AQUA-AEROBIC SYSTEMS, INC.
A Metawater Company

Aeration & Mixing Design Report

000 Test Project - Do Not Overwrite

Design# 169794

Option: Preliminary design for Activated Sludge

Aeration & Mixing:

Activated Sludge

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Activated Sludge DESIGN SUMMARY

Recommend size and quantity of covered discharge aerator and mixers required to aerate and mix aerobic digestor with ???% sludge concentration

BASIN INFLUENT CONDITIONS

Type of basin and size	Activated Sludge
Volume	0.75 MG
Elevation	5 ft
Power Volume	100 HP/MG
Basin Type	Rectangle
Length	100 ft
Width	100 ft
Water Depth	10 ft
Material	concrete
Temp Summer	20°C
Temp Winter	10°C
Average Flow	1 MGD
Peak Flow	2 MGD

BOD INF	450	Mg/l	**BOD EFF**	30	Mg/l
TSS INF	250	Mg/l	**TSS EFF**	30	Mg/l
TKN INF	50	Mg/l	**NH3-N EFF**	10	Mg/l

Process/Site Notes

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DESIGN CALCULATIONS

HYDRAULIC RETENTION TIME

HRT= 0.75 **MG /** 1 **MGD x 24hr / 1 day**

= 18 **hrs**

ACTUAL OXYGEN REQUIREMENTS

First, we solve for the actual oxygen requirement (AOR) based on the combined oxygen required for synthesis of the influent BOD5 (AORBOD) and that required for nitrification (AORTKN).

- Nitrification consists of the biological oxidation of ammonia to nitrate.
- These calculations account for the given average design flow, influent BOD OR COD and TKN loading, oxygen required per unit of BOD and TKN, respectively, and targeted residual dissolved oxygen concentration, usually 2.0 mg/L. We may also take credit for the TKN used as a nutrient by the biomass (5% of the influent BOD).
- The oxygen requirements for carbonaceous removal will typically be 1.25 lbs O2/lb BOD (or 1.25 kg O2/kg BOD) at the design average loading conditions.
- The oxygen requirements for carbonaceous removal will typically be 1.00 lbs O2/lb COD (or 1.00 kg O2/kg COD) at the design average loading conditions.
- We typically assume that 0.05 mg of the influent TKN will be used as a nutrient by every mg of BOD applied.
- The remaining TKN requires oxygen at a rate of 4.6 lb O2/lb TKN (or 4.6 kg O2/kg TKN) at the design average loading conditions.

The oxygen demand is based on 1.25 lb O2 / lb BOD applied and 4.6 lb O2 / lb TKN subject to nitrification.

AOR (BOD) 1.25 lb/lb x 450 mg/l x 1 MGD x 8.34 / 24 hr

= 195 lb O2 / hr

Nutrient TKN 0.05 mg TKN /mg BOD x 450 mg/l

= 23 mg/l

TKN Remaining 50 mg/l - 23 mg/l

= 27 mg/l

AOR (TKN) 4.6 lb/lb x 27 mg/l x 1 MGD x 8.34 / 24 hr

= 43 lb O2 / hr

Therefore AOR 238 lb O2 / hr

AOR (lb O2/hr) – Maximum hourly actual oxygen requirement. This value is the sum of **AOR (BOD) + AOR (TKN) -** Nutrient TKN may be subtracted from this sum.

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DESIGN CALCULATIONS

FIELD OXYGEN TRANSFER EFFICIENCY

FTE $SOTE \times [(Cs \times \beta) - Cr] \times 1.024^{(T-20)} \times \alpha$

9.09068501000757

Where SOTE	3 lb O2 / BHP-hr
T	20 °C
Cs	9.09mg/l (at 20°C and 5 ft)
β	0.95 typical, assumed
α	0.85 typical, assumed
Cr	2.0 mg/l
FTE	1.86 lb O2 / BHP-hr

POWER REQUIREMENT

Power (aeration) = $\frac{238 \text{ lb/hr}}{1.86 \text{ lb/BHP-hr} \times 0.92}$

= 139 **HP**

A mixing level of approxiamtely 100 HP/MG is recommended to provide complete mix conditions.

Power (mixing) = 100 **HP/MG x** **0.75 MG**

= 75 **HP**

Once we have determined the AOR, we calculate field transfer efficiency (FTE). FTE adjusts the known standard rate of oxygen transfer (SOTE) for our equipment based on actual site and wastewater conditions. For example, increasing elevation and water temperature both reduce a basin's capacity for holding dissolved oxygen in solution.

- **FTE (lb O2/BHP-hr)** – calculated rate of oxygen transfer for site conditions including dissolved oxygen deficit and equipment type. This value will be used to determine the required installed horsepower for mechanical surface aeration. The selected mechanical aerators will supply oxygen to the microorganisms by dispersing air into the mixed liquor.
- **Alpha (α)** – Unitless oxygen transfer ratio, or ratio of oxygen transfer coefficient KLa (1/hr) in wastewater to that in clean water. Alpha is influenced by wastewater characteristics, primarily dissolved solids concentration, as well as the type of aeration equipment.
- **KLa** – Oxygen transfer coefficient (1/hr). KLa depends on temperature and aeration system features, including depth of aerator, type of mixer, and basin geometry.
- **kT** – Reaeration rate constant. kT=k20* ϴ^(T-20) = k20* 1.024^(T-20). The given or assumed summer value for temperature, T, is used when calculating kT. We use the ratio of kT/k20 when solving for FTE.
- **Beta (β)** – Unitless oxygen saturation coefficient, or ratio of the dissolved oxygen saturation concentration (mg/L) in wastewater to that in clean water at the same temperature as the wastewater. Beta is influenced by wastewater constituents, primarily dissolved solids concentration. A value of 0.95 is typical for municipal applications. This value varies for industrial applications.
- **ϴ -** Temperature coefficient used to adjust the reaeration rate constant (1/day). kT=k20* ϴ^(T-20) = k20* 1.024^(T-20).
- **Cs -** Saturated dissolved oxygen concentration based on actual site conditions. The maximum soluble level of dissolved oxygen falls as temperature and/or elevation rise above 20°C and 0 ft (0 m), respectively.
- **Cr** - required dissolved oxygen concentration. This value is typically 2 mg/L.
- **D (mg/L) -** dissolved oxygen deficit, equals [(Cs x b) – Cr].
- **SOTE (lb O2/BHP-hr)** is the standard rate of oxygen transfer in clean water with zero salinity at 20°C , 1 atm, and zero dissolved oxygen. It is equal to the ratio of the rate of oxygen dissolution (lb/hr or kg/hr) to the brake-horsepower input for our equipment.
- **Cmax, 9.09 mg/L** is the saturated dissolved oxygen concentration at 20°C and 1 atm (14.7 psia) with zero salinity.
- **T**, temperature (°C) of wastewater. We typically use the summer temperature, in order to ensure that there will be sufficient oxygen applied year round.

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DEPTH CHECK

Prior to recommending a given aerator and/or mixer based on aeration and mixing requirements alone, we evaluate the suitability of the selected unit(s) for the given basin depth, basin material, and basin surface area. A given basin may require a higher quantity of lower-horsepower units and/or special accessories designed to protect the basin.

Each Aqua-Jet Aerator and AquaDDM Mixer has an allowable water depth range as well as a required water surface area. A shallow basin may require smaller units and/or anti-erosion assemblies. A deeper basin may require draft tubes. Freeze protection may be required for operation in cold climates.

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RECOMMENDED EQUIPMENT

In order to recommend equipment, we have evaluated the quantity of oxygen required for aeration and mixing of the given basin.

User-entered recommended equipment quantities and types to provide required minimum horsepower. Also note recommended accessories and other specials such as voltage.

Quantity	Equipment	Yes / No
2	Aqua-Jet Aerators	Yes
0	AquaDDM Mixers	No
0	OxyStar Aerators	No
0	TurboStar Directional Mixer	No

Quantity	Accessories	Yes / No
0	Anti-erosion Assemblies	No
2	Draft Tubes	Yes
2	LTD Assemblies	Yes
2	Arctic Pak	Yes
0	Aqua-Jet II Mist Cover	No