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A2O Biological Pool Calculator

calcuated value	
set value	
conversion chack value	
known condition	
design sstandards	

Proess Calculation						
	Design Paramater					
(一)	Water intake					
serial number	item	symbol	formula	calculated value	uite	remake
	Engineering design scale	$Q_{总}$=		7000	m^3/d	
	Coefficient of total change	K_z=		1.47		
	Average daily, average hourly fl	Q_h=	$Q_{总}/24$=	291.6666667	m^3/h	
		Q_s=	$Q_h/3600$=	0.081018519	m^3/s	
	Maximum daily and hourly flow	Q_{max}=	Q_h*K_z=	428.75	m^3/h	
		=	$Q_{max}/3600$=	0.119097222	m^3/s	
(二)	Influent and Effluent Water Quality					
ter quality paramet	Water intake idex (mg/L)	symbol	fluent Standards (mg/L	symbol	Removal rate%	remake
COD_{cr}	400	COD_t	50	COD_{te}	87.5	
BOD_5	120	S_0	10	S_e	91.66666667	90%~95%
TSS	220	T_{SS}	10	T_S	95.45454545	
NH_3-N	25	N_o	5	N_a	80	
TKN	35	N_k	5	N_{ke}	85.71428571	
NO_3^--N	0		10			
TN	35	N_t	15	N_{te}	57.14285714	60%~85%
TP	3	P_t	0.5	P_{te}	83.33333333	
PH	6~9		6~9			
碱度	280	S_{ALK}				
T_{max}	20	℃				
T_{min}	14	℃				
water treatment						
—	A^2O Biological pool (Anearobic/Anoxic/Aerobic)					
(一)	Determind whether the A^2O porcass can be used					
serial number	item	symbol	formula	calcalated value	uite	remake
	BOD_5/TN (Carbon to Nitrogen Ratio	k_1=	S_0/N_t=	3.428571429		≥4
	BOD_5/TP (Carbon to Phosphorus Rati	k_2=	S_0/P_t=	40		≥17
(二)	A^2O Biological pool valume calculated(Sludge Loading Rate Method)	BOD5, N and P were removed from the water				
	A^2/OBiological pool vulume design flow rate	Q=	$Q_{总}$=	7000	m^3/d	
	BOD_5 Sludge Loading	N=		0.08	kgBOD5/(kgMLSS·d)	0.1~0.2
	Mixed liquid suspension solid concentra	X=		3500	mgMLSS/L	3000~4000mg/L
	Sludge backfolw retio	R=		1		100%backflow
	Denitrification Rate	η_N=	N_t-N_{te}/N_t=	0.571428571		60%~85%
	Mixed liquid backfolw retio	$R_{内}$=	$\eta_N/(1-\eta_N)$ =	1.333333333		100%~400%
		=	value	2		200%
	Effective volume of A2O Biological reac	V=	$\frac{Q(S_o-S_e)}{NX}$ =	2750	m^3	
		=	value	2750	m^3	esidence time need to be determined
	Total residence time of A2O Biological re	HRT=	V/Q=	0.392857143	d	
		=	24×HRT=	9.428571429	h	
	The retio of Anaerobic/Anoxic/Aerobic res	k_3=		1:2:8		
	Anaerobic zone residence time	HRT_1=	HRT*1/(1+2+8) =	0.857142857	h	
	Anoxic zone residence time	HRT_2=	HRT*2/(1+2+8) =	1.714285714	h	
	Aerobic zone residence time	HRT_3=	HRT*8/(1+2+8) =	6.857142857	h	
	Aaerobic zone effective volume	$V_{厌}$=	V*1/(1+2+8) =	250	m^3	
	Anoxic zone effective volume	$V_{缺}$=	V*2/(1+2+8) =	500	m^3	
	Aerobic zone effective volume	$V_{好}$=	V*8/(1+2+8) =	2000	m^3	
(三)	k Nitrogen and Phosphorus load					
	Total nitrogen load in aerobic sec	k_N=	$\frac{QN_t}{XV_{好}}$ =	0.035	kgTN/(kgMLSS·d)	<0.05, Meet the requirments
	Total phosphorus load in anaerobic r	K_P=	$\frac{QP_t}{XV_{厌}}$ =	0.024	kgTP/(kgMLSS·d)	<0.06, Meet the requirments
(四)	lation of residual sludge volume					
	Total sludge yield(increase)	Y=		0.6	kgMLSS/kgBOD5	0.3~0.6
	The proportion of MLVSS in MLSS	f=		0.7	kgMLVSS/kgMLSS	0.7~0.8
	Endogenous Metabolism	K_d=		0.05	d^{-1}	
	Biomass Yield	P_x=	$YQ(S_o-S_e)-k_dVfX$=	125125	g/d	
		=		125.125	kg/d	
	Inorganic Sludge Yield	P_s=	$Q(T_{ss}-T_s)$×50%/1000=	735	kg/d	
	Residual Sludge Yield	ΔX=	P_x+P_s=	860.125	kg/d	
(五)	Alkalinity Verification					
	Nitrogen Content in Activated Slu	k_4=		0.124		以12.4%计
	Daily Microbial Assimilatory Nitrogen Re	N_0=	$P_x×k_4$=	15.5155	kg/d	For biological cell synthesis
		=	N_0×1000/Q=	2.2165	mg/L	
	The amount of NH3-N that has been ox	N_W=	$N_k-N_{ke}-N_0$=	27.7835	mgNH3-N/L	
	Amount of denitration required	N_T=	$N_t-N_{te}-N_0$=	17.7835	mgNO3-N/L	
	The amount of nitrate nitrogen that needs	N_r=	Q×N_T/1000=	124.4845	kgNO3-N/d	
	The oxidation of 1mgNH3-N consumes al	S_{ALK1}=		7.14	mg/mgNH3-N	
	Oxidizing NH3-N consumes total alka	S_{ALK2}=	$S_{ALK1}×N_W$=	198.37419	mg/L	
	Removal of 1mgBOD5 produces alkali	S_{ALK3}=		0.1	mg/mgBOD5	
	Remove the total alkalinity produced	S_{ALK4}=	$S_{ALK3}×(S_o-S_e)$ =	11	mg/L	
	Reduction of 1mgNO3-N produces alka	S_{ALK5}=		3.57	mg/mgNO3-N	
	Reduction of NO3-N produces total alk	S_{ALK6}=	$S_{ALK5}×N_T$=	63.487095	mg/L	
	Residual alkalinity	S_{ALK}=	$S_{ALK}-S_{ALK2}+S_{ALK4}+S_{ALK6}$=	156.112905	mg/L	>100mg/L(CaCO3计)
(六)	Size calculated of A2O Biological reaction tank					
	number of reaction tank	n=		2	组	
	Single reaction tank capacity	$V_{单}$=	V/n=	1375	m^3	
	Effective water depth of single react	H=		5	m	
	Effective area of single reaction	$S_{单}$=	$V_{单}$/H=	275	m^2	
	The number of corridors of a single push	n_1=		2	个	
	Gallery width	B=		9	m	
	Width of single reaction cell	W=	B×n_1=	18	m	
	Length of a single reaction poo	L=	$S_{单}$/W=	15.27777778	m	
		=	value	[illegible]	m	
	Check the width to depth ratio	k_3=	B/H=	1.8		1~2
	Check the aspect ratio	k_4=	L/B=	6.944444444		5~10
	Reaction tank superelevation	H_1=		0.5	m	0.5~1.0m
	Total reaction tank height	H_2=	H+H_1=	5.5	m	
(七)	Calculation of inlet and outlet pipes in reaction tank					
	Design flow of the main inlet pipe of the	Q_1=	Q_s=	0.081018519	m^3/s	
	Inlet pipe velocity	v=		0.8	m/s	0.7~2.0m/s
	Cross-sectional area of water inlet	S=	Q_1/v=	0.101273148	m^2	
	Inlet pipe diameter	D=	$\sqrt{\frac{4S}{\pi}}$ =	0.359089097	m	
		=	value	0.6	m	DN600
	Check pipe flow rate	v_1=	$\frac{Q_1}{\frac{1}{4}\pi D^2}$ =	0.286544393	m/s	0.7~2.0m/s
	Design flow of return sludge pipe	Q_2=	R×Q_s=	0.081018519	m^3/s	
	Flow rate of return sludge pipe	v_2=		0.8	m/s	0.7~2.0m/s
	Cross-sectional area of return sludg	S=	Q_2/v_2=	0.101273148	m^2	
	Diameter of return sludge pipe	D=	$\sqrt{\frac{4S}{\pi}}$ =	0.359089097	m	
		=	value	0.6	m	DN600
	Design flow of inlet hole of a single biologic	Q_3=	(1+R) Q_s/n=	0.081018519	m^3/s	Through the inlet shaft
	Inlet velocity	v_3=		0.6	m/s	
	Water inlet crossing area	A=	Q_3/v_3=	0.135030864	m^2	
	Long side of water inlet hole	$L_{孔}$=	$\sqrt{A}$ =	0.36746546	m	Suppose it's a square hole
		=	value	0.4	m	
	Weir discharge	Q_3=	(1+R+$R_{内}$) Q_s/n=	0.162037037	m^3/s	
	Outlet weir width	$B_{堰}$=		9	m	
	The water head above the weir	H=		0.083	m	The value ensures the weir
	Flow coefficient	m_0=	$0.405+\frac{0.0027}{H}$ =	0.43753012		
	Weir discharge	$Q_{堰}$=	$mB_{堰}\sqrt{2g}H^{3/2}$ =	0.41770783	m^3/s	≈Q_3
	Discharge rate of water outlet	Q_4=	Q_3=	0.162037037	m^3/s	
	Outlet flow rate	v_3=		0.6	m/s	
	Water outlet area	$A_{出}$=	Q_4/v_3=	0.270061728	m^2	
	Outlet hole side length	$L_{孔出}$=	$\sqrt{A}$ =	0.519674637	m	
		=	value	0.9	m	
	Design flow of outlet pipe	Q_5=	Q_3=	0.162037037	m^3/s	
	Flow rate of outlet pipe	v_4=		0.8	m/s	
	Cross-sectional area of outlet pi	S=	Q_5/v_4=	0.202546296	m^2	
	Outlet pipe diameter	D=	$\sqrt{\frac{4S}{\pi}}$ =	0.50782867	m	
		=	value	0.8	m	DN800
	Check pipe flow rate	v_5=	$\frac{Q_5}{\frac{1}{4}\pi D^2}$ =	0.322362448	m/s	0.7~2.0m/s
(八)	Aeration system design and calculation					
	BOD5 decomposition rate consta	k=		0.23	d^{-1}	
	BOD5 test time	t=		5	d	
	Remove BOD5 oxygen demand	D_{o1}=	$\frac{Q(S_0-S_e)}{1000(1-e^{-kt})}$ =	1126.779969	kgO2/d	
	BOD oxygen equivalent in resid	D_{o2}=	1.42×P_X=	177.6775	kgO2/d	Synthetic cells, no oxygen
	Carbon oxygen demand	D_{o3}=	$D_{o1}-D_{o2}$=	949.1024693	kgO2/d	
	Removing NH3-N oxygen demand	D_{N1}=	4.6Q(N_t-N_a)/1000=	966	kgO2/d	
	Residual sludge NH3-N oxygen d	D_{N2}=	4.6×12.4%×P_X=	71.3713	kgO2/d	Synthetic cells, no oxygen
	Nitrifying oxygen demand	D_{N3}=	$D_{N1}-D_{N2}$=	894.6287	kgO2/d	
	Nitrogen removal by	D_{N4}=	2.86×N_T=	356.02567	kgO2/d	
	Actual total average oxygen	AOR=	$D_{03}+D_{N3}-D_{N4}$=	1487.705499	kgO2/d	
		=	AOR/24=	61.98772914	kgO2/h	
	Actual total maximum oxygen	AOR_{max}=	1.4×AOR=	2082.787699	kgO2/d	
		=	AOR_{max}/24=	86.78282079	kgO2/h	
	Remove 1kgBOD5 oxygen demand	AOR_{BOD}=	$\frac{1000\,AOR}{Q(S_0-S_e)}$ =	1.932085064	kgO2/kgBOD	
	Water dissolved oxygen saturat	$C_{s(20)}$=		9.17	mg/L	Refer to Appendix XII
	T℃ water dissolved oxygen sat	$C_{s(14)}$=		10.17	mg/L	Refer to Appendix XII
	Standard atmosphere	$p_{标}$=		101300	Pa	
	Pressure correction factor	ρ=		1		Local pressure is higher than
	Concentration of dissolved	C_L=		2	mg/L	
	Ratio of oxygen transfer rate	α=		0.82		
	Ratio of saturated dissolved	β=		0.95		
	Microporous aerator from the	H_4=		0.2	m	According to installation
	Installation depth of	H_5=	H-H_4=	4.8	m	
	Pressure at the outlet of	p_b=	$p_{标}$+9800×H_5=	148340	Pa	
	Oxygen transfer efficiency of	E_A=		0.2		It is determined by device
	The percentage of oxygen when the air leaves the pool	O_t=	$\frac{21(1-E_A)}{79+21(1-E_A)}$ =	0.175365344		
	Aerobic tank dissolved oxygen	$C_{sm(14)}$=	$C_{s(14)}(\frac{p_b}{2.066\times10^5}+\frac{O_t}{0.42})$ =	11.54846563	mg/L	
	Aerobic tank standard state total average oxygen demand	SOR=	$\frac{AOR\times C_{s(20)}}{\alpha(\beta\rho C_{sm(T)}-C_L)\times1.024^{(T-20)}}$ =	2138.106259	kgO2/d	Converted from actual demand
		=	SOR/24=	89.0877608	kgO2/h	
	Aerobic pool standard state	SOR_{max}=	1.4×SOR=	124.7228651	kgO2/h	
	Average hourly capacity of	G_s=	SOR/0.3E_A=	1484.796013	m^3/h	
		=	G_s/60=	24.74660022	m^3/min	
	Average hourly capacity of a	G_{1S}=	G_s/n=	742.3980066	m^3/min	
		=	G_{1S}/60=	12.37330011	m^3/min	Fan selection reference
	Aerobic tank maximum hourly	G_{smax}=	1.4×G_s=	2078.714419	m^3/h	
		=	G_{smax}/60=	34.64524031	m^3/min	
		=	G_{smax}/3600=	0.577420672	m^3/s	
	Maximum hourly capacity of a	G_{smax1}=	G_{smax}/n=	1039.357209	m^3/min	
		=	G_{smax1}/60=	17.32262016	m^3/min	Fan selection reference
		=	G_{smax1}/3600=	0.288710336	m^3/s	
	Gas supply per m3 of sewage	G_{sp}=	24×G_s/Q=	5.090729188	m^3/m^3 sewage	≥$3m^3/m^3$ sewage
	Resistance of air supply	h_1=		0.001	Mpa	It depends on the situation
	Local resistance of air	h_2=		0.001	Mpa	It depends on the situation
	Aerator flooding head	h_3=	0.01×(H-H_4) =	0.048	Mpa	1m water head is 0.01MPa
	Aerator resistance	h_4=		0.004	Mpa	Acuities were 0.004 ~ 0.005
	Surplus water head	Δh=		0.005	Mpa	0.003 ~ 0.005 MPa
	Required wind pressure in	$p_{气}$=	$h_1+h_2+h_3+h_4+\Delta h$=	0.059	Mpa	
		=	$p_{气}$×1000=	59	kPa	Fan selection reference
	Individual aerator	q=		2	m^3/h	Data provided by the
	Single aerator service area	S_q=		0.3~0.75	m^2	Data provided by the
	The number of aerators in one	n_3=	G_{1max}/q=	519.6786047	pcs	
	Surface area of a single	F_o=	$V_{好}$/H/n=	200	m^2	
	Single cell aerator service	$Fo_{单}$=	F_o/n_3=	0.38485325	m^2	≤$0.75m^2$
	Wind speed of the branch pipe	$v_{风}$=		10	m/s	10~15m/s
	Air drying pipe diameter	$d_{风}$=	$\sqrt{\frac{4G_{smax}}{\pi v_{风}}}$ =	0.271144767	m	
		=	value	DN500		
	The air volume of the branch	G_{smax2}=	G_{smax1}/n_1=	0.144355168	m^3/s	
	Both sides of the air supply branch pipe diameter	$d_{支2}$=	$\sqrt{\frac{4G_{smax2}}{\pi v_{风}}}$ =	0.135572383	m	
		=	value	DN250		
(九)	Anoxic tank stirring equipment calculation					
	Number of anoxic pool groups	n_4=		2	group	
	Single anoxic pool volume	$V_{缺单}$=	$V_{缺}/n_4$=	250	m^3	
	Each m3 sewage mixing power re	$p_{搅拌}$=		5	w	2~8w/m^3
	Stirring power required for a	$p_{搅拌1}$=	$p_{搅拌}×V_{缺单}$=	1.25	kw	Mixing equipment selection
(十)	Mixed liquid reflux equipment calculation					
	Return flow rate of the mixtu	Q_R=	Q×$R_{内}$=	14000	m^3/d	
		=	Q_r/24=	583.3333333	m^3/h	
	The number of return pumps in	n_5=		1	set	Consider a second one
	Flow rate of a single return	$Q_{R单}$=	$Q_R/(n_5×n)$ =	291.6666667	m^3/h	Reflow pump selection

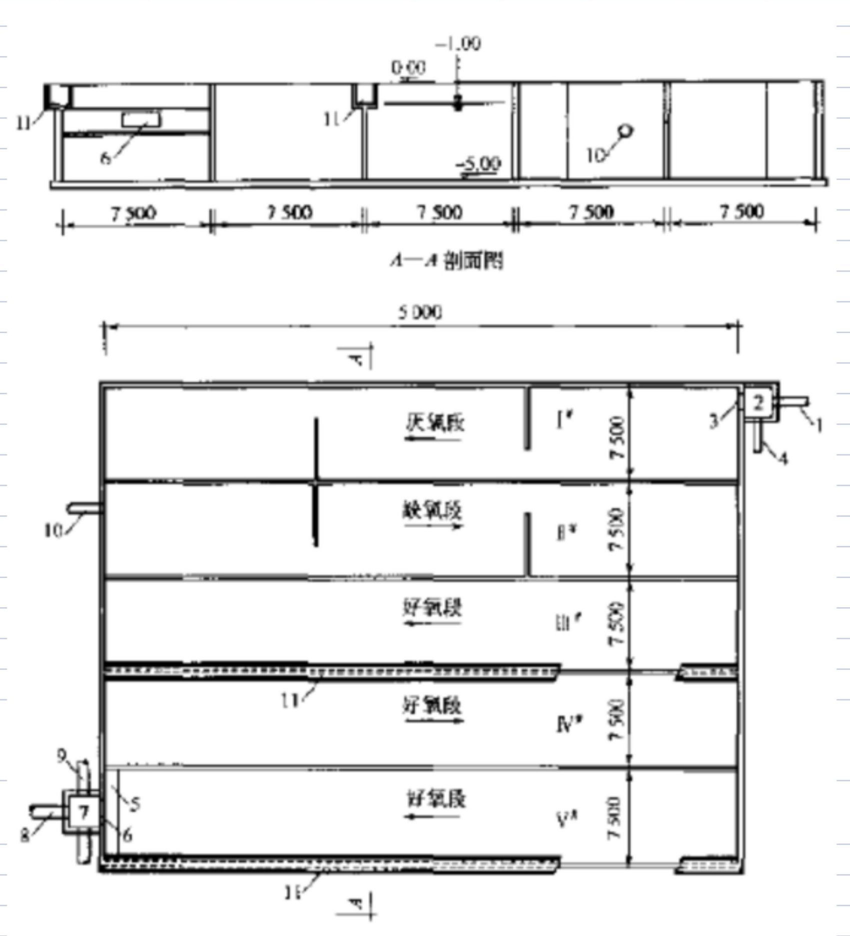

图 6-11 A²/O 脱氮除磷工艺计算图（单位：mm）
1—进水管；2—进水井；3—进水孔；4—回流污泥管；5—集水槽；6—出水孔；7—出水井；8—出水管；9—混合液回流管；10—混合液回流泵房；11—空气管廊

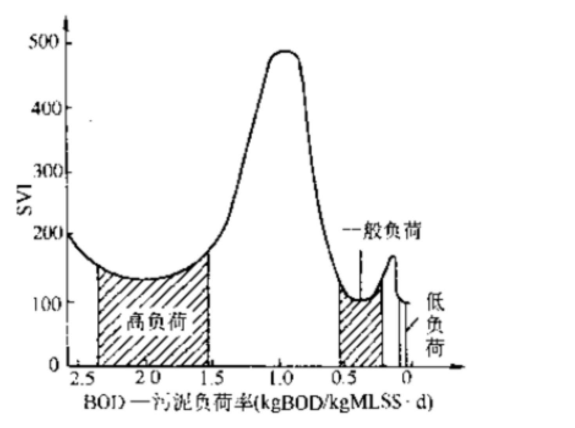

图 4-7 BOD—污泥负荷与 SVI 值之间的关系

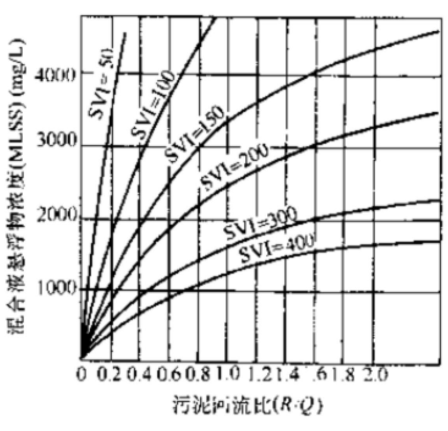

图 4-8 SVI 值、MLSS 及污泥回流比三者之间的关系

水中氧的溶解极限(mg/L) 表 5-30

水的性质	水温(℃) 0	5	10	15	20	25	30
	氧的溶解极限(mg/L)						
淡水	14.6	12.8	11.3	10.2	9.2	8.4	7.6
海水	11.3	10.0	9.0	8.1	7.4	6.7	6.1

附录十二 氧在蒸馏水中的溶解度（饱和度）

水温 T/℃	溶解度 /(mg/L)	水温 T/℃	溶解度 /(mg/L)	水温 T/℃	溶解度 /(mg/L)
0	14.62	5	12.80	10	11.33
1	14.23	6	12.48	11	11.08
2	13.84	7	12.17	12	10.83
3	13.48	8	11.87	13	10.60
4	13.13	9	11.59	14	10.37
15	10.15	21	8.99	27	8.07
16	9.95	22	8.83	28	7.92
17	9.74	23	8.68	29	7.77
18	9.54	24	8.53	30	7.63
19	9.35	25	8.38		
20	9.17	26	8.22		