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Design Calculation sheet along with assumptions

SBR (Sequencing Batch Reactor) – 450 KLd STP (Sewage Treatment Plants)

Important

In case of SBR only.

1. *The hydraulic retention time is not a basis of design , although it appears in table of design parameters , It is likewise not a design criteria ,* ***Because SBR is a batch process*** *, HRT (hydraulic retention time) has less meaning in comparison with continuous flow reactors*

2. *As HRT is not a design basis for SBR , that is why all other companies who say take x or y retention time , they will end up damaging the system .*

Inlet & outlet parameters

S.no	Parameters	Inlet	Outlet	Remarks
1	BOD 5	300 mg/l	25 mg/l	In calculation we will take outlet BOD = 0
2	TSS	200 mg/l	30 mg/l	
3	NH3- N	25 mg/l	1 mg/l	
4	Ammonical nitrogen	150 mg/l	50 mg/l	
5	Total Phosphorus	10 mg/l	2 mg/l	
6	TKN	40 mg/l	5 mg/l	
7	COD	600 mg/l	150 mg/l	

Design Assumptions

S.no	Parameters	At Outlet	Remarks
1	F/M Ratio (kgBOD applied/kgMLSS-d)	0.13	
2	MLSS	3500 mg/l	
3	Minimum Clarifier Depth	2.75 m	
4	Net Sludge yield (kg MLSS/kg BOD5)	0.76	
5	Wastewater Temp	25 Degree C	
6	Min Solids Retention time	8 days	Theta C (mean cell residence

			time)
7	***Reactor volume decanted each Day***	***60 %***	
8	***Net Elevation Above Sea Level***	***304 m***	
9	***DO mixed liquor concentration***	***2.5 mg/l***	
10	***Oxygen coefficients*** *kg O2/kg BOD 5* *kg O2/kg NH3- N*	 ***1.28*** ***4.60***	
11	***Oxygen Transfer rate of Diffusers***	***1.25 kgO /kW-hr***	
12	***Number of cycles per day*** *Includes two square basins for operational flexibility*	***4***	

A. Reactor Volume

BOD 5 Removed (kg/d) = [(BOD inlet – BOD Outlet) mg/l] X Flow (L/day) X 10 ^-6 (kg/mg)

BOD 5 Removed (kg/d) = 135 kg / day

Required Aerobic Mass (kg) =

$$\frac{\textbf{BOD 5 Removed (kg/d)}}{\textbf{F/M Ratio } \textit{(kgBOD applied/kgMLSS-d)}}$$

Required Aerobic Mass (kg) = 1038.46 kg MLSS

Reactor volume** (low water level*) ***(m3) **=**

$$\frac{\textbf{MLSS mass (Kg) X 10\^{}6 } \textit{(mg/kg)}}{\textbf{MLSS Conc (mg/l) X 10\^{}3 } \textit{(L/m3)}}$$

Reactor volume** (low water level*) ***(m3) **= 297 m3**

Since the Decant volume represents 60 % of the total volume

Total Reactor Volume m3 = 297 / (1-0.6)

= 743 m3 Reactor volume

B. Decant Volume

Total Decant volume* = Total Reactor Volume m3 - *Reactor volume* *(low water level*) *(m3)

= 743 – 297 = **446 m3 Decant volume**

C. Detention Time

Max Detention time (hour) = Total Reactor volume / Flow

= 40 hours

Min Detention time (hour) = Decant Volume / Flow

= 23.786 hours

D. SBR Dimensions

Basin Area (m2) = Basin Volume (*low water level* ***) m3 / Min Depth***

Basin Area (m2) = 108 m2

Basin Length (m) = 10.3 m = 11 m

Basin Depth = Total Reactor Volume / Basin Area

743 / (11*11) = 6.14 m

E. Aeration Required

Nitrogeneous O2 Demand (kg O2 / d) = NH3 – N oxidized (kg/d) X kg O2/kg BOD 5

NH3 – N oxidized (kg/d) = TKN removed (kg/ d) - Synthesis N (kg/d)

TKN Removed = (40 - 5) × 450 × 10^-3

= 15.75 kg/d

Synthethis N = 5% waste activated sludge of total daily sludge production

Sludge Production (*kg*/*d*) = *Net Sludge Yield* (*kgMLSS*/*kgBOD*5) × *BOD*5 *Removed* (*kg*/*d*)

Sludge Production = 0.76 (kgMLSS/kgBOD5) × 135 (kg/d) = 102.6 kg/ day

Synthesis N (kg/d) = 0.05 X 102.6 kg/d = 5.13 kg /day

NH3 – N oxidized (kg/d) = 15.75 kg/d – 5.13 kg/d = 10.62 kg / day

Nitrogeneous O2 Demand = 10.62 (kgNH3 –N oxidized/d) × 4.6 (kgO2/kgNH3 – N oxidized)

= 48.852 kgO2/d

Carbonaceous O2 Demand (kg O2/d) = BOD5 Mass (kg/d) × kg O2/kg BOD5

Carbonaceous O2 Demand = 5.13 (kg BOD5/d) × 1.28 kg O2/kg BOD5

= 6.5664 kg O2/d

AOR (kg/d) = Carbonaceous O2 Demand (kg/d) + Nitrogeneous O2 Demand (kg/d)

AOR = 6.5664 kgO2 /d + 48.852 kgO2 /d = 55.4184 kgO2 /d

Where AOR = Actual oxygen requirement

Note : at Standard Temp & Pressure , 1 m3 air = 1.29 kg weight

Oxygen in air = 21 %

F. Blower Usage

14 hours per day	*Based on 4 cycles per day (6 hour / cycle)*
1 hour	*Fill time*
3.5 hour	*React time*
0.75 hour	*Settle time*
0.5 hour	*Decant Time*
0.25 hour	*Idle time*

Richa Environmental Services Private Limited			
Actively involved in manufacturing , installation , design			
Sewage Treatment Plants STP	*Effluent Treatment Plants (ETP)*	*MBBR*	*Sequencing Batch Reactor*
MBR (Membrane Bio reactor)	*Lamella Clarifier*		

For feedback or any design related queries feel free to contact us .

Regards

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