Calculations for determining the aeration equipment required to fulfill the oxygen and/or mixing demand of biological wastewater treatment systems

Note: The methods and data presented here are intended for use by the designer to estimate the power requirement for the oxygen demand using AIRE-O2 aeration equipment. This method is not intended to cover every application. Questions can be answered by contacting Newterra at 952-448-6789

Project Name:	Red Lake
Project Number:	2303140
Location:	MN USA
Unit Process:	Lagoon
Prepared by:	BFA

Input Data (Blue Cells)

					Description
1	Flowrate =	0.146	MGD		*Input flowrate*
2	Volume =	26.00	MG		*Input volume*
3	BOD in =	200	mg/l	**Assumed Value Medium Strength Domestic Waste*	*Influent BOD*
4	BOD out =		mg/l		*Design output BOD*
5	NH_4-N =	20	mg/l	**Assumed Value Medium Strength Domestic Waste*	*Design ammonia or TKN removal*
6	Other =		mg/l		
7	BOD net =	200.0	mg/l		*line 7 = (line 3) - (line 4)*
8	BOD net =	243.5	lb/day		*line 8 = (line 7) x (line 1)/1000*
9	NH_4-N net =	24.4	lb/day		*line 9 = (line 5) x (line 1)/1000*
10	Other =	0.0	lb/day		*line 10 = (line 6) x (line 1)/1000*

ASSUMPTIONS

11	O_2 : BOD =	1.5	lb O_2 / lb BOD	*Typically varies between 1 and 2*
12	O_2 : NH_3-N=	4.6	lb O_2 / lb NH_4-N	*Typical value is 4.6*
13	O_2 : Other =		lb O_2 / lb Other	*Depends on species*

O_2 REQUIREMENT UNDER FIELD CONDITIONS (AOR)

14	O_2 for BOD =	365.3	lb O_2 / day	*line 14 = (line 11) x (line 8)*
15	O_2 for NH_4-N =	112.0	lb O_2 / day	*line 15 = (line 12) x (line 9)*
16	O_2 for Other =	0.0	lb O_2 / day	*line 16 = (line 13) x (line 10)*
17	AOR =	**477.3**	lb O_2 / day	*line 17 = (line 14) + (line 15) + (line 16)*
18	AOR =	**19.9**	lb O_2 / hour	*line 18 = (line 17) / (24)*

CORRECTION FACTORS TO DETERMINE O_2 REQUIREMENT UNDER STANDARD CONDITIONS (SOR)

19	Basin Temperature =	68	°F	*Input maximum basin temperature*
20	Elevation =	1300	ft above msl	*Input basin elevation*
21	C_w =	2.0	mg/l	*Operating O_2 conc. of wastewater*
22	α =	0.85		*Mass transfer correction factor*
23	β =	0.95		*Saturation factor*
24	C_{s20} =	9.09	mg/l	*O_2 saturation conc. at 20 deg Celcius*
25	τ =	1.00		*Temperature correction factor*
26	Ω =	0.95		*Altitude correction factor*
27	C_s =	8.7	mg/l	*O_2 saturation conc. at field conditions*
28	**(Standardized) SOR =**	**34.0**	**lb O_2 / hour**	

POWER REQUIREMENTS

Unit Model	Aspirator 2HP	
Unit Output	3.6	lb O_2 / hour
Power per Unit	*2.0*	hp

OXYGEN

SOR	34.0	lb O_2 / hour
# of Units Required	***10***	
Total Output	*36.0*	lb O_2 / hour
Total Oxygen Power	***20.0***	**hp**

MIXING

Type of Mixing	Facultative Lagoon	
Mixing Requirement	*5.0*	hp/MG
Mixing Power Required	*130.0*	hp
# of Units Required	***65***	
Total Mixing Power	***130.0***	**hp**

RECOMMENDATIONS

Unit Model **Aspirator 2HP** ***Number of Units*** **65**

Total Power **130.0** ***hp***

Basis of Design **Mixing**

NOTES

Aeration Industries International

Cell 1 Design Calculations

Project Name: 0
Project No.: 0

Date 1/0/1900
Prepared By 0
Revision: 0

Design Flow =	146,000	gpd =	552.61	m3/d
Lagoon Water Depth =	9	ft =	2.7	m

1st Cell in Series

Total Lagoon Volume =	36.45	MG =	137963	m3
Total Number of Cells in Series =	1			
Cell 1 Volume =	29.70	MG =	112415	m3
HRT in Cell 1 =	203.42	days		

Suspended Growth BOD Removal Calculations

Aerated Lagoon Reactors In Series
(Metcalf & Eddy, 4th Ed., p.271)

$$S = S_o / [1 + (k_T / n) * \tau)]^n$$

where
S = effluent BOD concentration, mg/l
S_o = influent BOD concentration, mg/l
τ = total retention time, days
T = wastewater temperature, C
k_T = reaction coefficient, days-1
n = number of reactors

$$k_T = k_{20} (\theta^{T-20})$$

where
k_{20} = reaction coefficient at 20 deg. C = 0.06 $days^{-1}$
θ = temperature factor = 1.04

REACTORS IN SERIES

Number of Reactors = 1

Min. Lagoon Temperature			**Max. Lagoon Temperature**		
T =	10	C	T =	20	C
τ =	203.42	days	τ =	203.42	days
So =	200	mg/l	So =	200	mg/l
k_T =	0.04	$days^{-1}$	k_T =	0.06	$days^{-1}$
S =	22	mg/l	S =	15	mg/l

Aeration Industries International

Cell 2 Design Calculations

Project Name: 0
Project No.: 0

Date 1/0/1900
Prepared By 0
Revision: 0

Design Flow =	146,000	gpd =	552.61	m3/d
Lagoon Water Depth =	9	ft =	2.7	m

2nd Cell in Series

Total Lagoon Volume =	36.45	MG =	137963	m3
Total Number of Cells in Series =	1			
Cell 2 Volume =	6.75	MG =	25548.8	m3
HRT in Cell 2 =	46.23	days		

Suspended Growth BOD Removal Calculations

Aerated Lagoon Reactors In Series
(Metcalf & Eddy, 4th Ed., p.271)

$$S = S_o / [1 + (k_T / n) * \tau)]^n$$

where
S = effluent BOD concentration, mg/l
S_o = influent BOD concentration, mg/l
τ = total retention time, days
T = wastewater temperature, C
k_T = reaction coefficient, days-1
n = number of reactors

$$k_T = k_{20} (\theta^{T-20})$$

where
k_{20} = reaction coefficient at 20 deg. C = 0.06 $days^{-1}$
θ = temperature factor = 1.04

REACTORS IN SERIES

Number of Reactors = 1

Min. Lagoon Temperature

T =	10	C
τ =	46.23	days
So =	22	mg/l
k_T =	0.04	$days^{-1}$
S =	8	mg/l

Max. Lagoon Temperature

T =	20	C
τ =	46.23	days
So =	15	mg/l
k_T =	0.06	$days^{-1}$
S =	4	mg/l