Water Environment Federation
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FACT SHEET

Food & Beverage Wastewater: Anaerobic Treatment and Polishing/Reuse Options

A guidance document for professionals in the food and beverage industry to provide information on anaerobic wastewater treatment and potential downstream polishing.

Food and Beverage (F&B) Wastewater: The table below presents a high-level description of wastewater characteristics associated with most food and beverage manufacturing and potential impacts.

Table 1: Food & Beverage Wastewater Characteristics

Constituent	Impacts
High content of readily degradable organic matter (COD; BOD_5; TOC)	• Potential overloading of existing system causing exceedances • Elevated surcharges
Clean-in-Place (CIP) Chemicals (caustic; nitric/ phosphoric acid)	• Potential to cause fluctuations in wastewater pH • High phosphorus and nitrogen loading • Potential foaming
Quaternary ammonium compounds (QUATS) and other disinfection chemicals	• Biological inhibition/toxicity resulting in potential discharge violations
High total dissolved solids (TDS) from manufacturing and water softeners	• Biological lysis due to rapid changes in osmotic pressure • Potential to cause an imbalance in monovalent to divalent cations • Corrosivity • Scaling
Fats, Oils & Grease (FOG)	• Line plugging • Impacts settling and liquid/solids separation • Biological upsets

Due to the high organic strength typically found in F&B wastewater, anaerobic biological treatment is often used as a first step due to the lower energy requirements, lower sludge production, lower nutrient requirements, and potential to recover biogas. The following table categorizes anaerobic wastewater treatment by loading rate and provides example technologies.

Table 2: Anaerobic Pretreatment Processes

	Influent Tolerance	Technologies
Low Rate Anaerobic Treatment	OLR 1-5 kg COD/m^3·d COD 3,000 to 100,000+ mg/L TSS < 5,000 mg/L FOG < 1,000 mg/L	• Lagoons • CSTRs • BVF • Digester
Medium Rate Anaerobic Treatment	OLR 2-15 kg COD/m^3·d COD < 30,000 mg/L TSS < 3,000 mg/L FOG < 150 mg/L	• AF • CSTRs • BVF • AnMBR
High Rate Anaerobic Treatment	OLR 8-30 kg COD/m^3·d COD < 30,000 mg/L TSS < 300 mg/L FOG < 30 mg/L	• UASB • IC • EGSB • ECSB

Table 2 Notes:
OLR – Organic Loading Rate
COD – Chemical Oxygen Demand
TSS – Total Suspended Solids
FOG – Fats, Oils and Grease
CSTR - Continuously Stirred Tank Reactor
BVF – Bulk Volume Fermenter
AF – Anaerobic Filter
UASB – Upflow Anaerobic Sludge Blanket
AnMBR – Anaerobic Membrane Bioreactor
IC – Internal Circulation
EGSB – Expanded Granular Sludge Bed
ECSB – External Circulation Sludge Bed

Additional Treatment Options:

Anaerobic effluent can be:

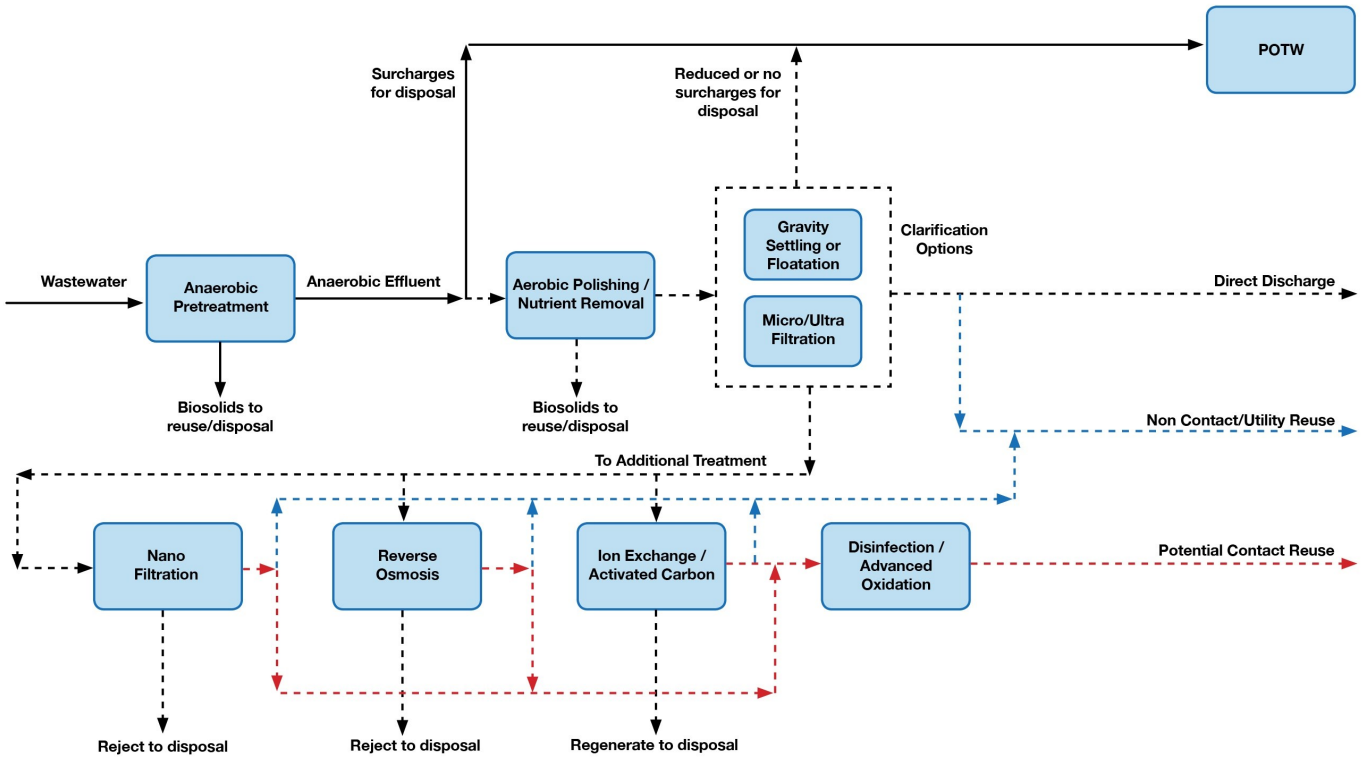
1. Discharged to POTW – industry will continue to pay surcharges for treatment and cost for potable water.
2. Direct Discharge – likely to require additional treatment such as aerobic biological nutrient removal (BNR) to meet regulatory permitting and discharge requirements.
3. Non-Contact/Utility Reuse – in addition to aerobic biological and/or BNR treatment, this would likely require tertiary filtration followed by nanofiltration, reverse osmosis, or ion exchange.
4. Potential Contact Reuse – in addition to tertiary filtration steps required for non-contact/utility reuse, this would likely require disinfection and/or advanced oxidation.

Table 3: Additional Anaerobic Effluent Treatment Options

Unit Process	Benefits	Cautions
Aerobic Polishing and Nutrient Removal (Suspended & Attached Growth such as CAS, MBBR, SBR, etc.)	• Degrades/removes additional COD/BOD, N and P	• Requires larger footprint
Aerobic MBR (Activated sludge with a UF for solids separation)	• Degrades/removes additional COD/BOD, N and P • Low TSS Effluent suitable for many reuse applications • Compact footprint • Higher mixed liquor suspended solids (MLSS) than conventional systems	• Influent screening (only required for wastewater with fibrous material) • Membrane material compatibility with CIP solutions, even though biomass makes it more resistant
Nanofiltration (NF)	• Removal of TSS and some Total Dissolved Solids (TDS) • Improved quality effluent suitable for many non-contact/ utility reuse applications	• Membrane material compatibility with CIP solutions • Influent pretreatment • Reject water requires treatment/disposal
Reverse Osmosis (RO)	• Removal of all TSS and most/ all TDS and COD • Suitable for non-contact/utility reuse requiring high quality water	• Membrane material compatibility with CIP solutions • Influent pretreatment • Reject water (high in TDS) requires treatment/disposal
Ion Exchange (IX)	• Removal of TDS • Improved effluent quality for non-contact/utility reuse	• Requires TSS removal • Resin disposal or regeneration • Regenerate requires treatment/disposal
Granular Activated Carbon (GAC)	• Removal of organics and certain dissolved compounds • Improved effluent quality for non-contact/utility reuse	• Requires TSS removal • Carbon disposal or regeneration is costly
Disinfection/Advanced Oxidation (AOP)	• Pathogen destruction • Oxidation of some organics • Improved effluent quality for potential contact reuse	• Ultraviolet (UV) - Impact of residual color and solids on effectiveness • UV - No disinfection residual • Chlorine - Potential impacts of residual chlorine on reuse applications • Ozone - Unstable and would be generated onsite • Ozone - sparingly soluble in water

As mentioned above, anaerobic effluent can be further treated depending on the desired effluent quality and other limitations. Use Table 3 above in conjunction with Figure 1 below.

Figure 1: Simple Block Flow Diagram for Treatment Options post Anaerobic Treatment



Acknowledgments

WEF Industrial Wastewater Committee
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