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Design of 50KLD MBBR based Sewage Treatment for Hostel Building, Nagpur

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Abstract: Sewage water recovery is the treatment or processing of Sewage water to make it applicable. This paper shows the design of various component of conventional sewage treatment plant using Moving Bed Biofilm Reactor technique at College Hostel, Nagpur. The project consisting of the design of complete Sewage Treatment Plant components consist of Bar Screen Chamber, Equalization Tank, Aeration Tank, Clarifier Tank, Pressure Sand filter, Activated Carbon Filter and Treated Water Tank. Among the available technologies for waste water treatment, MBBR sewage treatment is most suitable. It is a leading technology in waste water treatment as this system can operate at lower vestiges and give advanced efficiency of treatment. It's compact and effective option for domestic waste treatment. In duly designed MBBR, the whole reactor volume is active, with no dead space or short circuiting. This paper demonstrates the detailed procedure for the design of a MBBR grounded sewage treatment plant of 50 KLD capacity for an educational lot.

I. INTRODUCTION

Water plays an imperative part within the development of any action within the world. Due to the development of populace, utilization of water assets is more and accessibility is less. So, the demand for water is expanding. Sewage treatment is the method of evacuating contaminants from squander water, fundamentally from family sewage. Physical, chemical and biological forms are utilized to expel contaminants and deliver treated wastewater that's more secure for the environment. A by-product of sewage treatment is ordinarily semi-solid squander or slurry called sewage slime. The slime needs to experience encourage treatment some time recently being reasonable for transfer or application to arrive. Sewage can be [3] screening to trap strong objects and sedimentation by gravity to expel suspended solids. This level is in some cases alluded to as "Mechanical Treatment" in spite of the fact that chemicals are frequently utilized to quicken the sedimentation prepare. This Treatment can decrease the BOD of the approaching wastewater by 20-30% and the Full suspended solids by a few 50-60%. Essential treatment is the primary arrange of sewage treatment. The auxiliary treatment expels the broken-down natural matter that get away essential treatment. Auxiliary treatment is ordinarily performed by inborn, water-borne micro-organisms in a overseen environment. It requires a division prepare to evacuate the micro-organisms from the treated water earlier to release or tertiary treatment. Tertiary treatment is some of the time is characterized as anything more than essential and auxiliary treatment in arrange to permit discharge into a exceedingly delicate or delicate environment. Tertiary treatment can expel more than 99% of all the debasements from sewage, creating an emanating of nearly drinking water quality. Treated water is now and then sanitized chemically or physically earlier to release into a stream, waterway or wetland.

II. WHAT IS MBBR?

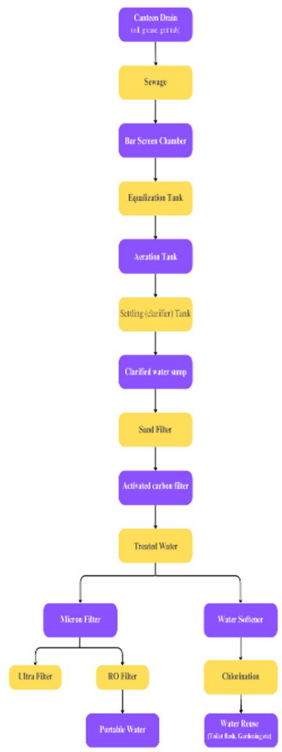
MBBR stands for Moving Bed Biofilm Reactor, which is a biological wastewater treatment process that utilizes microorganisms to remove organic matter and other pollutants from water. The MBBR technology consists of a tank filled with plastic media carriers that provide a surface area for the growth of microorganisms that form a biofilm on the media.

The MBBR technology is highly effective in treating a wide range of wastewater types, including municipal, industrial, and agricultural wastewater. It is also a compact and scalable process, which means it can be used in small or large-scale applications, depending on the specific requirements.

Compared to other biological wastewater treatment processes, the MBBR technology has several advantages, including low energy consumption, easy operation and maintenance, and high treatment efficiency.

These advantages make the MBBR technology a popular choice for wastewater treatment in many parts of the world.

1) *Health Risks:* Wastewater can contain harmful microorganisms, pathogens, and chemicals that can pose health risks to humans and animals if not properly treated. Rising levels of wastewater can increase the risk of waterborne diseases and illnesses
2) *Environmental Pollution:* Wastewater can pollute surface water and groundwater, leading to the degradation of aquatic ecosystems and harming wildlife. Excess nutrients in wastewater can also cause eutrophication, which can lead to algal blooms and fish kills.



3) *Depletion Of Freshwater Resources:* As the demand for water increases, the use of treated wastewater for irrigation and other non-potable purposes is becoming more common. However, if the amount of wastewater generated exceeds the capacity of treatment plants, it can lead to a depletion of freshwater resources.
4) *Economic Costs:* Treating wastewater is a costly process, and rising levels of wastewater can put a strain on municipal and industrial wastewater treatment facilities. Inadequate treatment can lead to costly infrastructure repairs, fines for noncompliance with regulations, and lost productivity due to health issues.
5) *Climate Change:* Climate change can exacerbate the effects of rising wastewater by altering precipitation patterns, increasing the frequency and intensity of floods and droughts, and affecting water quality. This can further stress water resources and increase the demand for wastewater treatment.

The objectives of the MBBR (Moving Bed Biofilm Reactor) technology are:

a) *Efficient Removal Of Organic Matter And Other Pollutants From Wastewater:* The MBBR technology uses a biofilm of microorganisms to break down organic matter and other pollutants in wastewater, thereby improving the quality of the effluent.
b) *High Treatment Efficiency*: The MBBR technology is known for its high treatment efficiency, which is achieved through the use of a large surface area of plastic media carriers, high concentration of microorganisms, and continuous mixing of the wastewater and biofilm.

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c) *Flexibility And Adaptability:* The MBBR technology is adaptable to a wide range of wastewater types and can be easily scaled up or down depending on the specific requirements. The process can also be easily modified to accommodate changes in flow rate and organic load.
d) *Low Energy Consumption And Operational Costs:* The MBBR technology has lower energy consumption and operational costs compared to other biological treatment processes, due to its low sludge production and low aeration requirements.
e) *Reduced Environmental Impact:* The MBBR technology can reduce the environmental impact of wastewater treatment by producing a high-quality effluent that can be discharged into water bodies or reused for irrigation or other non-potable purposes. Overall, the objectives of the MBBR technology are to provide an efficient, cost effective, and environmentally friendly method for treating wastewater, thereby helping to protect public health and the environment.

III. DATA

1) *General Details*

Description	Values	Values
Consumed water	45 lpcd	45
Population	1400	1400
Discharge(Q)	45 * 1400= 6300lit/day= 63 m^3/day = 2.625 m^3/hr	6300 lit/day
		63m^3/day
		2.625 m^3/hr

2) *Bar Screen Chamber*

Description	Values	Values
Average hourly flow	2.625 m^3/hr	2.625m^3/hr
Peak hourly flow	3 * 2.625 =7.875 m^3/hr = 0.0021875 m^3/sec	0.0021875 m^3/sec
Assume design flow velocity	0.3 m/sec	0.3 m/sec
Cross sectional area of screen bar	0.00216875/0.3 = 0.00729167 m^2	0.00065625 m^2
Cross sectional area is increased by 50 % to compensate		
Flow area blocked by the bars	0.00729167 * 1.5 = 0.0109375 m^2	0.000984375 m^2
Required minimum dimensions	0.1m * 0.1m	
Instead provide as per site condition 1*1*2 SWD		

3) *Equalization Tank*

Description	Values	Values
Assume detention time	6 hr	6 hr
Volume of tank	Q * DT = 2.625 * 6 = 15.75 m^3	15.75 m^3
Assume free board	0.3 m	0.3 m^3
Assume water depth of tank	2 m	2m
Tank area	15.75/2 = 7.875 m^2	7.875 m^2

4) *Aeration Tank*

Description	Values	Values
Assume BOD	$200*10^{-6}$ kg/lit	$200*10^{-6}$ kg/lit
Incoming sewage load (Q)	63 m^3/day	63 m^3/day
Assume F/M	0.1 per day	0.1/day
BOD load/day	63*1000*200*(1/1000000) =12.6	12.6
M (Biomass)	12.6 kg/day= 12.6/0.1 = 126 kg	126 kg

Assume MASS = mg/lit	3500 mg/lit = 3.5 kg/m^3	3.5 kg/m^3
Aeration tank volume	126/3.5 = 36 m^3	36 m^3
Average retention time	36*24/63 = 13.71428 hrs	13.71428 hrs
Assume depth of aeration tank	2 m	2 m^3/day
area of aeration tank	36/2=18 m^2	18 m^2
assume width of aeration tank	2.5 m	2.5 m
length of aeration tank	18/2.5 = 7.2 m	7.2 m
assume aeration time	22 hrs	22 hrs
BOD load/hr	12.6/22 = 0.57272727 kg/hr	0.57272727 kg/hr
Assume air per kg BOD	60m^3/hr	60m^3/hr
air requirement for BOD	0.57272727*60 = 34.3636362 kg/hr	34.3636362 kg/hr
assume requirement tank volume	1.1 m	1.1 m
air required for mixing	34.3636362*1.1 = 37.80 kg/hr	37.80 kg/hr
assume requirement floor area	2 m^2	2 m^2
air requirement for mixing	2*18 = 36 m^3/hr	36 m^3/hr
air to be supplied	max (36, 37.80, 34.36) = 37.80 m^3/hr	37.80 m^3/hr

5) *Clarifier Tank*

Description	Values	Values
Q	63 m^3/day	63 m^3/day
Assume pumping	20 hrs	20 hrs
Maximum hourly through put	63/20 = 3.15 m^3/hr	3.15 m^3/hr
assume design overflow rate	16 m^3/m^2/day = 0.6667 m^3/m^2/hr	0.6667 m^3/m^2/hr
c/s area of tank	3.15/0.6667 = 4.7247 m^2	4.7247 m^2
assume circular tank	π * d^2= c/s area of tank = 2.4526 m = 2.5m	2.5 m
assume depth of tank	2.5 m	2.5 m
assume MASS	3500mg/lit = 3.5 kg/m^3	3.5 kg/m^3
solid load	3.15*3.5 = 11.025 kg/hr	11.025 kg/hr
solid loading rate	11.025/4.7247 = 2.3334 kg/m^2/hr	2.3334 kg/m^2/hr
volume of tank	4.7247*2.5 = 11.8117 m^3	11.8117 m^3
hydraulic detention time	11.8117*24/63 = 4.49 hrs = 5hrs	5 hrs

6) *Pressure Sand Filter*

Description	Values	Values
Q	63 m^3/hr	63 m^3/hr
assume design filtration	20 hrs	20 hrs
allow rest	30 min backwash and 10 min rinse	
filtration rate	63/20=3.15 m^3/hr	3.15 m^3/hr
assume loading rate on filter	12 m^3/m^2/day	12 m^3/m^2/day
c/s area of filter (min)	3.15/12 = 0.2625 m^2	0.2625 m^2
dia of filter	π/4 * d^2 = c/s area of filter = 0.57812 m	0.57812 m
Assume height of filter	1.5 m	1.5 m
depth of sand filter	0.6 m	0.6 m

7) Activated Carbon Filter

Description	Values	Values
Q	63 m^3/hr	63 m^3/hr
assume design filtration	20 hrs	20 hrs
allow rest	30 min backwash and 10 min rinse	
filtration rate	63/20=3.15 m^3/hr	3.15 m^3/hr
assume loading rate on filter	12 m^3/m^2/day	10 m^3/m^2/day
c/s area of filter (min)	3.15/12 = 0.2625 m^2	0.315 m^2
Diameter of filter	$\pi/4 * d^2$ = c/s area of filter = 0.57812 m	0.633301 m
Assume height of filter	1.5 m	1.5m
depth of sand filter	0.6 m	0.6m

8) Treated Water Tank

Description	Values	Values
assume detention time	6 hrs	6 hrs
detention time vol/Q volume	6*24/63 = 2.2857 m^3	2.2857 m^3
assume circular tank	$\pi/4 * d^2$ = volume = 1.7059 m	1.7059 m
assume depth of tank	1.5 m	1.5 m

IV. CONCLUSION

Constructing a sewage treatment plant is necessary. According to Indian Codal provision, the plant is properly planned to accommodate for potential future expansion. The plant is precisely constructed to meet the requirement over a very long length of time. Through this paper, the basic strategy for the plan of a MBBR based sewage treatment plant of 50 KLD capacity for a private format is illustrated. The treated water is also utilised for fire protection, toilet flushing and gardening purpose.

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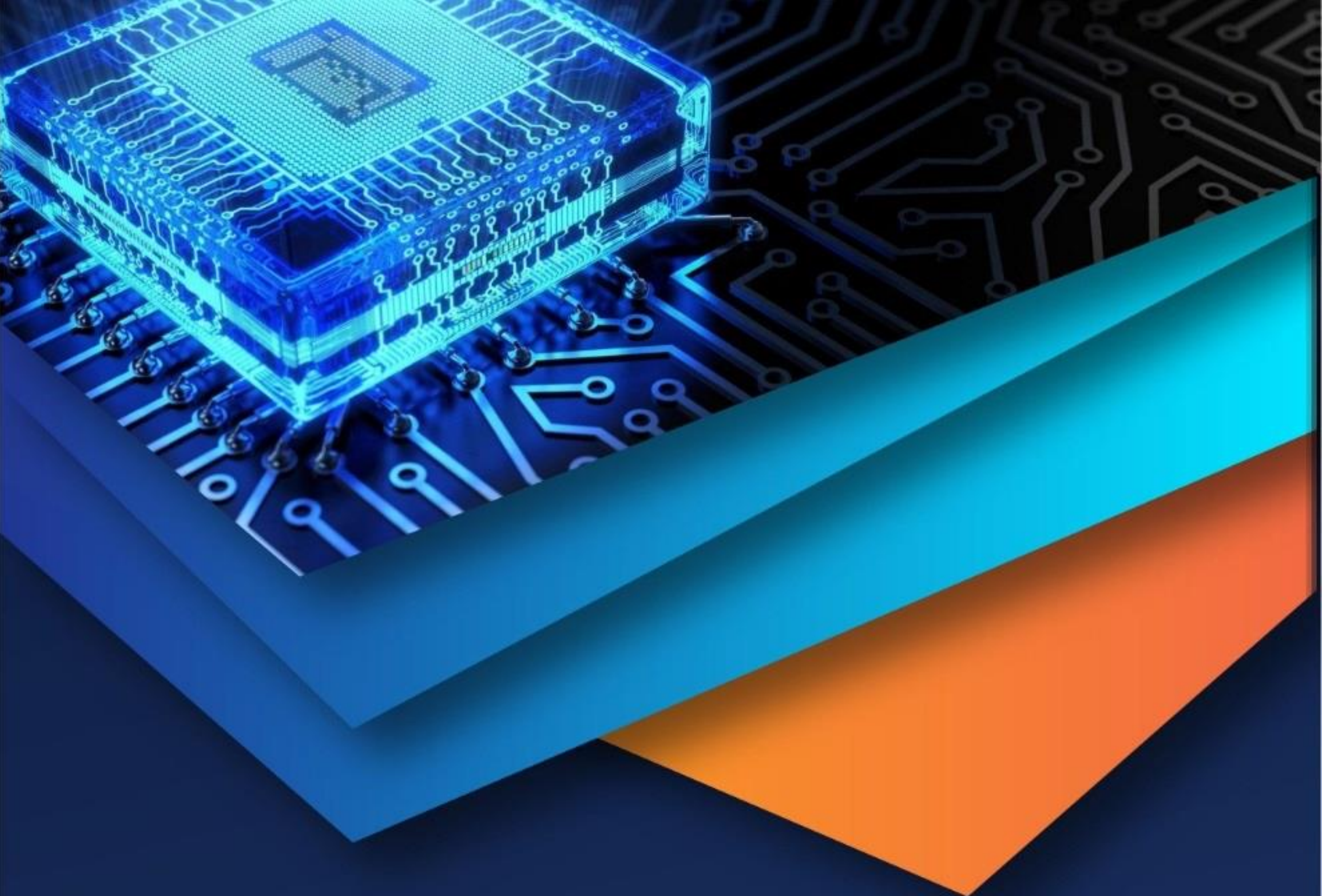

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