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Operation Philosophy of SBR based Sewage Treatment Plant

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ABSTRACT: Sewage treatment plants in the rural areas are being increased by the Government of India Initiative Under Swachh Bharat Mission (SBM) and also as per the National Green Tribunal (NGT) norms. This is required Including reuse of water up to 20% for all habitations. In this scenario, the treatment plant should be cost effective and alsothe maintenance of the treatment plant shall be with minimum cost using the local resources of NGOs. There is a vast need for economising the things in place. The capacities of Sewage treatment plants are Ranging from 2 MLD to 100 MLD SBR basins for treating Swage. Modern plants are designed including Bio Nutrient Removal ie. Nitrification, denitrification, Phosphorus removal along with reducing the BOD to required levels as per NGT guidelines. The process contains Physio chemical parameters Both physical and chemical properties of the wastewater to be treated to the desired levels.

For Raw sewage COD : BODratioshall 2:1 ie. COD should not be more than two times the BOD. However, the sewage from openchannels may contain higher COD levels Compared to BOD when there is intervention or mixing of industrial effluents Into the sewage.

This paper address the important Points as well as steps To achieve the Required Parameters duly giving importance to the cost of treatment. Overall life cycle cost of an STP Shall be minimum By choosing the right technology And operating the same With minimum use of chemicals

1. INTRODUCTION

Sewage treatment plants are designed for the following parameters

Table : 1 : Characteristics of Raw sewage and Treated water Outlet

Characteristics	Unit	Inlet	Treated Outlet
pH		7-8	6-8
BOD @ 20 Deg C	mg/lit	250	10
COD	mg/lit	425	50
TSS	mg/lit	375	10
TKN as N	mg/lit	45	5
Total Phosphorous as P	mg/lit	7.1	1
Coliform Bacteria	MPN/100 ml	5.00 x 10^5	230

** The above parameters are as per the present norms for disposal

Bais Requirements of Sewage treatment Plant with following units:

a. Primary Treatment System

i. Stilling Chamber

ii. Fine Screens

iii. Grit Removal Unit

iv. Parshall Flume

b. Sequential Batch Reactor (SBR)

c. Chlorination System

d. Sludge Handling System (centrifuge / filter press / screw press)

i. Biological Sludge Sump and Transfer Pumps

ii. Mechanical Dewatering Unit

2. DETAILED COMPONENT DESCRIPTION

a. I&D (Interception and Diversion works):

Sewage treatment plant consists of the following Components ie. I&D (Interception and Diversion) . When the flow is from aopen channel lined or unlined, it is pertinent to provide I&D to take the sewage into the wet well. I&D acts as primary treatment also as coarse screen as well as grit channel with low velocity in larger capacity plants. By providing I&D with screening and grit removal will decrease the load of BOD and TSS up to certain extent . By providing this I&D , pumps at wet well will work efficiently.

b. Wet well :

There will be diurnal variations in the flow of sewage . Pumps shall be capableof handling lean flow, average flow and peak flow during the day. Pump configuration shall be such that one of the pumps with nearer to duty parameters like discharge and head shall handle these variations. Minimum 50% of the standby shall be ensured while designing.

The pump configuration shall be, he pumps provided shall For lean flow Average And also number of pumps put together should cater for Peak flow conditions. By providing Such an arrangement The pump Running hours When the flow is less and lean flows are coming into the STPwill enhance energy efficiency .

c. Variable Frequency Drives (VFD)

By providing Variable frequency drives to the pumps wherein the pump RPM (Rotations per minute) can be reduced based on the Load there by reducing the power consumption.

VFD provided with the pumps will have a smooth starting And flow control without throttling the valves. Because of less power ,low operating costs are ensured. Discharge is directly proportional to the RPM,head is directly proportional to the square of rpm and power is directly proportional to Cube of RPM The functions of VFD are Ac to DC conversion by rectifier And incoming voltage Converted to DC. Capacitors smoothen the DC voltage. DC to variable AC conversion is done by inverter Electronic switches create AC of the required frequency and voltage. By regulating the pump speed and the efficiency of the pump By choosing number of pumps for variable conditions, it is practical to achieve that the pump duty point is always met In all conditions. It is aware that the sewage flow will not be constant and uniform Over the 24 hours of the day.Peak factor is considered in designing the sewage treatment plants as well as the wet well for providing the number of pumps and different Flow conditions

As the sewage enters below the ground level, there is a necessity of pumping the sewage to a higher elevation at Stilling Chamber and from there it flows by gravity through fine screen chambers of 6MM openings , followed by a grit chamber With lesser velocity so that the heavy grit particles of specific gravity more than 2.65 up to a particle size of 0.15 mm will be

settled and the grit removed Will be very useful in reducing the BOD and TSS by 20% . The load on the further biological treatment plant will be reduced for better efficiency of the system. In SBR basins there will be a selector zone wherein Anoxic conditions are Being created where nitrification as well as denitrification will occur . After that flow is Sent to the reactor basin where it acts on the extended aeration principles Low F/M,high MLSS. The limits are given as 0.05 to 0.3 F/M per day and MLSS of 3500 to 5000 mg/lit as per CPHEEO Manual.

d. SBR Basins:

In SBRbasins, DO (Dissolved Oxygen) sensors are placed to assess DO levels available in the basin during the treatment DO level will be enhanced by providing required oxygen throughfine bubble diffusers placed at 250 mm above floor level of the basin.

Required MLSS shall be maintained by recirculation and pumping the surplus sludge by providing RAS and SAS pumps . These will be operated at the end of each cycle intermittently. If the DO is higher than 2 mg/lit, the blowers automatically control the air supply by using VFD drives.

N = 120 f/P, f = frequency in Hz, P is number of poles. 4 pole motor at 50 Hz, RPM = 1500, at 40 HZ RPM = 1200 and at 30 HZ RPM is 900. VFD changes the frequency from zero to 50Hz or even higher thereby controlling the motor speed By maintaining the required oxygen to do the treatment

Maintaining the F/M ratio as well as MLSS Is a key parameter In SBR basins There will be a provision of Return activated sludge will be pumped to selector zone. This will enhance the Nitrification , denitrification and as well as phosphorus removal

Calculation of SBR volume and HRT:

Daily flow In cubic metres per day

Inlet BOD: 250 mg/lit

MLSS: 3500 to 5000 (generally taken as 4400 mg/lit)

MLVSS : 70% of MLSS

F/M : 0.05 to 0.3 per day (Generally taken as 0.135 /day)

Total volume of basins = Daily Flow X BOD / (MLVSS x F/M)

Number of basins provided Is decided Based on Daily flow in MLD

Tentatively Up to 20 MLD - 2 Basins, 20 to 60 MLD - 4 basins, 60 to 150 mld – 6 basins , 150 to 250 mld - 12 basins and so on. more than 250 mld 16 basins .

Number of cycles of this batch process is designed by the time taken for each stage.

Filling and Aeration Phase : 1.5 Hours

Settling Phase : 0.5 to 0.75 Hours

Decant Phase : 0.75 to 1 Hours

Total cycle time : 3 Hours. (2.5 to 6 Hours as per CPHEEO manual)

Number of cycles per day : 8 Nos.

Decant depth varies from 2 to 2.5 metres. Side water depth of SBR Basin depends on the decant depth.

Sidewater depth is calculated based on Top water level (TWL) and bottom water level (BWL) Average Effective aeration depth is Aeration depth minus 0.25 which is the Depth at which height fine bubble diffusers are placed .

Selector zone shall be approximately 50 minutes retention time This includes recirculation flow of 25% of the feed flow to each basin.

Total Volume of SBR basins provided will have HRT of 13 to 15 hours based on various parameters described above.

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C Tech Basin Operation sequence

2 Basin System - Cycle Time - 3 Hours — Number of Basins simultaneously

F/A	Filling and Aeration	90	Minutes	**1**
S	Settling	30	Minutes	**1**
D	Decanting	60	Minutes	**1**
Total Cycle Time		180	Minutes	

Time , Hrs ----->

	0.25	0.5	0.75	1	1.25	1.5	1.75	2	2.25	2.5	2.75	3
Basin 1	F/A	F/A	F/A	F/A	F/A	F/A	S	S	D	D	D	D
Basin 2	S	S	D	D	D	D	F/A	F/A	F/A	F/A	F/A	F/A

4 Basin System - Cycle Time - 3 Hours — Number of Basins simultaneously

F/A	Filling and Aeration	90	Minutes	2
S	Settling	45	Minutes	1
D	Decanting	45	Minutes	1
Total Cycle Time		180	Minutes	

Time , Hrs ----->

	0.25	**0.5**	**0.75**	**1**	**1.25**	**1.5**	**1.75**	**2**	**2.25**	**2.5**	**2.75**	**3**
Basin 1	F/A	F/A	F/A	F/A	F/A	F/A	S	S	S	D	D	D
Basin 2	S	S	S	D	D	D	F/A	F/A	F/A	F/A	F/A	F/A
Basin 3	D	D	D	F/A	F/A	F/A	F/A	F/A	F/A	S	S	S
Basin 4	F/A	F/A	F/A	S	S	S	D	D	D	F/A	F/A	F/A

6 Basin System - Cycle Time - 3 Hours — Number of Basins simultaneously

F/A	Filling and Aeration	90	Minutes	**3**
S	Settling	30	Minutes	**1**
D	Decanting	60	Minutes	**2**

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Time , Hrs ----->

	0.25	0.5	0.75	1	1.25	1.5	1.75	2	2.25	2.5	2.75	3
Basin 1	F/A	F/A	F/A	F/A	F/A	F/A	S	S	D	D	D	D
Basin 2	S	S	D	D	D	D	F/A	F/A	F/A	F/A	F/A	F/A
Basin 3	D	D	F/A	F/A	F/A	F/A	F/A	F/A	S	S	D	D
Basin 4	F/A	F/A	S	S	D	D	D	D	F/A	F/A	F/A	F/A
Basin 5	D	D	D	D	F/A	F/A	F/A	F/A	F/A	F/A	S	S
Basin 6	F/A	F/A	F/A	F/A	S	S	D	D	D	D	F/A	F/A

e. Air Blowers requirement :

Oxygen required for BOD removal shall 1.2 kg of Oxygen per KG of BOD to be removed Oxygen required for nitrogen Is 4.56 kg of Oxygen per kg of nitrogen to be removed There Phosphorus assimilation of 2.5% of the board removed And nitrogen Assimilation of 5% of the BOD removed

There is also an oxygen release between nitrate to nitrogen During denitrification. KgO2releasedperKgofNitrate-Nitrogen during denitrification Is 2.86. Volume of the basin depends on MLSS and F/Mand also peak flow condition.

The sequential batch reactor process is a cyclic Actuated treatment process Multiple reactors are provided to treat the wastewater in batch Sequential batch reactors . Tis will be operated to oxidised Carbonate BOD / COD, nitrify the ammonia and denitrify to reduce total nitrogento less than 5 mg/lit. In this process, because of 2.5% of the assimilation of biomass due to phosphorous removal , separate chemical treatment for phosphorous removal is not required.

The process includes filling and aeration, sedimentation and decanting with different timings To make a cycle time of 2.5 to 6 hours As per the CPHCEO manual and generally Fill and aeration time will be 1.5 hours Followed by Sedimentation For 45 minutes and decanting 45 minutes However, the decanting time can be up to one hour making the cycle time 3 hours and 8 cycles per day.. The sludge developed in the form of MLSS shall be recycled as return activated sludge to Selector zonewhich will be maintained under Anoxic conditions By providing Coarse bubble diffusion, sludge entering the selector zone will mix with the sewage to maintain Required MLSS as well as Removing the Nitrogen and phosphorus

There can be a graphical representation of volume of SBR basin will decrease with higher MLSS as well as with increase in F/M . The volume of Reactor basin depends on The number of basins receiving simultaneously as well as aeration And also the number of basins having simultaneous Decanting. For example, in a 12 basin system there will be six basins receiving the raw sewage and aeration of six basins with Four numbers of reactors decanting simultaneously. Maintaining the sludges between 12 to 20 days is Required for maintaining the optimum System under SBR basin.

f. Power consumption

For a 30 mld capacity STP under SBR technology, The Electrical installed load will be about 1300 KW and operating load will be about 900 KW which is 30 KW per MLD. This parameter varies from 25 KW per MLD for higher capacity plants 47 KW per MLD for smaller capacity plants. Electrical load details are tabulated below.

Diesel generating set for critical loads will be provided as part of STP as the operations are 24 x 7. Pumps – 2 Nos., Air blowers – 2 Nos, Decanters – 2 Nos. , Sluice gates – 2 Nos. , electric actuated valves – 6 Nos. , service water pumps 1 No. and lighting load 15 kilowatt Is considered and the overall DG load will be about 500 KVA

Surplus activated sludge from SBR basin to maintain the required MLSS is crucial parameter . The following components will be part of sludge handling unit There will be a sludge sump provided with 4 hours retention Centrifuge Decanters of 25KW With two working one standby will be provided There will be centrifuge feed pumps and agitators for dozing pumps and dozing pumps With approximately 10 kilowatt load

The power consumption for mld is calculated Which varies with the Capacity of treatment plant It is about 30 kilowatts per mld 45 kilowatt per mld For a 7 MLD treatment plant.

New developments like Pulse aeration Mode is carried out during start up of the plant for 2-3 months stabilization for bacterial growth. Initially sludge from the fully stabilized plant can be fed to the SBR Basins. Blower profile mode with 5 set points for on and off of the blowers in sequence with pre-defined timings in the fill and aeration period of 1.5 hours. DO profile mode is also in practise in which depending on the DO, the blowers will automatically increase the air transfer or reduce if there is sufficient DO in the system

Table 2: Tentative electrical load list of 30 MLD SBR Based STP

S No	STP Component	Description	Total Qty	KW	Connected Load	Operating Qty	Operating Load
1	Wet Well	RSPS pumps	6	52.5	315	4	210
		EOT crane	1	3.7	3.7	1	3.7
2	Receiving Chamber	Mechanical Coarse screen	2	1.1	2.2	2	2.2
		Inlet Gates	2	1.5	3	2	3
		Belt conveyor	1	1.5	1.5	1	1.5
3	Pre-Treatment Units	Mechanical Fine screen	2	1.5	3	2	3
		Gates	4	1.5	6	4	6
		Mechanical grit	2	1.5	3	2	3
		Grit classifier	1	1.1	1.1	1	1.1
		Organic return pump	2	0.75	1.5	2	1.5
		Belt conveyor	1	1.5	1.5	1	1.5
4	SBR Basins	Sluice Gates	6	1.1	6.6	6	6.6
		Decanters	4	0.55	2.2	2	1.1
		RAS & SAS pumps	8	7.5	60	4	30
5	Chlorine Contact Tank	Service water pumps	2	5	10	1	5
6	ChlorinationSystem	Chlorine booster pumps	2	3.7	7.4	1	3.7
		EOT crane	1	3.7	3.7	1	3.7
7	Air Blower Room	Air Blowers	6	132	792	4	528

S No	STP Component	Description	Total Qty	KW	Connected Load	Operating Qty	Operating Load
	and MCC Panel	Actuators for valves	6	1.1	6.6	4	4.4
		EOT crane	1	3.7	3.7	1	3.7
8	Sludge sump and Centrifuge building (Sludge Handling Units)	Sludge Air Blowers	2	3.7	7.4	1	3.7
		Centrifuge feed pumps screw type	3	3.7	11.1	2	7.4
		Centrifuges	3	30	90	2	60
		EOT	1	3.7	3.7	1	3.7
		Agitators	2	1.5	3	2	3
		Dosing Pumps & Agitators	3	1.5	4.5	3	4.5
5	Plant Area Lighting		1	15	15	1	15
		Total			**1368.4**		**920**

3. CONCLUSION

It is very important to maintain the health of the biological process in reducing the pollutant load of BOD to the safe standards and also the proper Operation and maintenance of the system is very crucial. Maintaining F/M, MLSS and DO control in the system is essential and supporting sensors and OCEMS (Online continuous Effluent Monitoring System) shall be implemented to know the quality of the treated effluent. There will be online sensors to measure pH, BOD, COD , TSS and Residual chlorine real time data and gives the indication if any of the parameters are not matching with the requirement. By doing so lot of energy can be conserved in case of less pollutant load or less flow in various conditions. The treated sewage as per above system is suitable for reuse for non-potable applications and Ultrafiltration or disc filters can be provided as per the requirement of end use and UV disinfection is also recommended.

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