Grey-water Treatment and Technologies

Rajesh B. Biniwale, Ph.D., D.Sc.
Sr. Principal Scientist and Head
Cleaner Technology and
Modeling Division
National Environmental
Engineering Research Institute
Nagpur 440020 India
rb_biniwale@neeri.res.in

Director
Ecologique Science Technik
(India) Pvt.Ltd.
39, Agnelayout, Nagpur 440025
director@estpl.co.in
rajeshbiniwale@gmail.com
9822745768

At Center of India: Nagpur
Sewage Treatment: Methods, Issues, solutions

Domestic Sewage

- Soakpits
- Septic Tanks

Size specific

Conventional STP (ASP, MBBR, SBR)

Advanced (Membrane etc.)

Energy/ Consumables

Disposal to water bodies

reuse/disposal to water bodies

Wastewater Stabilization Ponds

Possible GWR/ reuse

Reuse/ Recycle

RT/ Area

Wastewater Stabilization Ponds

Reuse/ Recycle

Minimum Energy
Science
Behind
Sewage
Treatment

Sewage Components
• Particulates, Suspended
• Particulates dissolved (mostly salts)
• Organic matter (dissolved)
• Nutrients (N, P)
• Fecal Coliform

Physical Separation

Solid Separations (terminal settling velocity)

Secondary Biological Treatment

• Biochemical Oxidation of Organics to H₂O and CO₂
• Nitrification-denitrification
• Bio-availability of nutrients
• Biomass growth/recycle

Tertiary Disinfection Treatment

Pathogen removal

Coagulants
• Conventionally alum
• Surfactants

Oxygen Supply
• Conventionally aerators
• Diffusers

Disinfecting agent (strong oxidants)
• Conventionally Chlorine
• Hypo-chlorides
• Ozone
Approach for Rural Setup

Sewage Components
- Particulates, Suspended
- Particulates dissolved (mostly salts)
- Organic matter (dissolved)
- Nutrients (N, P)
- Fecal Coliform

Physical Separation

Solid Separations
(Impact separation, Against gravity force)

Secondary Biological Treatment

- Biochemical Oxidation of Organics to H₂O and CO₂
- Nitrification-denitrification
- Bio-availability of nutrients, and uptake
- NO Excess Biomass growth

Tertiary Disinfection Treatment

- Pathogen removal
- No carcinogenic chlorinated compounds

No Chemicals, Let it be Physical

Oxygen Supply
- Nature employed, let plants take care
- NO electrical/mechanical

Disinfecting
- solar disinfection

irrigation reuse
## Technology Selection Approach

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Technology</th>
<th>Application</th>
<th>Advantages</th>
<th>Challenges</th>
</tr>
</thead>
</table>
| 1       | Soak-pit                 | House-hold    | Low cost  
Can treat wastewater                                                          | High water table area  
Potential to contaminate GW  
Water can not be recycled directly  
Solid particles in Grey water |
| 2       | Decentralised CWs        | Community levels | Moderate Costs and operation is easier  
Water available for reuse                                                        | Topography should support for gravity flow  
Will need to consider avoiding solid waste |
| 3       | End-of the village CWs   | Village Level  | Already some places WW ponds are created, applicable very well.  
Can convert WWSPs to handle more wastewater                                      | Receives entire wastewater which could have faecal matter (at least animal waste)  
Technology becomes slightly capex extensive |
Design Approach

- Operating windows for wastewater, parameters
- Source based selection of unit operations
- Space availability and levels
- Proximity of end use of treated water
- Quality of water required
- Soil strata
- Design of plant, conceptual, structural and asthetics
Extent of Treatment

• In case of Grey-water, pollutant loads are low
• If the reuse is for irrigation purpose then treatment upto BOD <30 mg/L should be fine
• Grey water treatment should be considered as different than STP
Decentralized treatment: + points

• Improve reachability, reduce the need for sewage transportation system
• Allowing use of the treated water in-situ
• Minimizing pumping, transportation, thus energy efficient
• Smaller systems technically empowering the smaller LUBs
• Treatment where it is needed
Phytorid: Paradigm Shift in STP Technology

• Technology is based on ecological wastewater treatment designed to mimic the cleansing functions of wetlands with a smaller footprint.
• Combination of Physical separation and nature available biological components to treat sewage.
• Designed to effectively work in tropical conditions and properly camouflage in the aesthetics of landscape.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Inlet sewage quality</th>
<th>Treated water quality</th>
<th>Standards for inland surface water</th>
<th>Standards Land Irrigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>7.1 to 7.5</td>
<td>7.2</td>
<td>5.5-9.0</td>
<td>5.5-9.0</td>
</tr>
<tr>
<td>BoD (mg/L)</td>
<td>80 to 300</td>
<td>&lt;10 to 20</td>
<td>30</td>
<td>100</td>
</tr>
<tr>
<td>CoD (mg/L)</td>
<td>130 to 350</td>
<td>&lt; 50 to 100</td>
<td>250</td>
<td>Not Specified</td>
</tr>
<tr>
<td>TSS (mg/L)</td>
<td>80 to 90</td>
<td>&lt; 15</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>Fecal Coli Farm (MNP/100ml)</td>
<td>$10^6$ to $10^7$</td>
<td>&lt;500</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Nitrogen (mg/L)</td>
<td>10 to 50</td>
<td>4-5</td>
<td>5</td>
<td>Not Specified</td>
</tr>
<tr>
<td>Phosphate (mg/L)</td>
<td>10 to 50</td>
<td>1-4</td>
<td>5</td>
<td>Not Specified</td>
</tr>
</tbody>
</table>
Phytorid Technology: Case studies

Area Required is 0.2-0.3 Sqm per capita
Phytorid Treating Nag River Water: Pilot Project

Raw sewage in nallah

Plant at Agricultural college, PKV Nagpur
Plant Capacity 100 m³/day

Phytorid System

Treated water
### Performance of PHYTORID for Sewage typical results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Inlet sewage quality</th>
<th>Treated water quality</th>
<th>Standards for inland surface water</th>
<th>Standards Land Irrigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>7.1 to 7.5</td>
<td>7.2</td>
<td>5.5-9.0</td>
<td>5.5-9.0</td>
</tr>
<tr>
<td>Biochemical Oxygen Demand (mg/L)</td>
<td>40 to 130</td>
<td>&lt;10</td>
<td>30</td>
<td>100</td>
</tr>
<tr>
<td>Chemical Oxygen Demand (mg/L)</td>
<td>130 to 350</td>
<td>&lt; 20-35</td>
<td>250</td>
<td>Not Specified</td>
</tr>
<tr>
<td>Total Suspended solids (mg/L)</td>
<td>80 to 90</td>
<td>&lt; 10</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>Fecal Coli Farm (MNP/100ml)</td>
<td>$10^6$ to $10^7$</td>
<td>&lt;20</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Nitrogen (mg/L)</td>
<td>10 to 50</td>
<td>4-5</td>
<td>5</td>
<td>Not Specified</td>
</tr>
<tr>
<td>Phosphate (mg/L)</td>
<td>10 to 50</td>
<td>1-4</td>
<td>5</td>
<td>Not Specified</td>
</tr>
</tbody>
</table>
Case Study: Semi-Urban

Lonar Lake, Maharashtra

Capacity: 500 kld
Area: 600 m²
Reuse of Treated Water: Irrigation
Approach for the sewage treatment

Phytorid system

Streams from small villages/towns

Basin Approach
- Reducing pollution load from sewage
- Decentralised treatment system at villages and town levels
- Nallah-in-situ treatment
## Maharashtra Project: NABARD-MJP

<table>
<thead>
<tr>
<th>Sr No</th>
<th>Village</th>
<th>Capacity of WWTP (In MLD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Shiroli</td>
<td>0.85 &amp; 0.25</td>
</tr>
<tr>
<td>2</td>
<td>Kodoli</td>
<td>1.0 &amp; 0.15</td>
</tr>
<tr>
<td>3</td>
<td>Lonand</td>
<td>0.7</td>
</tr>
<tr>
<td>4</td>
<td>Ozar</td>
<td>1.0 &amp; 0.6</td>
</tr>
<tr>
<td>5</td>
<td>Kalwan</td>
<td>0.6</td>
</tr>
<tr>
<td>6</td>
<td>Chandwad</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>Pimpalgaon</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>Jamkhed</td>
<td>0.6 &amp; 0.50</td>
</tr>
<tr>
<td>9</td>
<td>Shevgaon</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>Murbad</td>
<td>0.55 &amp; 0.45</td>
</tr>
<tr>
<td>11</td>
<td>Pasthal</td>
<td>0.6</td>
</tr>
<tr>
<td>12</td>
<td>Varangaon</td>
<td>0.6</td>
</tr>
<tr>
<td>13</td>
<td>Loni Kalbhor</td>
<td>1</td>
</tr>
<tr>
<td>14</td>
<td>Hiwarkhed</td>
<td>0.55</td>
</tr>
<tr>
<td>Periods in Months</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>-------------------</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td>Maintenance Item</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Replantation (partial if needed)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Water Quality analysis</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cleaning of Screening Chamber [this could be every week, in case load of floating matter is high]</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Harvesting of overgrown plants and roots</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hydraulics/ water level Checks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solids Cleaning in Phytorid Chambers</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Cleaning of Settling chamber</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gravel checks and reshuffle</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Pump maintenance (if pump is installed)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Biomedia augmentation (10% of the first time addition)</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Conclusions

• Constructed wetland is the needed innovative technology: Ecologically benign

• Nearly free of fossil based energy therefore sustainable and doable

• Cost effective in terms of O&M is most important factor
Thank You

More Information contact
Dr. Rajesh Biniwale
(M) 09822-745-768