INDUSTRIAL WATER MANAGEMENT

TREATMENT OPTIONS

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Whitewater Ltd, UK
Wastewater Treatment Options

- Treatment processes
- End of pipe treatment
- Segregation of waste streams
- At source treatment
Treatment Processes

- Physical
- Chemical
- Biological
- Advanced Oxidation Processes
Treatment Processes

- Diluting a wastewater to comply with discharge standards is **not** treatment.
- Removing a contaminant from one phase into another is **not** the same as destroying it.
Treatment Processes

- **Physical**
  - membrane separation (MF, UF, RO)
  - adsorption (GAC, silica, synthetics, etc)
  - clarification
  - stripping
  - evaporation
Treatment Processes

DAF plant - dairy effluent

Evaporator - utility effluent

UF Module
Treatment Processes

➢ Chemical
  ➢ neutralisation
  ➢ precipitation
  ➢ coagulation
  ➢ oxidation/reduction
  ➢ ion exchange
  ➢ electrodialysis
Treatment Processes

Reduction - copper plating effluent

Ion exchange plant

Lime neutralisation plant
Treatment Processes

- **Biological**
  - aerobic
    - activated sludge
    - nitrification
    - N and P removal
    - “designer bugs”
    - fungi
    - PACT
  - Anaerobic
Treatment Processes

Membrane bioreactor
Activated sludge plants
Treatment Processes

- Membrane bioreactors
- Activated sludge biology
- Biomass separation by membrane
- UF or MF
- MLSS 5000-10000mg/l
- Reduced footprint
- Low turbidity permeate
- Disinfected by filtration
- Permeate suitable for reuse or RO feed
Treatment Processes

- **Submerged**
  - **Flat sheet**
    - Usually in aeration tank
    - Aeration air reduces fouling
  - **Hollow fibre**
    - Usually separate tank with coarse bubble aeration for fouling control
Treatment Processes

- **Flat sheet**
  - Polyethylene
  - Formed as plate
  - Air bubbles keep surface clean
  - 0.4µm pores
Treatment Processes

- **Hollow fibre**
  - Formed as loose bundles
  - Air bubbles keep surface clean
  - May be in aeration tank or in a separate tank
  - 0.4-2.8mm OD
  - Predominantly PVDF
Treatment Processes

- **External**
  - Hollow fibre
  - Formed as loose bundles
  - Air bubbles keep surface clean
  - May be in aeration tank or in a separate tank
  - 0.4-2.8mm OD
  - Predominantly PVDF
Treatment Processes

- **Upflow Anaerobic Sludge Blanket (UASB)**
  - First Biothane plant at Gist Brocades, Delft 1985 Low sludge production
  - Mainly used in industrial wastewater treatment
  - Fast settling granular sludge
Treatment Processes

- Advanced Oxidation Processes
  - generation of OH•
  - Fenton’s Reagent \((H_2O_2 + Fe^{2+})\)
  - ozone/peroxide/UV
  - UV/TiO_2
  - Ultrasonics
  - Wet air oxidation
  - Supercritical water oxidation
Treatment Processes

Ozone generator

UV/Ozone reactor

UV irradiation chamber
# Treatment Processes

Pilot plant results for W3T ozone/UV unit
April 2012 treating Bandar Tun Razak STW FE

<table>
<thead>
<tr>
<th>Sample</th>
<th>COD (mg/L)</th>
<th>TOC (mg/L)</th>
<th>BOD (mg/L)</th>
<th>TOTAL COLIFORM (MPN)</th>
<th>E.Coli (MPN)</th>
<th>SUSPENDED SOLID (mg/L)</th>
<th>TURBIDITY (NTU)</th>
<th>pH</th>
<th>CONDUCTIVITY (µS/cm)</th>
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</thead>
<tbody>
<tr>
<td>Raw IWK’s effluent</td>
<td>16</td>
<td>5.9</td>
<td>198,630</td>
<td>54,750</td>
<td>5</td>
<td>2.12</td>
<td>7.08</td>
<td>261</td>
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<tr>
<td>Filtrate effluent</td>
<td>14</td>
<td>6.9</td>
<td>Not measured</td>
<td>Not measured</td>
<td>3.5</td>
<td>1.04</td>
<td>7.17</td>
<td>246</td>
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<tr>
<td>Effluent at W3T outlet (Treated effluent)</td>
<td>4</td>
<td>4.2</td>
<td>0</td>
<td>0</td>
<td>0.6</td>
<td>0.68</td>
<td>7.17</td>
<td>237</td>
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<tr>
<td>Treated effluent after 1 hour in product tank</td>
<td>3</td>
<td>4.7</td>
<td>Not measured</td>
<td>Not measured</td>
<td>1.4</td>
<td>0.42</td>
<td>7.22</td>
<td>217</td>
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</table>
Wet air oxidation

Loprox® wet air oxidation plant at Bayer treating 190tpd of pharmaceutical manufacturing wastewater commissioned 1993

150 - 320°C
100 - 220 barg
Oxidation to CO₂, N₂, water
High capex and opex
ZERO LIQUID DISCHARGE

- **Technology**
  - membrane separations
  - evaporation
- **Limitations**
  - atmospheric emissions
  - disposal of solid residue
- **Economics**
ZERO LIQUID DISCHARGE

- Vapor Compressor
- Heater
- Condensate
- Recirculation Pump
- Mist Eliminator
- Vapor Body
- Feed
- Crystals to Centrifuge or Filter
ZERO LIQUID DISCHARGE
End of Pipe Treatment

- Simple to install
- High flow
- Mixture of contaminants
- Contaminant concentration may be low
- Difficult to achieve low residuals of specific contaminants
- Usually produces waste (eg sludge)
End of Pipe treatment for plating shop wastewater
Segregation of Wastes

- Allows “at source” treatment
- Easy to implement on new build
- Identification of drains may be difficult in existing factories
- Problems of batch process industries
  - intermittent flows
  - varying composition in “campaigns”
At Source Treatment

- Flows are smaller
- Specific to individual contaminants
- Contaminants are present in lower volumes therefore higher concentration
- Plant is smaller
At Source Treatment

- At source treatment provides opportunities for recovery
  - water
  - raw materials
  - energy
    - biogas from anaerobic digestion
    - heat recovery from evaporation
At Source Treatment

RO used at source to recover rinse water and plating solution
Wastewater Treatment Options

SELECTING THE RIGHT TREATMENT PROCESS

CAN REDUCE COSTS !!!