly filled with almost equal size of coconut coir. The effluent should be filled through an inlet pipe at the bottom for upward flow. After 4 to 12 hours of retention time the effluent is drawn out from outlet provided at the top of containers. The reactor has to be aerated by using air compressor to maintain aerobic condition inside.

8.3.2 Rotating Disc Bioreactor

The rotating disc bioreactor consists of a horizontal rotating shaft on which a number of rounded large diameter plastic discs are fixed. These are kept inside a concrete bioreactor tank. The effluent is pumped into the tank where nearly 40% of the disc surface remain submerged into the waste water (Fig 8.3). On operation the shaft in rotated slowly at a rate of 1 to 2 rpm. The organisms present in the wastewater adhere to the rotating surface of the disc. These multiply and cover almost the entire surface area. This bio-mass becomes approximately 1 to 4 mm. thick within a weeks time. The biological population present on the surface area of the disc is mostly responsible for
treatment achieved. The BOD removal is generally 85-95%. Inside the tank filled with wastewater the rotating discs provide large volume and surface for developing biological culture and provides constant contact for the biological growth with the wastewater. These discs also treat the water efficiently.

8.3.3 Basket Type Bioreactor

A circular Basket type Bioreactor is proposed with an inner diameter of 11.3 feet and height 10 feet giving a capacity of 1000 cft. The bottom is given slope so as to drain out sludge. The immobilized cells are cultured in a basket which can be made of plastic or PVC materials. Its dimensions are 3' x 2½' rectangular in shape. Four baskets are mounted on a central shaft, which rotates at a slow speed of 5-6 rpm. The air is pumped through a aeration tube which extends almost up to the bottom of the tank Fig.8.4. The wastewater is pumped in and is aerated by agitator and immobilized bio-mass acts on it. It may be mentioned here that these bioreactors are very effective and bring down the pollution load in terms of BOD to a desirable standard. The BOD removal capacity of this bioreactor is up to 95%. It is apparent that this type of bioreactor is very effective and cell retention time is quite low (three to four hours only).

These bioreactors can be kept in a line 10 in numbers. The water from oxidation pond may be pumped through there and the treated effluent can be taken out from the top as shown in the Fig. 8.4.
8.4 Aerated Lagoons

For the oxidation of dissolved organics of the waste water, cemented tanks of 4-6 meter deep are prepared. These tanks are called aerated lagoons. The waste water passed through these lagoons are aerated mechanically by using fans or other means. As a result of the oxidation of soluble organics present in the wastewater, sludge is formed after 3-4 days. Nearly 85-90% BOD can be removed by this process. A series of such lagoons can be prepared to improve the water quality.
Fig. 1.1 A geographical map showing the stretch of Sheonath river and its relation with other tributaries.
Fig 1.2: The sketch of Sheonath River showing rough location of the study sites
Fig 3.1: Photograph showing the physiographic details of the Study Site No. 1

Fig 3.2: Photograph showing the physiographic details of the Study Site No. 2
Fig 3.3: Photograph showing the physiographic details of the Study Site No. 3

Fig 3.4: Photograph showing the physiographic details of the Study Site No. 4, 5, 6
Fig 3.5: Photograph showing the physiographic details of the Study Site No. 7

Fig 3.6: Photograph showing the physiographic details of the Study Site No. 8, 9
Fig 3.7: Photograph showing the physiographic details of the Study Site No. 10

Fig 3.8: Photograph showing the physiographic details of the Kosa Nallah
Fig 3.9: Photograph showing the physiographic details of the Bhilai Nallah
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Fig 6.61

Figures showing the Population Levels of Indicator Organisms Chironomas and Mayfly Nymph, Site 1 to 5.
Fig 6.62
Figures showing the Population Levels of Indicator Organisms Chironomas and Mayfly Nymph, Site 6 to 10
Fig 8.1 NEWLY DESIGNED EFFLUENT TREATMENT PLANT
Fig 8.2 COCONUT COIR FILLED BIOREACTOR
Fig 8.3 ROTATING DISC BIOREACTOR
Fig 8.4 BASKET TYPE BIOREACTOR