WINERY WASTEWATER TREATMENT & REUSE:
Membrane Bioreactor Technology

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Membrane Bioreactor

- Membrane bioreactor (MBR)
  - High-rate activated sludge process
  - Microfiltration replaces clarifier
  - Compact treatment unit
  - High effluent quality allows recycling
- 0.1 micron pore size, polyvinylidene fluoride (PVDF) membranes
Membrane Bioreactor Schematic

- Raw PW
- 2 mm Screening
- EQ Zone
- Excess Sludge
- Membrane Module
- Diffusers
- Anoxic Zone
- Aeration Zone
- Effluent to storage/reuse
- Blower
- Membrane Bioreactor Schematic

Legend:
- Blower
- Diffusers
- 2 mm Screening
- EQ Zone
- Membrane Module
- Aeration Zone
- Effluent to storage/reuse
- Excess Sludge
Membrane Bioreactor

• Typical flow rate: 5,000 to 20,000 gpd

• Optimal winery size: 50,000 to 250,000 cases

• 10,000 gpd unit: 60’ L x 12’ W x 11.5’ High reactor,
  - roughly 1/10th of a pond area.
  - energy: 30 HP

• Modularity
Flat Plate Membrane

- 0.08 micron pore size, polyvinylidene fluoride (PVDF) membranes
- Design Flux: 15 gpd/sf
- TMP: 1.03 – 2.90 PSI
- Cleaning: In-place, semi-annual, 4 hours, Hypochlorite followed by Citric acid
- Filtration via static water pressure
- Membranes relaxed every few minutes
Hollow Fiber Membrane

- 0.1 micron pore size,
- Polyvinylidene fluoride (PVDF) membranes
- Design Flux: 5 gpd/sf
- TMP: 1.0 – 5.5 PSI
- Cleaning: In-place, Hypochlorite 90 days, semi-annual Citric Acid
- Filtration via pump pulling suction pressure
- Relaxation every 12 minutes for 60 sec
Membrane Bioreactor Process Parameters

- Flow – readout
- Dissolved Oxygen – readout
- pH - readout
- Transmembrane Pressure - readout
- Effluent Quality – BOD, TSS, N, P – wet chemistry
Membrane Bioreactor Costs

- Reactor cost $300,000 to $600,000
- Overall installed cost $1 to 1.8 million dollars
- Membrane replacement every 5 years - $50,000
- Energy costs 10 to 25% more than a comparable pond
## Pollution Level

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Units</th>
<th>Crushing Season Range</th>
<th>MBR Effluent</th>
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</thead>
<tbody>
<tr>
<td>BOD&lt;sub&gt;5&lt;/sub&gt;</td>
<td>mg/L</td>
<td>500 - 12,000</td>
<td>2 - 10</td>
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<tr>
<td>pH</td>
<td>--</td>
<td>2.5 - 9.5</td>
<td>6.5-9.5</td>
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<tr>
<td>Total Suspended Solids</td>
<td>mg/L</td>
<td>40 - 800</td>
<td>2 - 10</td>
</tr>
<tr>
<td>Total Dissolved Solids</td>
<td>mg/L</td>
<td>80 - 2,900</td>
<td>300 -1,500</td>
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<tr>
<td>Nitrogen</td>
<td>mg/L</td>
<td>5 - 50</td>
<td>5 - 50</td>
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</tbody>
</table>
Membrane Bioreactor Effluent Quality

- BOD and TSS < 10 mg/L consistently, majority of samples below 2 mg/L
- Instrumentation, process control and lab testing ensures better operation and effluent quality
- Effluent quality independent of sludge settling characteristics
- Membrane tear - small but distinct increase in the TSS/BOD
- Ability to denitrify with anoxic zone – low nitrogen achievable
Membrane Bioreactor Effluent Reuse

- Consistent effluent quality with low BOD & TSS allows for more reuse options
- Vineyard and landscape Irrigation
- Reuse inside the winery – toilet flushing, floor rinsing, initial rinse of tanks
- Prepares the effluent for further membrane treatment
Membrane Bioreactor Case Study
Sterling Vineyards - 10,000 gpd system

- Existing pond system
- Limited room to expand ponds
- Desire for superior effluent quality
- Reduce water consumption
- Effluent reuse for irrigation
Sterling MBR
Hess Collection Winery Case Study

- 10,000 gpd PW Flow
- Pretreatment for Sewer Discharge
- Compact system
- Superior Effluent Quality
Truck Loading Dock
Aeration Zone
Treated Effluent
Membrane Bioreactor Case Studies
DeLoach Winery – 5000 gpd system

- Leachfield overloaded
- Preserve vineyards, ponds not desired
- Superior effluent quality
- Effluent reused for irrigation
Membrane Bioreactor Case Studies
Francis Ford Copolla Winery
20,000 gpd SS system

- Leachfield soils not available
- Minimize impact to native vegetation
- Denitrification required
- MBR treatment with the Title 22 standards
Hess Collection Influent TSS

Influent TSS

Date

Influent TSS, mg/L

TSS
Influent TSS AVG
Hess Collection Effluent BOD

Effluent BOD Both Tanks

Date

Effluent BOD, mg/L

0 1 2 3 4 5 6 7 8 9 10 11 12

BOD Tank 2
BOD Tank 1
Low Rate Systems

- Simple
- Robust
- Large land use
- Low operational involvement

Includes:
- Subsurface Treatment
- Facultative Aerated Ponds
- Wetlands
Medium Rate Treatment

- Less land use than the low rate systems

Includes:
- Activated sludge treatment including sequencing batch reactors (SBRs).
- Advantex
High Rate Treatment

- Advanced Treatment
- Minimal Land Use

Includes:
- Membrane Bioreactors (MBR)
- Upflow Anaerobic Sludge Blankets (UASB)
Subsurface Treatment

• Settling (Septic) Tank Followed By Perforated Subsurface Piping
• Low visual impact
• Require low maintenance and operator attention
• Downside is these systems require large land use

Factors affecting Subsurface Treatment:
• Depth and quality of the soil
• Depth to groundwater
• Setback from wells, flood zones, etc.
Septic Tanks and Leachfield
Facultative Aerated Ponds

- Earthen Pond with Aeration
- High Retention Time (60 to 120 days)
- Low Maintenance
- Aerobic and Anaerobic Reactions
- Provides for Effluent Storage
Summary

• MBR is an option when high effluent quality is desired for effluent reuse
• Over 99 percent removal efficiencies were achieved for BOD$_5$, COD and TSS
• Space saving technology
• Current pricing attractive for 50,000 to 250,000 case wineries