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Case Report

Performance evaluation of 1 MLD MBBR type sewage treatment plant

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ABSTRACT

Sewage treatment system considered to be an inevitable step to handle the burgeoning water scarcity in the recent years. In this study a 1 MLD (Million Litres per Day) sewage treatment plant was selected and evaluated its performance efficiency for a period of 8 Weeks (02.10.2021 to 20.11.2021). The adapted treatment technology was Moving bed Bioreactor (MBBR) which is an attached biological growth method. This technology totally driven by MBBR Carrier media, which provides an enormous surface area for the microbial attachment. The treatment system has the following units such as Bar screen chamber, Grit Chamber, Oil & Grease Chamber, Equalization Tank, Anoxic Tank, MBBR Tank, Settling Tank, Filter Feed Tank, Pressure Sand Filter (PSF), Activated Carbon Filter (ACF), Chlorine dosing and Treated Water Tank. Water samples were collected from different treatment units for 10 days and analysed for the major water quality parameters such as Biochemical oxygen demand (BOD), Chemical oxygen demand (COD), Total Kjeldhals Nitrogen (TKN) and Total suspended solids (TSS). The analysis showed that all treated water parameters meet the State Pollution board standards. Also the results were very much useful to prepare a Standard Operating Procedure (SOP) which helps in hindrance free Operation and Maintenance of the system.

1. Introduction

1.1. Screening (Bar screen and grit chamber)

The raw sewage first be screened through a manual bar screen, where all particles with diameter below 5 mm as well as small pieces of the fibre and floating suspended matters like polythene paper, polythene bags, rags and others materials are removed. These units are used to protect downstream equipment such as pumps, pipelines, valves etc. from damage and clogging by rags and other large objects. The bar screen and grit chamber is cleaned manually by means of rakes. The screened clean effluent flows by gravity to an equalization tank. [1,2]

1.2. Oil & grease chamber

The screened wastewater then gets skimmed properly to remove Oil and Grease. The removal principle based on density and viscosity of the sewage.

1.3. Equalization tank

The raw wastewater collected in the equalization tank, where it is equalized with respect to its characteristics, homogeneity, flow and uniform pollution load as well as to make bacteria acclimatized. The equalization tank is designed for hydraulic retention time of around 6 hours. Proper equalization process minimizes the shock loadings

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and stabilizes the pH to improve the biological oxidation reaction in the next downstream units.

1.4. Anoxic tank

Anoxic zones in wastewater are useful for nitrogen removal. Wastewater has a high nitrate and nitrite content, and the treatment process must break down those compounds to avoid causing nutrient pollution when the plant discharges its effluent back into the environment. In anoxic zones bacteria break down the nitrogen products and release nitrogen gas into the atmosphere.

1.5. MBBR tank (Secondary-treatment)[3–5]

The process of Oxidation, synthesis and endogenous respiration happens in the MBBR tank or aeration tank. Eco-friendly available in the sewage facilitates the above process; hence the complex organic compound gets converted to simpler organic substance. Bacteria or bio augmenter staying in MBBR Media surface and does the job utilizing the supplied oxygen through Air blowers.

Fig. 1: MBBR media

1.6. Tube settler

The oxidized sewage will be dosed with coagulants and flocculants and allowed to pass through the Tube Settler. Here the suspended solid gets settled inside the tube settler through the intact arrangements of tube settler media. A substantial amount BOD and COD are also removed in the coagulation and flocculation process.

1.7. Disinfection System

Chlorine disinfection system installed to oxidize the pathogenic bacteria from the treated sewage water and then allowed to pass through the filtration units like PSF and ACF.

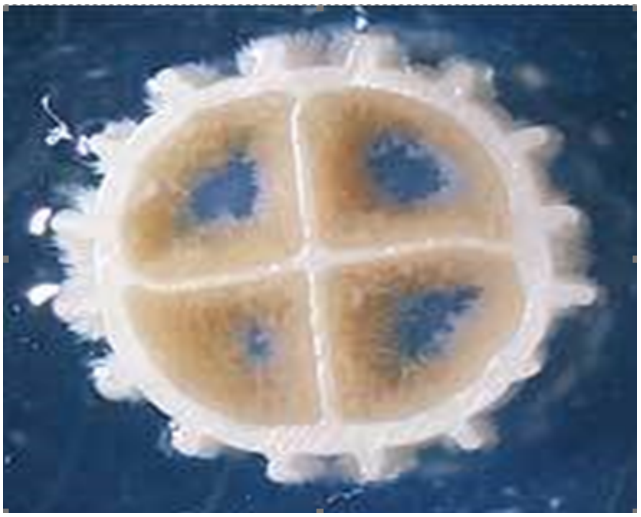

Fig. 2: Bacterial attachment

Fig. 3: STP 1 MLD front view

1.8. Pressure Sand Filter (PSF)

From the filter feed tank, the clear water is pumped to the pressure sand filter. The filtration takes place in the downward mode. The filter is filled with a layer of graded sand media supported by a layer of graded gravel. The suspended matters from the effluent get filtered.

1.9. Activated carbon filter (ACF)

In this unit the feed flow is downward through a layer of granular activated carbon filter in which dissolved organics of the effluent are absorbed. It is necessary to backwash the carbon filter every eight hours.

Fig. 4: MBBR aeration zone

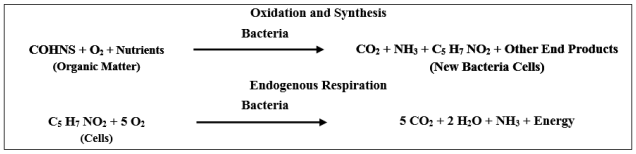

Fig. 5: Biological process happens in aeration zone

2. Sludge Treatment and handling

The sludge generated in the Sludge Holding Tank is taken to a sludge sump. The waste is then pumped to a Sludge Drying Bed. The dried cake may be disposed of to deliver in the brickfield for burning. The further waste sludge will be flow back to equalization tank for further treatment.

2.1. Sewage treatment plant existing

Project Name: Rajiv Gandhi Institute of Medical Sciences (RIMS), Kadapa A.P

Project Type: Sewage Treatment Plant.

Design Capacity: 1 MLD.

Operation Hours: 24 hrs.

Technology: Moving Bed Bioreactor (MBBR).

System Erected by: M/S. Green Enviro Polestar, Pondicherry.

3. Results and Discussion

All the sorted water parameters were been tested by following the standard method (APHA, 1998).[6,7] The average BOD (Biochemical Oxygen Demand), COD (Chemical Oxygen Demand), TSS (Total Suspended Solids) and TKN (Total Kjeldal's Nitrogen) removal efficiency from the existing 1 MLD Sewage treatment plant were observed to be 95%, 89%, 68.5% and 78% respectively. Hence, we

Table 1: Scheme and unit volume of 1 MLD sewage treatment plant

S.No	Scheme of Sewage Treatment Plant	Unit Volume (m^3)
1.	Bar screen Chamber	0.528
2.	Grit Chamber	2.70
3.	Oil & Grease Chamber	10.58
4.	Equalization Tank	304
5.	Anoxic Tank	107
6.	MBBR Tank	465
7.	Settling Tank (Tube Settler)	109
8.	Filter Feed Tank	85
9.	Treated Water Tank	252
10.	Chlorine Dosing System	0.1

Table 2: Biochemical oxygen demand (BOD) removal efficiency

Date	BOD		
	Raw Sewage (mg/l)	Treated Sewage (mg/l)	Removal Efficiency (%)
02.10.2021	380	33	91.31
09.10.2021	324	12	96.29
16.10.2021	385	19	95.06
23.10.2021	382	15	96.07
30.10.2021	363	18	95.04
06.11.2021	396	21	94.69
13.11.2021	342	12	96.49
20.11.2021	280	7	97.50

Table 3: Chemical oxygen demand (COD) removal efficiency

Date	COD		
	Raw Sewage (mg/l)	Treated Sewage (mg/l)	Removal Efficiency (%)
02.10.2021	655	65	90.07
09.10.2021	752	145	80.71
16.10.2021	774	99	87.20
23.10.2021	688	54	92.15
30.10.2021	520	88	83.07
06.11.2021	680	55	91.91
13.11.2021	765	44	94.24
20.11.2021	702	48	93.16

Table 4: Total suspended solids (TSS)removal efficiency

Date	TSS		
	Raw Sewage (mg/l)	Treated Sewage (mg/l)	Removal Efficiency (%)
02.10.2021	180	67	62.77
09.10.2021	212	53	75.00
16.10.2021	218	69	68.34
23.10.2021	165	62	62.42
30.10.2021	189	54	71.42
06.11.2021	222	77	65.31
13.11.2021	240	74	69.16
20.11.2021	227	57	74.88

Table 5: Total kjeldal's nitrogen (TKN) removal efficiency

Date	TKN Raw Sewage (mg/l)	TKN Treated Sewage (mg/l)	Removal Efficiency (%)
02.10.2021	78	33	57.70
09.10.2021	65	16	75.39
16.10.2021	54	17	68.52
23.10.2021	74	14	81.09
30.10.2021	64	8	87.50
06.11.2021	66	12	81.82
13.11.2021	48	8	83.34
20.11.2021	53	6	88.68

could able to see very good removal efficiency of BOD, COD and TKN. A very good reduction of BOD, COD and TKN value shows that there would be a healthy bacterial growth in the MBBR Unit and proper nitrogen removal happens in the Anoxic tank. Also, a better F/M (Food to the ratio of Microorganisms) observed to be maintained in the MBBR Tank. But the TSS reduction value found to be unacceptable; hence the PSF (Pressure Sand Filter) and ACF (Activated Carbon Filter) filters need to be operated properly as per the operation manual. Both the filters needs to be backwashed at regular basis and the delta P value (Pressure difference which can be monitored through the pressure gauges) should be maintained below 0.5 Kg/Cm^2. Hence, this study can be helpful for the maintenance engineers in doing proper operation of the sewage treatment plant of the RIMS Hospital.

4. Source of Funding

None.

5. Conflict of Interest

None.

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