Floating treatment wetlands: An innovative approach for the remediation of sewage water

Joint Project of WASA & NIBGE

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Problem: Environmental pollution

- In Pakistan, 35% burden of diseases is attributed due to environmental pollution (WHO).

- Pakistan is among 17 countries that may face severe water shortages by 2025. "In this situation reuse of wastewater following proper treatment would be an option for reducing the water shortage" (World Bank Report).
Wastewater treatment: Solution

Conventional technologies: It is difficult for the industries and other organizations of Pakistan to apply those for wastewater treatment.

Why?

High capital (Pak Rs. 100 Millions = 1 Million US$) and operational costs*.

Lack of trained manpower, use of electricity and expensive chemicals, 24 h look after.

*Daily operational cost is about Pak Rs. 50,000/- (500 US$) in an industry to operate Wastewater Treatment Plant.
Floating treatment wetlands: Solution

We have addressed the issues of capital and operational costs

To develop Floating Treatment Wetlands

through the use of

Indigenous Plants (vegetation)
Locally Fabricated Floating Mat
Floating treatment wetland

An innovative technology for water pollution management.

- Floating mats sustain and support plants.
- Roots grow into the water.
Mechanisms of floating treatment wetlands

- Filtration
- Adsorption
- Absorption
- Provision of oxygen and nutrients
- Formation of microbial biofilm
- Drug residues
- Oil & grease
- Detergents
- Dyes
- Heavy metals and nutrients (N & P)
Floating treatment wetlands: Advantages

- Lower cost technology than other wastewater treatment options
- It is a more sustainable and efficient technology
- No new or complex technological tools are needed.
- No energy is needed, with periodic on-site labour.
- Aesthetically pleasing technology.
- Reduce/eliminate the foul odor (bad smell).
- Applicable in almost all types of wastewater stabilization pond, drain, lake, river.
- Use of local material (indigenous plants and floating mat).
- It can be applied as a primary or secondary or tertiary treatment.
- Industrial and domestic wastewater treatment.
Examples of application FTWs technology for the remediation of domestic and industrial effluent
In Pakistan, for the very first time, floating treatment wetland technology has been developed and applied for the remediation of sewage effluent in the lab as well as in the field.

WASA Faisalabad and NIBGE Joint Project
## Characteristics of sewage effluent (40% industrial effluent) of Faisalabad city

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Sources</th>
<th>NEQS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Paharang drain</td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>7.7 (1.3)</td>
<td></td>
</tr>
<tr>
<td>COD (mg l(^{-1}))</td>
<td>460 (105)</td>
<td></td>
</tr>
<tr>
<td>BOD (mg l(^{-1}))</td>
<td>189 (58)</td>
<td></td>
</tr>
<tr>
<td>Dissolved Oxygen (mg l(^{-1}))</td>
<td>0.5 (0.1)</td>
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<tr>
<td>TS (mg l(^{-1}))</td>
<td>3444 (580)</td>
<td>NG</td>
</tr>
<tr>
<td>TDS (mg l(^{-1}))</td>
<td>3279 (460)</td>
<td>3500</td>
</tr>
<tr>
<td>TSS (mg l(^{-1}))</td>
<td>164 (12)</td>
<td>150</td>
</tr>
<tr>
<td>Cl (mg l(^{-1}))</td>
<td>939 (82)</td>
<td>1000</td>
</tr>
<tr>
<td>SO(_4) (mg l(^{-1}))</td>
<td>328 (45)</td>
<td>600</td>
</tr>
<tr>
<td>Cd (mg l(^{-1}))</td>
<td>0.5 (0.07)</td>
<td>0.1</td>
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<tr>
<td>Cr (mg l(^{-1}))</td>
<td>2.3 (0.36)</td>
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</tr>
<tr>
<td>Fe (mg l(^{-1}))</td>
<td>11.6 (1.2)</td>
<td>2</td>
</tr>
<tr>
<td>Ni (mg l(^{-1}))</td>
<td>3.8 (0.48)</td>
<td>1</td>
</tr>
<tr>
<td>Oil and grease (mg l(^{-1}))</td>
<td>8.5 (1.3)</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Madhuana drain</td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>7.6 (0.85)</td>
<td>6-10</td>
</tr>
<tr>
<td>COD (mg l(^{-1}))</td>
<td>508 (83)</td>
<td>150</td>
</tr>
<tr>
<td>BOD (mg l(^{-1}))</td>
<td>213 (65)</td>
<td>80</td>
</tr>
<tr>
<td>Dissolved Oxygen (mg l(^{-1}))</td>
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<tr>
<td>TS (mg l(^{-1}))</td>
<td>4354 (620)</td>
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</tr>
<tr>
<td>TDS (mg l(^{-1}))</td>
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</tr>
<tr>
<td>TSS (mg l(^{-1}))</td>
<td>180 (24)</td>
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</tr>
<tr>
<td>Cl (mg l(^{-1}))</td>
<td>1150 (108)</td>
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</tr>
<tr>
<td>SO(_4) (mg l(^{-1}))</td>
<td>505 (78)</td>
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</tr>
<tr>
<td>Cd (mg l(^{-1}))</td>
<td>0.78 (0.08)</td>
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</tr>
<tr>
<td>Cr (mg l(^{-1}))</td>
<td>8.7 (1.33)</td>
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</tr>
<tr>
<td>Fe (mg l(^{-1}))</td>
<td>13.7 (1.60)</td>
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</tr>
<tr>
<td>Ni (mg l(^{-1}))</td>
<td>6.5 (0.62)</td>
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</tr>
<tr>
<td>Oil and grease (mg l(^{-1}))</td>
<td>15.7 (2.7)</td>
<td></td>
</tr>
</tbody>
</table>

**Anaerobic** condition produce bad smell due the production of H\(_2\)S.
Development of floating treatment wetlands: Lab scale studies

Floating mat

Plantation in the mat

Treatment of sewage effluent of Faisalabad city
Faisalabad sewage water treatment by FTWs

Treated effluent meet NEQS after 72 h

Pilot scale studies at NIBGE
Visit of MD WASA FSD (Eng. Syed Zahid Aziz) of NIBGE
Visit of MD (Eng. Syed Zahid Aziz) WASA and his Team at NIBGE
WASA & NIBGE sign Agreement for Sewage Effluent Treatment

Sewage waste stabilization ponds at Chokera, Faisalabad could be in the near future turn into aesthetically sound area and the untreated wastewater from the city will be treated using floating wetlands, experienced for the very first time in the country.

That follows a signing of a project agreement between National Institute for Biotechnology and Genetic Engineering (NIBGE), an institute of Pakistan Atomic Energy Commission (PAEC) and Water and Sanitation Agency (WASA), Faisalabad, on April 07, 2014. The agreement was signed by Dr. Shahid Mansoor, SI, Director NIBGE and Mr. Syed Zahid Aziz, Managing Director WASA.

The Environmental Biotechnology Division at NIBGE is being engaged in the application of the floating treatment wetlands at the selected site. In the first phase, approximately 10,000ft² floating treatment wetlands will be applied for the treatment of sewage effluent of Faisalabad city and in future, it may extend to 100,000 ft². This project is applied in nature and is very important from an environmental point of view. Dr. Muhammad Afzal, PS, (P.I.), Dr. Qaiser M. Khan DCS, (Head &Co-P.I.), Mr. Amer Jamal Hashmat (SS), Dr. Ejazul Islam (SS), Dr. Samina Iqbal (PS), Mr. Anwar ul-Haq (SS) &Eng. Aslam Hayat (SE) are the main team members of project.
Fabrication of floating mat

It is 400 times less expensive than the floating mat available in the international market
Development of floating treatment wetlands at Chokera, WASA Wastewater Treatment Plant, FSD
Application of FTWs (10,000 ft$^2$) for the remediation of sewage effluent of Faisalabad city

Quite innovative project and for the very first time applied in Pakistan
Lot of vegetation on the mat and certainly roots in water
Joint project of WASA and NIBGE

FLOATING TREATMENT WETLANDS
TO IMPROVE WASTEWATER QUALITY
A JOINT PROJECT OF
WATER & SANITATION AGENCY (WASA) FAISALABAD
AND
NATIONAL INSTITUTE FOR BIOTECHNOLOGY
AND GENETIC ENGINEERING (NIBGE)
Pakistan Atomic Energy Commission (PAEC)
2014 - 2016
Growth of the flowering plants on sewage water
Growth of Rose plants on sewage water
Google earth image showing FTWs applied in Faisalabad

Covered Area ~ 10,000 sq ft
Development of the **Roots** below the mat
Reduction (\%) in pollution level in sewage effluent of Faisalabad city by FTWs

% reduction

<table>
<thead>
<tr>
<th>Parameter</th>
<th>COD</th>
<th>BOD</th>
<th>Cr</th>
<th>Fe</th>
<th>N</th>
<th>P</th>
<th>Cl</th>
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<tbody>
<tr>
<td>Reduction</td>
<td>60</td>
<td>70</td>
<td>60</td>
<td>60</td>
<td>50</td>
<td>50</td>
<td>60</td>
</tr>
</tbody>
</table>
Visit of local Scientist/Engineers of the FTWs
Visit of the Foreigners Scientists/Engineers of the FTWs
WASA provided more funds for the application of the technology in another sewage stabilization pond
Vegetation of non-edible trees at the embankments of the pond
Floating wetlands: a new approach to wastewater remediation

By Dr Muhammad Afzal

Pakistan Atomic Energy Commission (PAEC) has a clear mandate on the safe application of modern sciences with an aim to improve the socio-economic growth of the country. National Institute for Biotechnology and Genetic Engineering (NIBGE) is one of the main biotechnology institutes of the four bioscience centres of PAEC. The institute is a focal point of modern biotechnology and provides a technology receiving unit to help the development of country through

Application of floating treatment wetlands in Pakistan for the remediation of sewage effluent of Faisalabad

ate. Principally, the roots emerging out from the netted base of the floating mat are the main players in remediation of the effluent. They either filter/adsorb inorganic pollutants, including heavy metals and particulate matter through their extensive root system, or take them up, as harmful organic material like drug residues, dyes, and detergents, to break it down naturally to harmless compounds independently or with the help of carefully chosen microbes that proliferate on or within roots and plant tissue.

Faisalabad city is the industrial hub of Pakistan with a population of more than 2.7 million and sewage effluent generation of nearly 435 million gallons per day that is discharged in the Chenab and Ravi rivers through Paharang and Madhuana drains, respectively. Many small and large scale industries are located in the city and surrounding area and discharge their wastewater
Impact of WASA-NIBGE Joint Project

• Improvement in sewage effluent quality.
• Exploration of this sustainable technology in Pakistan.
• Application of FTWs in OGDCL and Interloop.
• We are going to apply in LUMS Lahore, Noor Fatima Fabrics Khurianwal, Rafhan Maize Products Jaranwala.
• We can apply this technology in River Ravi to improve the quality of the water.
Remediation of Textile Effluents by FTWs

After 72 h

Water Quality Parameters

Control

FTWs
Application of bacterial assisted constructed/floating wetlands in the Interloop for the remediation of textile effluent (50,000 liters)

In the vicinity of Interloop Limited Khurianwala, Faisalabad (in progress)
Application of FTWs for the remediation of oil contaminated water at OGDCL
Bioremediation of crude oil contaminated soil at sea shore Karachi in 2003
Development of wetlands to improve the quality of Interloop effluent
Phytoremediation of crude oil contaminated soil at OGDCL
Application of FTWs at LUMS Lahore

We are going to apply 10,000 sq ft FTWs in drain in the front of LUMS to improve sewage effluent quality and remove bad smell/odor.

Drain in the front of LUMS, Lahore
Provision of Environmental Testing Facilities to Private and Public Sector since 1993

EPA Certified lab

72 tests were performed:
Main are: COD, BOD, heavy metals, toxicity, formaldehyde, antifungal and anti microbial tests, *E.coli*, coliforms, etc.
Team members

• Dr. Muhammad Afzal, Principal Scientist/Group Leader, PhD, Key Advisor of the Project.

• Dr. Qaiser M. Khan, Deputy Chief Scientist/ Head of Division, PhD, Co-Advisor of the Project.

• Dr. Samina Iqbal, Principal Scientist, PhD

• Dr. Ejazul Islam, Senior Scientist, PhD

• Mr. Amer J. Hashmat, Senior Scientist, M.Phil, Environmental Engineer

• Mr. Anwarul Haq, Principal Scientist, M.Phil Environmental Science

• Mr. Ghulam Shabir, Senior Technician, M.Phil Analytical Chemistry
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• Eng. Muhammad Hafeez, Director WWT,
• Eng. Syed Zahid Aziz, MD
Thank you very much for your attention