Treatment and Potential Uses of Wastewater

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Composition of Wastewater

Municipal Wastewater

- 99.93% water
- 0.07% Total solids (SS + Dissolved)

Treatment and reuse only deals with:

- Aimed to convert into settleable sludge to produce energy (anaerobic digestion)
- 50% Organic
- 50% inert

Organic composition: 50% Protein; 40% Carbohydrates and 10% Fats and Oils, and trace amounts of priority and Surfactants (detergents, Soap, Shampoo, etc.)

Compost-like end product as fertilizers for land application

Threat to potential contamination of surface water due to Nitrogen & Phosphorous

- Municipal wastewater typically contains: 220 mg/L of both SS & BOD
- Microbiological composition of Wastewater includes: $10^5 - 10^8$ CFU Coliform, $10^3 - 10^4$ CFU Fecal Streptococci, etc.
- Water > 1000 mg/L TDS is unsafe for irrigation.
## Composition of Wastewater

### Industrial Wastewater (Point Source Pollution)

<table>
<thead>
<tr>
<th>Sector</th>
<th>Pollutant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron and Steel</td>
<td>BOD, COD, Oil, Metals, Acids, Phenols, Cyanide</td>
</tr>
<tr>
<td>Textiles and Leather</td>
<td>BOD, Solids, Sulfates and Chromium</td>
</tr>
<tr>
<td>Pulp and Paper</td>
<td>BOD, COD, Solids, Chlorinated organic compounds</td>
</tr>
<tr>
<td>Petrochemicals and Refineries</td>
<td>BOD, COD, Mineral oils, Phenols, and Chromium</td>
</tr>
<tr>
<td>Chemicals</td>
<td>COD, Organic chemicals, Heavy metals, SS and cyanide</td>
</tr>
<tr>
<td>Non-ferrous metals</td>
<td>Fluorine and SS</td>
</tr>
<tr>
<td>Microelectronics</td>
<td>COD and Organic Chemicals</td>
</tr>
<tr>
<td>Mining</td>
<td>SS, Metals, Acids and Salts</td>
</tr>
</tbody>
</table>

- **Removal of Inorganic Chemicals** are concern and require mechanized treatment technique.
### Agricultural Wastewater (Nonpoint and point Source Pollution)

<table>
<thead>
<tr>
<th>Source</th>
<th>Pollutant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sediment Runoff</td>
<td>SS and Turbidity</td>
</tr>
<tr>
<td>Nutrient Runoff</td>
<td>Nitrogen, Phosphorous, Sludge</td>
</tr>
<tr>
<td>Pesticides</td>
<td>Active ingredients, other ingredients</td>
</tr>
<tr>
<td>Animal Wastes</td>
<td>Strong Copper, Nitrate, Phosphate and concentration, Antibiotics, Parasites, Pathogenic Bacteria, etc</td>
</tr>
<tr>
<td>Piggery Wastes</td>
<td>Same as animal wastes, and elevated Copper</td>
</tr>
<tr>
<td>Milking Parlor Wastes</td>
<td>Organic pollutants, Disinfection chemicals, etc.</td>
</tr>
<tr>
<td>Slaughtering Wastes</td>
<td>Same as Milking Parlor</td>
</tr>
<tr>
<td>Vegetable Washing</td>
<td>Soil and Vegetable Pieces, and Pesticides</td>
</tr>
</tbody>
</table>

**Major concerns - Organic Pollutants and ‘Natural Treatment Techniques’ can be used.**
Municipal Wastewaters

- **Natural Treatment Techniques (NTTs):** Stabilization or oxidation ponds, Natural and Constructed Wetlands, Phyto and Bio-remediation. *(Land Footprint is more).*

- **Mechanized Treatment Techniques:** Aerated Lagoon, Trickling Filters, Conventional Treatment Techniques, etc. *(Costly and recurring energy foot print and O & M cost).*

- **Combination of NTT & Mechanized system:** CW followed by oxidation or stabilization pond, Or, Aerated Lagoon followed by oxidation pond. *(Marginal land and Energy foot prints).*

- **Advanced Technique:** Blasted Sand Flocculation (BSF) together with mechanized system. *(Efficient & Reduced land foot prints)*
Contaminant Removal Mechanisms: Multiple Processes At Work

Constructed Wetland

Reed material as filtering media

Mechanized system: Aerated Lagoon

Waste Stabilization pond

Combination of AL & OP (Ghosh & Bose, 1994)

Ballasted Sand Flocculation
Industrial Wastewater Techniques:
Mechanized techniques vary from types of Industrial effluents.

Primary – Secondary- Tertiary Treatment of Wastewater
Potential Uses of Reclaimed Wastewaters

- Urban uses
- Industrial uses
- Agricultural purposes
- Habitat restoration/enhancement/creation
- Groundwater recharge

Concerns:
- Public Health
- Public acceptance

Uses of Treated Wastewater:

Municipal
  - Recreation
  - Urban use
  - Groundwater Recharge

Industrial
  - Industries
  - Agriculture
Potential Urban Uses

- **Irrigation** - public parks, schools, road and building construction, landscaped areas, golf courses, etc.

- **Commercial** - vehicle washing facilities, laundry facilities, mixing pesticides and herbicides

- **Construction** - dust control, concrete production

- **Toilet and urinal flushing**

- **Fire protection**

**Lawn watering**  **Building Construction**  **Car washing**
Potential Agricultural Uses

Agricultural uses

Benefits
- High concentrations of nutrients
- May eliminate need for fertilizer
- Long-term soil enrichment
- Decreases demand on potable water supply
- Additional treatment in soil

Limitations
- Health risk from associated pathogens
- Health risk from other contaminants (e.g. metals, chemicals, pharmaceuticals)
- Decrease in soil quality from accumulation of metals and acidification.
- Contamination of groundwater
Potential Uses for GW Recharge

Groundwater Recharge

Advantages
- Establish saltwater intrusion barriers
- Provide further treatment for future reuse
- Provide storage of reclaimed water for subsequent retrieval and reuse
- Control or prevent ground subsidence
- No evaporation, taste and odor

Limitations
- Extensive land areas needed for spreading basins
- Costs of treatment, water quality monitoring, and injection/infiltration facilities may be expensive.
- Recharge may increase danger to aquifer contamination due to inadequate pretreatment.
- Inadequate institutional arrangement or groundwater laws
India’s Status on Wastewater

NWP (2012): incentivizes for recycle and re-use of water.

Survey (2010): **Class-I** (Population > 0.1 million): 498 i/c 35 metropolitan cities

**Class-II** (0.1 > Population > 0.05 million): 410 India’s cities
India’s Status of Municipal Wastewater

➢ Wastewater generation

- Class-I cities: 35,558 MLD (44% from Metropolitan cities)
- Class-II towns: 2,697 MLD (Source: CPCB, 2009)

➢ Existing capacity of wastewater treatment

- Class I cities: 11,553 MLD (32% of wastewater generated)
- Class-II towns: 233.7 MLD (8.66% of wastewater generated).
Status of Municipal Wastewater treatment in urban areas (source: CPCB-CUPS/70/2009-2010)

- **Metropolitan cities (35)**
  - Population > 1 million
  - Sewage generation: 15,664 MLD
  - Sewage treatment capacity: 8,040 MLD
  - Treatment capacity: 51.3%

- **Class-I cities (463)**
  - 1 million > Population > 0.1 million
  - Sewage generation: 19,894 MLD
  - Sewage treatment capacity: 3,513 MLD
  - Treatment capacity: 17.66%

- **Class-II cities (410)**
  - 0.1 million > Population > 0.05 million
  - Sewage generation: 2696 MLD
  - Sewage treatment capacity: 233.7 MLD
  - Treatment capacity: 8.66%
## Status of Municipal water supply, wastewater generation and treatment in India

<table>
<thead>
<tr>
<th>Category</th>
<th>No. of cities</th>
<th>Total water supply (MLD)</th>
<th>Wastewater generation (MLD)</th>
<th>% wastewater generation to water supply</th>
<th>% of wastewater treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class-I</td>
<td>498</td>
<td>44,769</td>
<td>35,558</td>
<td>79 %</td>
<td>32 %</td>
</tr>
<tr>
<td>(i/c Metropolitan)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class-II</td>
<td>410</td>
<td>3,324</td>
<td>2696.7</td>
<td>81 %</td>
<td>8.66%</td>
</tr>
<tr>
<td>Total</td>
<td>908</td>
<td>48,093</td>
<td>38,254.7</td>
<td>79.5%</td>
<td>30.8%</td>
</tr>
</tbody>
</table>

- Untreated wastewaters flow onto/to overland, streams, and surface water bodies

**Industrial wastewaters:** About 57,000 polluting industries generate about 13,468 MLD (nearly, 60% treated).
Water supply and sewage disposal status in class I cities

Source: R. C. Trevedi, (CPCB, 2005)

Showed a rising trend in all sectors
Water supply and wastewater generation and treatment in class II towns of India

Source: R. C. Trevedi, (CPCB, 2005)

Showed not much improvement to wastewater treatment side
<table>
<thead>
<tr>
<th>Category</th>
<th>Sewage generation (MLD)</th>
<th>Treatment (%)</th>
<th>Disposal to/on</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class – I cities</td>
<td>2637.7</td>
<td>44.5%</td>
<td>Ganga River</td>
</tr>
<tr>
<td></td>
<td>7841.5</td>
<td>46.8%</td>
<td>Tributaries of Ganga</td>
</tr>
<tr>
<td></td>
<td>907.4</td>
<td>16%</td>
<td>Land</td>
</tr>
<tr>
<td>Class-II cities</td>
<td>122</td>
<td>13.4%</td>
<td>Ganga River</td>
</tr>
<tr>
<td></td>
<td>134.6</td>
<td>6.6%</td>
<td>Tributaries of Ganga</td>
</tr>
<tr>
<td></td>
<td>767.3</td>
<td>7%</td>
<td>Land</td>
</tr>
<tr>
<td>Total</td>
<td>12,410.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Status of Ganga Basin (2005-06) :**

- Ganga river : **1569.6 MLD** of untreated sewage
- Tributaries : **4297.4 MLD** of untreated sewage
- Land : **1475.8 MLD** of untreated sewage
- Total : **7342.8 MLD** of untreated sewage
WQ status of the River Ganga

- Total length the river: 2525 km
- In Uttarakhand & Uttar Pradesh: 1450 km
- U. P. & Bihar boundary: 110 km
- Bihar: 445 km
- West Bengal: 520 km

Length Up to Haridwar from source, 253 km
WQ status of River Ganga – in Uttarakhand

BOD > 3 mg/L

FC > 5000 MPN/100 ml

TC > 5000 MPN/100 ml
WQ status of the River Ganga – U. P. (upper stretch)

**WATER QUALITY OF RIVER GANGLA IN UTTAR PRADESH UPPER STRETCH-2010**

**DO (mg/l)**

- **MIN**: 6.7, 7, 7.4, 7.9, 6.9, 5.6, 5.5, 5.6, 5.5, 4.7
- **MAX**: 10, 8.9, 8.2, 9, 8.3, 8.9, 8.7, 10, 12, 9.4
- **MEAN**: 8.1, 8.0, 7.9, 8.2, 7.8, 7.2, 7.0, 7.5, 8.1, 6.3
- **DO < 6 mg/l**

**B.O.D. (mg/l)**

- **MIN**: 3.0, 2.0, 2.4, 2.3, 2.6, 3.1, 4.0, 2.4, 2.3, 4.6
- **MAX**: 6.0, 3.2, 3.4, 3.1, 3.8, 5.5, 5.6, 4.8, 4.4, 7.8
- **MEAN**: 4.2, 2.7, 2.9, 2.8, 3.0, 4.0, 5.0, 3.6, 3.3, 6.1
- **BOD > 3 mg/l**
WQ status of Ganga river – U.P (Upper stretch)

**WATER QUALITY OF RIVER GANGA IN UTTAR PRADESH UPPER STRETCH-2010**

**FC > 5000 MPN/100 ml**

**TOTAL COLIFORM (MPN/100 ml)**

**TC > 5000 MPN/100 ml**
WQ status of Ganga river – in Bihar

In Bihar Upper stretch considerable improvement in DO & BOD
WQ status of Ganga river in Bihar

**WATER QUALITY OF RIVER GANGA IN BIHAR UPPER STRETCH - 2010**

<table>
<thead>
<tr>
<th></th>
<th>BUXTAR</th>
<th>RAMREKHAGH AT BUXTAR</th>
<th>INDRAPURI DEHRI ON SONE</th>
<th>DORIGANJ CHAPARA</th>
<th>KHURJA PATNA (U/S)</th>
<th>DARBBANGA GHAT, PATNA</th>
<th>PATNA D/S</th>
<th>PUNPUN, PATNA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MIN</strong></td>
<td>500</td>
<td>3000</td>
<td>500</td>
<td>1100</td>
<td>500</td>
<td>2400</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td><strong>MAX</strong></td>
<td>3000</td>
<td>9000</td>
<td>1300</td>
<td>1700</td>
<td>2400</td>
<td>16000</td>
<td>9000</td>
<td>2400</td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
<td>1889</td>
<td>7889</td>
<td>911</td>
<td>1367</td>
<td>1720</td>
<td>7711</td>
<td>4278</td>
<td>1333</td>
</tr>
</tbody>
</table>

**WATER QUALITY OF RIVER GANGA IN BIHAR UPPER STRETCH - 2010**

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<th>PUNPUN, PATNA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MIN</strong></td>
<td>1400</td>
<td>12000</td>
<td>1400</td>
<td>2800</td>
<td>1400</td>
<td>9000</td>
<td>9000</td>
<td>1700</td>
</tr>
<tr>
<td><strong>MAX</strong></td>
<td>9000</td>
<td>24000</td>
<td>3000</td>
<td>9000</td>
<td>5000</td>
<td>24000</td>
<td>24000</td>
<td>5000</td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
<td>4600</td>
<td>21778</td>
<td>2389</td>
<td>4933</td>
<td>3170</td>
<td>21444</td>
<td>15333</td>
<td>2744</td>
</tr>
</tbody>
</table>
WQ status of Ganga river in West Bengal

**Water Quality of River Ganga in West Bengal - 2010**

**DO (mg/l):**
- **MIN**: 6.2, 6.5, 7, 4.7, 6.4, 5.2, 4.8, 4.7, 6.6, 6.6, 7.4, 6.9
- **MAX**: 10.9, 10, 9.8, 9.1, 9.5, 9.9, 8.6, 9.6, 10.1, 7.2, 7.2
- **MEAN**: 7.7, 7.8, 7.9, 6.8, 7.6, 6.9, 6.2, 6.6, 7.4, 6.9, 6.9

**Avg. DO > 6.5 mg/l**

**B.O.D. (mg/l):**
- **MIN**: 1.2, 0.8, 1.5, 1.1, 1.0, 0.7, 1.4, 2.0, 1.1, 1.1, 1.1
- **MAX**: 2.1, 2.9, 2.8, 6.0, 1.7, 3.2, 3.0, 5.3, 2.5, 6.3, 6.3
- **MEAN**: 1.6, 1.8, 2.1, 4.2, 1.4, 2.1, 2.2, 3.2, 1.6, 4.2, 4.2
WQ status of Ganga river in WB

All stations > 5000 MPN/100 ml

All stations > 5000 MPN Per 100 ml
Concluding Remarks

- **Municipal wastewater** typically contains **99.93% water** and **0.07% total solids.** Of 0.07% TS, 50% Organic contains and balance 50% inert. Treatment is concern to remove organic contents, which can be used as nutrients for agricultural purposes. Hence, treated effluents have a lot of potential for different beneficial uses such as, Urban, Agricultural, and groundwater recharge.

- **Industrial wastewater** composition varies based on types of Industries and typically contains high COD, trace metals, and toxic elements and hence need mechanized treatment before allowing effluents to flow out of Industries.

- **NTT** such as, CW, Stabilization ponds, Phyto and Bio Remediation techniques, which require considerable land footprint, can be used for Municipal Wastewater Treatment.

- **Wastewater** is not a waste, it has a lot of productive values, and can be regarded as potential recourses of water.
Thanks