Advances in Membrane Bioreactors

Introduction

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Advances in Membrane Bioreactors

1 MBR quick review
2 MACmbr – MACarrier membrane bioreactor
3 AnMBR – Anaerobic Membrane Bioreactor
MBR quick review
Simplifying Wastewater Treatment

- Replaces conventional clarification, aeration and filtration
- Combines the physical barrier characteristics of a membrane with biological treatment
- Produces high quality effluent at all times
Advantages of MBR Technology vs. CAS

Achieves secondary and tertiary treatment in one compact step

- Footprint
- Cost
- Reliability
- Effluent Quality
MACmbr Technology
MACmbr Technology

- Addition of carbon-based MACarrier to the mixed liquor in an MBR

- Enhance removal of organics, including:
  - recalcitrant COD
  - toxic compounds
  - micro-pollutants, PPCPs

- MACarrier provides sites for adsorption as well as attachment for biomass

- The biomass degrades the adsorbed COD and then regenerates the MACarrier

- The dose of MACarrier is adjusted to maintain the target concentration in the biomass (~1000 - 2000 mg/l)
MACmbr Technology

• Solves challenge of stringent COD discharge requirements while enhancing process stabilization

• Robust & reliable solution to enhance biological process stability combined with proven MBR technology

• Lowest cost of ownership vs. competing technologies (post-treatment)
Advances in Membrane Bioreactors

MACmbr

Applications:

- Initial application was refining in China and Russia … stringent COD limits for direct discharge
- Pharmaceutical… recalcitrant organics removal
- Textile, F&B… color removal
- Microelectronics… process stabilization
- Municipal …. micro-pollutant removal, pharmaceuticals and personal care products (PPCP)
• Enhanced removal of organics, including recalcitrant COD, toxic compounds, and micro-pollutants

• Solves problems of stringent COD requirements for discharge or reuse, process stabilization, color removal, and micro-pollutant removal.

• Robust & reliable solution: biological process stability, proven MBR technology

• Lowest cost of ownership vs. competing technologies (post treatment of CAS)
AnMBR – Anaerobic Membrane Bioreactor
Why Anaerobic Treatment?

- No Biological oxygen required (energy +)
- Methane rich biogas generation (energy+)
- Reduced sludge production
- Reduced footprint (high OLR)
Conventional Anaerobic Digester Process

- **Biomass**
- **Feed (Food)**
- **Residual**

Biogas Out

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Why Membranes?

• Membranes continuously remove water from the digester while retaining biomass and organics reducing required digester volume – smaller footprint.
• Membrane filtration results in a superior effluent quality with no suspended solids in the permeate.
• Conventional anaerobic processes have retention challenges and often suffer upsets discharging untreated water.
• Prevent methanogens (active biomass) in the reactor from washing out during upsets for fast recovery from changes in loading conditions.
• Separate SRT from HRT for a more robust and reliable biological process.
Anaerobic Membrane Bioreactor Process

- Biomass
- Feed (Food)
- Residual
- Permeate

Biogas Out
ZeeWeed Anaerobic MBR

- Strength - Reinforced hollow fibre braid
- PVDF membrane - developed for wastewater
- Experience - 20 years of proven performance
- Leverages - leadership in MBR plant design
## ZeeWeed AnMBR Pilot Results at Brewery

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Unit</th>
<th>Pilot</th>
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<tbody>
<tr>
<td>WW Type</td>
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<td>Brewery</td>
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<tr>
<td>Full Scale Flow</td>
<td>MLD</td>
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<tr>
<td>Influent COD P1</td>
<td>mg/L</td>
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<tr>
<td>Influent COD P2</td>
<td>mg/L</td>
<td>5000 - 15000</td>
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<td>Existing AD</td>
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<table>
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<tr>
<th>Application</th>
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<tr>
<td>Process Conditions</td>
<td>Net Flux P1</td>
<td>LMH (GFD)</td>
<td>10 (6)</td>
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<tr>
<td></td>
<td>Net Flux P2</td>
<td>LMH (GFD)</td>
<td>5 (3)</td>
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<tr>
<td></td>
<td>OLR</td>
<td>kg COD/m3/d</td>
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<tr>
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<td>HRT</td>
<td>hrs</td>
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<tr>
<td></td>
<td>SRT</td>
<td>days</td>
<td>30+</td>
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<tr>
<td></td>
<td>Bioreactor MLSS</td>
<td>g/L</td>
<td>15</td>
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<tr>
<td></td>
<td>Influent TSS</td>
<td>mg/L</td>
<td>600 - 4000</td>
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| Results       | Effluent COD   | mg/L | <200 |
|               | Effluent BOD   | mg/L | NA   |
|               | Effluent TSS   | mg/L | <5   |
|               | COD Removal    | %    | 95+  |
ZeeWeed AnMBR Summary

- Methane rich biogas can be used as a renewable, storable, source of energy for heat and power.
- Superior effluent quality and reliability utilizing ZeeWeed Membranes
- No biological oxygen required reducing energy costs
- Modular scalable system design, minimize onsite construction
- Retrofit upgrade for existing anaerobic digestion systems enabling water reuse.
- Leverages over 20 years of experience and leadership in MBR plant design.
Questions?

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