Zero Liquid Discharge for Pharma
Challenges & Solutions
5.02.2013
Green Chemistry

REDUCE

REUSE

RECOVER

RECYCLE

Water & Wastewater Solution
# Effluent Composition

<table>
<thead>
<tr>
<th>Solvents</th>
<th>Inorganic Solids</th>
<th>Other Impurities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methanol</td>
<td>Total Hardness</td>
<td>COD</td>
</tr>
<tr>
<td>MDC</td>
<td>Total Alkalinity</td>
<td>BOD</td>
</tr>
<tr>
<td>ACN</td>
<td>Sodium</td>
<td>TOC</td>
</tr>
<tr>
<td>IPA</td>
<td>Chloride</td>
<td>Ammonical Nitrogen</td>
</tr>
<tr>
<td>Toluene</td>
<td>Sulphates</td>
<td></td>
</tr>
<tr>
<td>Acetone</td>
<td>Silica</td>
<td></td>
</tr>
<tr>
<td>Ethanol</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethyl Acetate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>n-Heptane</td>
<td></td>
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</tbody>
</table>
**Effluent Segregation**

**Mother Liquor Streams**
- Solvent washing streams
- High COD
- High TDS
- High Hardness
- Ammonical Nitrogen

**Lean Stream**
- Plant Washing effluent
- Utility waste
- Moderate COD
- Moderate TDS
- Moderate Hardness
Standard Zero Discharge Scheme.

Process Plant

High COD Stream

Stripper

Low Boilers

MEE

ATFD

Dry Product

RO Permeate

Low COD Stream

ETP

UF & RO

RO Reject
Alternate - Zero Discharge Scheme...

High COD Stream

Process Plant

Low Boilers

Stripper

MEE

ATFD

Dry Product

Reuse for Utility

Low COD Stream

Low Boilers

MEE

MEE

RO Reject

RO Permeate

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UF & RO

Dry Product

Reuse for Utility
Key Challenges

- Effluent Segregation
- Inefficient Stripping
- Use of Falling Film Evaporators
- Lesser Capacity Axial Pumps
- High Scaling & Cleaning Frequency
- Worst Scenario Design
- Material Compatibility
- System Integration
Effluent Segregation

• Gaseous streams which are generated intermittently

• Carcinogenic Streams

• Hazardous Streams e.g. Cyanide

• Low TDS & High COD Streams
Inefficient Stripping of Solvents

- Results in high COD in MEE condensate
- Gases like Ammonia increases the Heat exchange area required in MEE, hence need to be take care separately
- High Steam Consumption in MEE
- Reduction in MEE capacity
Using Falling Film

ADVANTAGES:

• Better Heat Transfer Coefficient - Lesser Area - Lower Capex
• Low Power consumption - Lower Opex
• Can be started up quickly and changed to cleaning mode - Low Down time
• Useful in heat sensitive chemical solutions - Lower Residence Time / lower Holdup

LIMITATIONS:

• Not suitable at higher suspended solid concentration and higher viscosity. - Limited Application
• Distribution system is critical and can lead to tube fouling in absence of adequate wetting rate. – Critical operation
• Frequent C.I.P. Required. – requires actual experience to confirm cleaning frequency
Using Lesser capacity Axial Pumps

• Axial Pumps are cheaper than Centrifugal Pumps

• Handles large flow rates but Low Head, hence, 1-2 Tube passes has to be taken

• Can not Manage Pump heads

• Compared with Centrifugal pump, if axial pump flows are less, the calendria tubes will lead to have liquid & Vapor phases resulting into scaling & plugging

• Heavy Maintenance Problems
High scaling & cleaning Frequency of MEEs

- Resulting in frequent cleaning and even Jet cleaning
- Due to Jet cleaning system is to be designed overall 18-20 hrs as against 24 hrs thus resulting in nearly 17% more cap. thus increasing CAPEX
- Frequent cleaning increases effluent volume thus further issues with the MEE to handle increased load
WORST CASE DESIGNS

- TS consideration more - Increase in overall CAPEX & OPEX
- Hydraulic rate more - Frequent shutdowns – More effluent generation – more chemical cost
Solution...

- Selection of Appropriate Technologies
- Integrated Design Approach
- End to End solution
- Optimum Design
Effluent Segregation
Properly designed Strippers
Use of Forced Circulation
Using Centrifugal Pumps
Optimum design of MEE
MOC Selection as per compatibility
System Integration
New Technologies
Flubex – As an alternative to Forced Circulation or in Combination

Flubex- Concept

- Recirculating fluidized bed heat exchanger
- Evaporation by Flashing in Vapor Liquid Separator.
- Fluidizing medium in Tube.
- Self-cleaning action.
Flubex - Advantages

- Continuous self-cleaning action avoid scaling.
- No Frequent C.I.P.
- No standby unit required.
- Lesser floor space.
Photo Chemical Oxidation (Advanced Oxidation)
- Advanced wastewater treatment using photochemical oxidation.
- It destroys/treats non-biodegradable organic contaminants present in wastewater, which are generally represented as “Recalcitrant Chemical oxygen demand”.
- Photochemical oxidation is enhancing the oxidation rate with the help of ultraviolet light in presence of oxidizing chemicals such as hydrogen peroxide, ozone etc.
Typical PCO Plant
**Key Features**

<table>
<thead>
<tr>
<th>Recommendations for maximum Efficiency</th>
<th>Ideal Conditions for system</th>
<th>Pre-Treatment for the System</th>
</tr>
</thead>
<tbody>
<tr>
<td>• TSS &lt; 50 ppm,</td>
<td>• Presence of solvents.</td>
<td>• Clarification &amp; Filtration</td>
</tr>
<tr>
<td>• O&amp;G &lt; 10 ppm</td>
<td>• Revamping of Biological</td>
<td>• Oil &amp; Grease Removal</td>
</tr>
<tr>
<td>• Turbidity &lt; 5.0 NTU.</td>
<td>system with advanced</td>
<td>• Oxygen Scavenger Removal</td>
</tr>
<tr>
<td>• Scale forming salts are to be</td>
<td>Technology &amp; higher flow</td>
<td></td>
</tr>
<tr>
<td>precipitated in pre-treatment.</td>
<td></td>
<td></td>
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<tr>
<td>• Oxygen scavengers, if any,</td>
<td>• Substances having toxicity</td>
<td></td>
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<tr>
<td>are to be eliminated in Pre –</td>
<td>• Where the effluent is</td>
<td></td>
</tr>
<tr>
<td>treatment.</td>
<td>having A Ox</td>
<td></td>
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<tr>
<td></td>
<td>• Where foul smell coming</td>
<td></td>
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<tr>
<td></td>
<td>out due to biological</td>
<td></td>
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<tr>
<td></td>
<td>activity cannot be</td>
<td></td>
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<tr>
<td></td>
<td>tolerated.</td>
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<tr>
<td></td>
<td>• Where secondary sludge</td>
<td></td>
</tr>
<tr>
<td></td>
<td>disposal becomes a</td>
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</tr>
<tr>
<td></td>
<td>problem.</td>
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</tbody>
</table>
Key Features

- Physico-Chemical Process
- Can start & stop whenever effluent is available
- Will treat COD & Toxic chemicals.
- Occupies Lesser floor space
- Capacity augmentation is simple.
- Can handle shock loads.
- No secondary sludge generation.
- Destroy Cyanide and treat Organic Halides
- No limitation for Dissolved solids
Limitations

- Suspended impurities will affect the process efficiency.
- Efficiency will depend upon purity of oxidizing chemicals.
- UV lamps has limited life span.
- Oil & Grease will hamper the process.
Applications of PCO

Typical Treatment Scheme

- Pharma High COD Effluent
- Mixed Solvent Stream
- Solvent Stripper
- Ammonia Stream
- pH Increase
- Stripper
- Process Condensate to ETP
- MEE with ATFD
- AOX
- Incinerator
- Cyanide Stream
Applications of PCO

Pharma High COD Effluent → Mixed Solvent Stream → Solvent Stripper

Ammonia Stream

AOX

Cyanide Stream

Eliminates Ammonia Stripper and Incinerator

Process Condensate to ETP

MEE with ATFD
ABOUT PRAJ
About PRAJ

- Established in 1984
- Technocrat Promoted Group
- 1st Company to avail Venture capital Funding through ICICI
- Listed Company
End-to-End Solutions for

- Ethanol;
- Biodiesel; and
- Beer production
- Energy Crop Agri-Services
- Bio-nutrients for Ethanol industry
- Water and Wastewater Solutions
- Customized Engineering & Manufacturing
Resources - Manufacturing Facilities

Pune Unit - For Domestic Market

Kandla Special Economic Zone: Units 1 & 2
SEZ Unit 2 dedicated to customized equipment manufacturing

- ASME – Sec VIII Div 1 & 2
- AD Merkblatter
- API 650
- TEMA
- BS
- AS 1210
- IS 2825
- DIN
• In-House R&D laboratory unit certification by Department of Scientific and Industrial Research, Government of India
• Spread over an area of 5 acres
• Matrix employs highly qualified scientists, micro and molecular biologists and PhDs
• Praj Matrix has 11 Patents to its credit
• Has filed 3 more patents
If have a will…
We will show you the Way