AquaSust

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SBR process engineering design Calculator

Blue block is the design datameter : Calculation item
Brown: Example data
Red : Item data
Orange: Calculation formula or remarks

1	External condition					
1.1	Design scale	Q	m^3/d	50000	10000	
1.2	Diurnal variation coefficient	K_d		1.17	1.26	
1.3	Coefficient of total change	K_T		1.38	1.46	
1.4	Influent BOD5	Lj	mg/L	150	124	
1.5	Water inlet CODCr	Cj	mg/L	330	318	
1.6	Water inlet SS	Sj	mg/L	200	165	
1.7	Water inlet TN	Nj	mg/L	35	29.8	
1.8	Effluent BOD5	Lch	mg/L	20	20	
1.9	Effluent CODCr	Cch	mg/L	100	100	
1.10	Effluent SS	Sch	mg/L	20	20	
1.11	Effluent TN	Nch	mg/L	15	15	
1.12	Design minimum water temperature	T	℃	10	14.6	
1.13	Sludge index	SVI	mL/g	150	160	
2	Selected parameter					
2.1	Cycle length	T_C	h	6	4	The time of a complete cycle
2.2	Period number	N	次/天	4	6	Maximum number of running cycles per day for a pool
2.3	Reaction time	T_F	h	4	2	Refers only to the time of the reaction stage of the reaction pool
2.4	Settling time	T_s	h	1	1	Refers only to the time of the sedimentation stage of the sedimentation tank (also the reaction tank)
2.5	Decanting time	T_{ch}	h	1	1	Refers only to the duration of the decanting stage of the sedimentation tank (also the reaction tank)
2.6	Pool depth	H	m	5	4.5	The difference between the highest water level and the lowest water level of the designed settling tank
2.7	Safe altitude	H_f	m	0.7	0.7	Prevent sludge from being carried out of the weir to the height of the sludge layer
2.8	Depth of protective layer	H_p	m	0.25	0.25	The depth of the weir to prevent scum from being brought out
3	Calculated sludge volume					
3.1	Design water capacity	Q_d	m^3/d	58500	12600	$Q_d=K_dQ$
3.2	Aerobic mud age	θ_{CN}	d	8.0	5.1	$\theta_{CN}=3.4F\cdot1.103^{15-T}$ 其中： $BOD_5<1200kg/d,F=1.8$; $BOD_5\geqslant6000kg/d,F=1.45$)
3.3'	Age test value of reactive mud	θ'_{CF}	d	11.9	7.2	$\theta'_{CF}=\theta_{CN}/(1-2.9N_d/(0.75L_j*OVc')$ 式中： $N_d=N_j-0.05(L_j-L_{ch})-N_{CH}$ $OVc'=0.56+0.15\cdot1.072^{T-15}/(0.67/\theta_{CN}+0.17\cdot1.072^{T-15})$
3.3	Reaction mud age	θ_{CF}	d	11.9	7.2	$OVc=0.56+0.15\cdot1.072^{T-15}/(1/\theta'_{CF}+0.17\cdot1.072^{T-15})$
3.4	Anoxic mud age	θ_{CD}	d	3.8	2.1	$\theta_{CD}=\theta_{CF}-\theta_{CN}$
3.5	Total sludge age	θ_C	d	17.8	14.4	$\theta_C=\theta_{CF}\cdot T_C/T_F$
3.6	Sludge yield coefficient	Y	kgSS/kgBOD5	1.137	1.161	$Y=K(0.75+0.6S_j/L_j-0.8*0.17*0.75\theta_{CF}1.072^{T-15}/(1+0.17\theta_{CF}1.072^{T-15})$; 其中： K=0.9~0.95
3.7	Total sludge volume of the reaction tank	S_T	kg	154191	21924	$S_T=Q_d\theta_CY(L_j-L_{ch})/1000$
4	Calculate the capacity of the reaction pool					
4.1	Given maximum daily maximum flow rate	Q_h	m^3/h	2880	669	
4.2	Actual settling time	T's	h	1.83	1.83	$T's=T_s+T_{ch}-1/6$
4.3	Reaction pool capacity	V	m^3	51194	7515	$V=S_TSVI\{H_f+H_p+[(H_f+H_p)^2+62400Q_hHT's/(S_TSVI\cdot N)]^{1/2}\}/(1300T's)$
5	Other parameters					
5.1	Anoxic response period	T_D	h	1.3	0.6	$T_D=T_F/(1+\theta_{CN}/\theta_{CD})$
5.2	Aerobic reaction period	T_O	h	2.7	1.4	$T_O=T_F-T_D$
5.3	Intermittent water intake decantation depth	ΔH	m	1.69	1.60	$\Delta H=24Q_h\cdot H/(N\cdot V)$
	Depth of continuous water intake decantation	ΔH	m	1.41	1.20	$\Delta H=24Q_h\cdot H/(N\cdot V)(1-T_C/T_{ch})$
5.4	Sludge concentration at high water level	N_{WT}	g/L	3.01	2.92	$N_{WT}=S_T/V$
5.5	Sludge concentration at low water level	N_{WL}	g/L	4.55	4.53	$N_{WL}=S_T\cdot H/(V\cdot H_L)$
5.6	Sludge load	F_W	$kgBOD_5/kgMLSS\cdot d$	0.085	0.143	$F_W=L_j/[\theta_CY(L_j-L_{ch})]\cdot T_C/T_F$
5.7	Hydraulic retention time	t	h	21.0	14.3	$t=24V/Q_d$
5.8	Select the number of pools in the intermittent water intake mode	n	pieces	**6**	**4**	Satisfy as much as possible simultaneously : (1) $n\geqslant2$ (2) $n=k_1T_C$ (3) $n=k_2T_C/T_{ch}$ (4) $n=k_3T_C/T_O$
5.9	Volume per pond	V_i	m^3	8532	1879	$V_i=V/n$
5.10	Area of single pond	F_i	m^2	1706	417	$F_i=V_i/H$
5.11	Water storage capacity of a single pond	ΔV_i	m^3	2880	669	$\Delta V_i=V_i\cdot\Delta H/H$
5.12	Calculated minimum water level	H_L	m	3.31	2.90	$H_L=H-\Delta H$
5.13	Calculate the minimum mud level	H_s	m	2.64	2.35	$H_s=H-H_p-\Delta H-H_f$
5.14	Width of single pool	B	m	16.9	10.2	Partition scheme by square pool $B=(F_i/n)^{1/2}$
5.15	Single pool length	L	m	101.2	40.9	$L=F_i/B$
5.16	Actual total area of square pool	As	m^2	10239	1670	Partition area is not considered
5.17	Actual total volume of the square pool	Vs	m^3	59385	8517	Partition area is not considered
5.18	Pool elevation	H_1	m	0.8	0.6	H_1=0.6~0.8m
5.19	Total depth of the pool	H_Z	m	5.8	5.1	$H_Z=H+H_1$
5.20	Inlet flow of a single pool	Q_j	m^3/h	1440	223	$Q_j=\Delta V_i/(TF/2)$
5.21	The number of decanters in a single pool is provided	n_b	pcs	1	1	
5.22	Single decanter flow rate	Q_b	m^3/h	2880	669	$Q_b=\Delta V_i/(n_b\cdot T_{ch})$
5.23	The gutter is higher than the pool	H_0	m	1.20	1.60	H0 is obtained after the gutter bottom elevation is determined according to the engineering conditions
5.24	Drain depth when decanting	δ	m	0.60	0.30	Based on the slope of the drainage ditch and the amount of decantation
5.25	Maximum head	H_{max}	m	3.20	2.60	$H_{max}=H-H_0-\delta$ (When the bottom of the ditch is lower than the bottom of the pool:$H_{max}=H+H_0-\delta$)
5.26	Minimum head	H_{min}	m	1.5	1.0	$H_{min}=H_{max}-\Delta H$
5.27	Decanter selection	Mod	HLB2880-1.5-1.7/5-800PC	HLB669-1.0-1.6/4.5-400PA		
6	Biological selector and reflux					According to the combination of reaction tank and sedimentation tank
6.1	The proportion of the volume of the reaction pool	P	%	21.5%	14.4%	$P=100\theta_{CD}/\theta_C$
6.2	Biological selector single pool volume	V_1	m^3	1836	271	$V_1=P\cdot V_i$
6.3	Biological selector single pool length	L_1	m	21.8	5.9	$L_1=P\cdot L$
6.4	Reflux ratio	R	%	450%	450%	
6.5	Reflux time	T_R	h	1.0	1.0	
6.6	Reflux pump design flow rate	Q_R	m^3/s	1.80	0.28	$Q_R=R*Q_j/3600$
6.7	Reflux pump design head	H_R	mH_2O	1.4	1.8	Need to be determined by the resistance calculation
6.8	Number of reflux pumps running at the same time	n_R	pcs	3.0	2.0	
6.9	Number of backflow pumps in reserve	n_{R1}	pcs	1.0	1.0	
6.10	Design flow of a single return pump	Q_{R1}	m^3/s	0.6	0.1	$Q_{R1}=Q_R/n_R$
6.11	Shaft power required for return pump	Nc	kW	8.2	2.5	$N_C=1000Q_{R1}*H_R/102$
6.12	Overall efficiency of return pump	η_Z	%	75.0%	65.0%	Check the pump efficiency curve
6.13	The return pump needs to be equipped with motor power	N_b	kW	11.0	3.8	$N_b=N_C/\eta_Z$
6.14	The return pump needs to be equipped with motor power	Ne	kW	0.1	4	

表1：只去除含碳有机物时最小泥龄和建议泥龄

污水处理厂规模	BOD_5<1200kg/d	BOD_5≥6000kg/d
最小泥龄/d	5	4
建议泥龄/d	6	5

表2：要求硝化时最小泥龄和建议泥龄

污水处理厂规模	BOD_5<1200kg/d			BOD_5≥6000kg/d		
设计水温/℃	10	12	14	10	12	14
最小泥龄/d	10	8.2	6.8	8	6.6	5.4
建议泥龄/d	11	9.2	7.8	9	7.6	6.4

表3：降解含碳有机物单位耗氧量Ovc（$kgO_2/kgBOD_5$）

T/℃	泥龄 θ_{CF}(d)											
	4	5	6	8	9	10	12	14	16	18	20	25
8	0.82	0.86	0.90	0.96	0.99	1.01	1.05	1.08	1.11	1.14	1.16	1.20
9	0.83	0.88	0.91	0.98	1.00	1.03	1.07	1.10	1.13	1.15	1.17	1.21
10	0.85	0.89	0.93	0.99	1.02	1.04	1.08	1.11	1.14	1.16	1.18	1.22
11	0.86	0.91	0.94	1.01	1.03	1.06	1.10	1.13	1.15	1.18	1.20	1.23
12	0.87	0.92	0.96	1.02	1.05	1.07	1.11	1.14	1.17	1.19	1.21	1.24
13	0.89	0.94	0.97	1.04	1.06	1.09	1.12	1.16	1.18	1.20	1.22	1.25
14	0.90	0.95	0.99	1.05	1.08	1.10	1.14	1.17	1.19	1.21	1.23	1.26
15	0.92	0.97	1.01	1.07	1.09	1.12	1.15	1.18	1.21	1.23	1.24	1.27

注：COD_j/L_j≤2.2时有效。

德国ATV标准SVI设计值

处理目标	SVI（mL/g）	
	工业废水影响小	工业废水影响大
无硝化	100~150	120~180
硝化（及反硝化）	100~150	120~180
污泥稳定	75~120	120~150