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Waste Water Treatment in Underground Metro Rail Stations by using Fluidized Aerobic Bio Reactor

P. Velmurugan[1]
[1] Civil Environmental Engineering,
Babu Banarasi Das University, Lucknow- 226028
(U.P), India,

Arif Siddique
[2] Assistant Professor, Civil Engineering Department,
Babu Banarasi Das University, Lucknow- 226028
(U.P), India

***Abstract*: Scarcity of water is the main problems facing by the people and other living organisms in the World. Water plays a vital role to survive and it needs in large amount to manufacture a product, to the living of people even animals and plants needed its daily, without water no one can survive in the world. The exponential growth of people increases water demand progressively. In this present study the continuous assessment was performed at the different metro station to identify or calculate freshwater usage, wastewater generation, draining of wastewater, initial concentration of wastewater and pump flow of wastewater. These studies were conducted at Lucknow underground metro rail stations up to around 3.5 km stretch. Fluidized aerobic biotechnology was used to assess the performance of reducing, recycle and reuse of wastewater.**

Keywords: Fluidized Aerobic Bio-Technology, Waste Water Treatment, Biological Oxygen Demand, Sewage Treatment Plant

1. INTRODUCTION

1.1 Metro rail system in India

The exponential growth of people in India, the demand has been increasing for livability and environmental protection because it's level of purity decreases. The infrastructure has become a vital role in developing countries and created new underground development so that urbanization and urban development in India is going rapidly. In an urban environment, people move faster to do their work for their development and national development also. The metro mode transport allows people to travel faster simultaneously and help people escape from the traffic and exposure to pollution. The metro rail system was introduced to provide more convenience to the people and it's used as more efficient, extensive use of public transport.

1.2 Water resources

In the rainy season (July to September 2018), the metro city gets a rainfall of 896.22 mm from the South-west monsoon winds. Gomti River has been the main source for supplying drinking water. Even though 70% of municipal supplies dependent on groundwater.

1.3 Water environment

The hydro-geological system characterized by quartic weather rocks and alluvial formation. It controls the level of groundwater availability. In Lucknow, the groundwater availability is estimated as 292 mm^3. Salinity and excessive usage of water have contributed to the depletion of groundwater level and drastically affected. The water quality in the area is within the permissible limit as per IS 10500 except fluoride content. The water quality index contour map of Lucknow as shown in figure 1.

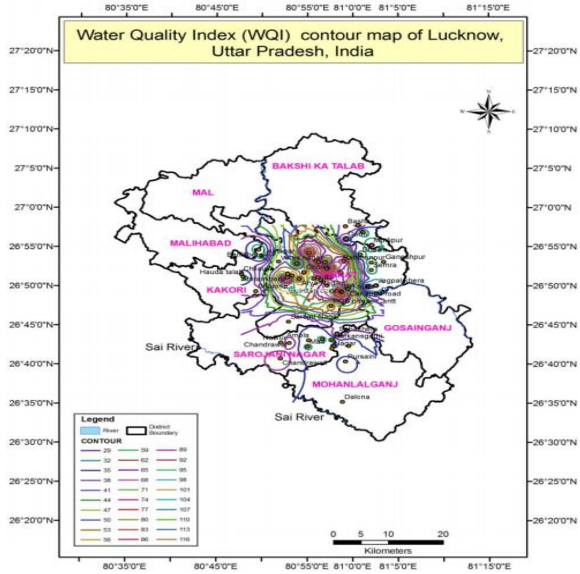

Figure 1: Water quality index (WQI) contour map of Lucknow

1.4 Water demand

In metro Station, water is very much needed for drinking, toilet cleaning and other purposes like AC. For sanitary purposes repairs, the raw water treated and brought into the national standard level of purity before consumption. The water demand will increase drastically by daily usage at the metro station. Lucknow Municipal Corporation is responsible for to supply water requirement for Metro Station. Thus, 100 KLD of water is the requirement for one station.

2. LITERATURE SURVEY

Biofilm reactor provides proven and Emerging Technologies with latest standard practice methods for moving bed [1]. In the study, bio carrier made up of low-density polypropylene and density of 870 kg/m^3 and

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surface area of 524 m^2 used in the treatment of wastewater using fluidized bed reactor [2]. This mode l[3], shown to satisfactory account for the experimental data. In this study mass transfer of oxygen from the gas to three gas phase inverse fluidized bed has been studied [4]. The effects of liquid and gas velocities, particle size addition of organic additives on the volumetric mass transfer Coefficient [5]. The effects of liquid gas velocities, solid loading and volumetric mass transfer were determined [6]. Bioreactors showed down flow pattern of the prototype of low concentration synthetic and municipal wastewater treatment [7]. The largest removal of COD was attained when the reactor was operated at an air velocity of 0.024 m/s [8]. This study explains the effect in fluidization behavior and hydrodynamic behavioral changes caused by weight, height and material [9]. This study [10], explains the inverse fluidized bed reactor for treating industrial wastewater.

3. PROBLEM DEFINITION

The usage of water increases dramatically at the metro rail station and also it produces waste water. The aim of this study is to improve the efficiency of the wastewater treatment process and reuse the treated effluent at three underground stations of Lucknow. The fluidized aerobic bioreactor was used to treat the wastewater. Treated effluent water can be used for sanitation, washrooms, toilets, plantation works, etc. Conventional wastewater treatment methods are more expensive, occupied large space, power intensive and it's require monitoring. The fluidized aerobic bioreactor is a better alternative than the conventional treatment system because of that space and power saving technology.

The objectives of the study are as follows:

1) To treat all wastewater in the underground metro station (Stretches) prior to disposal for recycling.
2) To reuse the treated effluent in all possible situations in the underground Metro stations.
3) To reduce the fresh water utilization in sanitation works
4) To minimize the public water supplies.
5) To minimize the recharge bore well waters

4. METHODOLOGY

4.1 Design model of fluidized aerobic bio reactor

The bioreactor treatment process was classified as primary or physical treatment, secondary or biological treatment, tertiary or chemical treatment. In primary treatment, physical impurities were removed like stone, food, plastic, oil, grease, metals and the PH level of water was maintained. In the secondary stage, BOD and COD level reduced by oxidation and also the toxicity of some impurities where minimized. Then some impurities converted into carbon dioxide and biosolids at this stage. In the tertiary stage by incorporating chlorination, multi-grade filtration, activated carbon filtration forms chemical oxidation, kills bacteria and microbial pathogens. Outlet water passes through the activated carbon bed after that directed to use for cleaning, irrigation, gardening, etc.

4.2 Fluidized aerobic bio reactor operation

It is an advanced biological technology specially designed to compact size, less energy for operation and maintenance free while efficiency is high. In fluidized bed reactor. The wastewater to be treated passes through activated carbon bed at sufficient velocity to cause fluidization. FBR consists of Ring-back media as biofilm carrier elements help to maintain BOD and COD in a compact bioreactor. The flow of fluidized aerobic bioreactor operations as shown in figure 2.

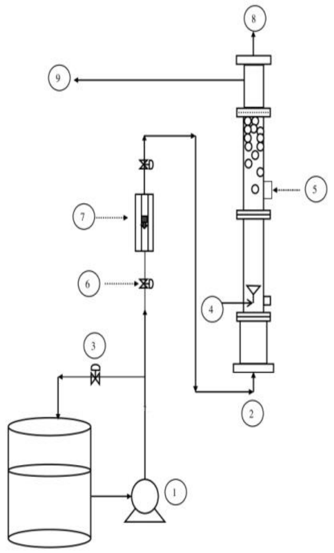

Figure 2: Flow of fluidized aerobic bio reactor operation

1. Pump. 2. Waste Water Inlet. 3. By pass Valve. 4. Air inlet. 5. Solids inlet. 6. Control Valve.7. Rota meter. 8. Air outlet. 9. Effluent.

4.3 Design of STP based on FBR table

Table 1 shows the parameters to be considered for the construction of the fluidized bed reactor.

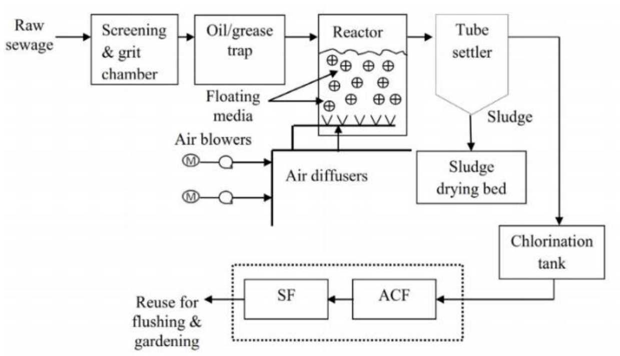

Figure 3: Design of STP based on FBR

The design of STP based on FBR as shown in figure 3. The raw wastewater collected from each station was processed preliminary, secondary and followed by and tertiary treatment. The FBR reactor was constructed to a rectangular shape. Then filled with 30% of the total volume of the tank with polypropylene carrier elements. The effective surface area for polypropylene carrier varies between 200 to 500 m^2. To enhance effective oxygen transfer efficiency, diffused aeration provided at the rate of 15 m/s and reactor is designed for 9-12 hours HRT and fluidized condition was maintained.

Table 1: Design of STP based on FBR –table

S.NO	PARAMETER	VALUE
SCREEN CHAMBER (FINE SCREEN)		
A	Velocity, m/min	2.0
B	Head Loss, m	0.8
C	HRT, min	3.0
D	Peak Factor	3.0
GIRT CHAMBER		
A	Detention Time, s	60
B	Horizontal Velocity m/sec	0.3
C	Diameter of the particle removed, mm	0.15
D	Specific gravity of the particle	2.65
E	Peak Factor	3
OIL & GREASE TRAP		
A	HRT, min	30
B	Peak Factor	3
COLLECTION TANK		
A	Hydraulic Retention Time, Hrs	3
FLUIDIZED AEROBIC BIO REACTOR		
A	Organic Leading Rate, kg BOD @ 20^0 C (Cubic meter x d)	1.0
B	Oxygen required, kg/kg/ BOD	2.5
C	Oxygen transfer efficiency, %	12
D	Specific gravity of the element	0.9-0.93
E	Element required	30% Tank Volume
F	Specific gravity of air @ 30 Deg	1.165
TUBE SETTLER		
A	Surface leading Rate	20
B	Tube inclination degree	55
C	Tube shape	Rectangular/Cylindrical
SLUDGE DRYING BED		
A	Area of sludge drying bed, Sq.m/Capita	0.03
B	Sludge removal cycle, days	10
C	Depth of sludge provided, m	0.3
D	Depth of sand layer	0.15
E	Depth of gravel layer	0.2
F	Drain pipe diameter, mm	200

5. RESULTS AND DISCUSSION

5.1 performance evaluation of constructed STP

Table 2 shows that removal efficiency of the FBR reactor as TSS variety 83- 85%, BOD 92-93 % and COD 74- 83 % respectively. Provided high surface area to microbes, organic heating rate and diffused aeration to the bottom of the STP by which a high rate of treatment efficiency was obtained. Irrespective of the climatic condition FBR efficiency is high and consistent, compact and controllable as compared to the conventional system.

Table 2: Achieved parameter

S. No	***Parameters***	***Inlet to STP (PPM)***	***Outlet after FBR Process***
1	PH	6.5 – 8.5	7-8
2	COD, mg/l	600-700	194 mg/l
3	BOD, @ 20 deg. C, mg/l	300-450	<20
4	Suspended solids, mg/l	300-350	<10
5	Oil & grease	50	<5

5. CONCLUSION

This method of wastewater treatment more effective than conventional methods. It helps to maintain microorganism's concentration and provide stability against toxic on the shock load. FAB methodology removes pollutant and increases the quality of water more effectively. Fluidized aerobic bioreactor implementation in metro stations to minimize the fresh water usage and recycle, reuse of wastewater as a standardized level of quality which is a more effective method on metro rail locations to treat the wastewater. FAB Technology delivers treated effluent water as required by local legislation norms and conditions. This system is more compact in decentralizing of water to be metro stations. This invention of technology significantly decreases the uses of fresh water at metro stations and delivers water as required standards, can be used for cleaning toilet and sanitary purposes, etc.

6. FUTURE SCOPE

FBI technology has been an effective method and has a potential scope for future improvement in treating wastewater. Effective design of reactor helps to achieve efficient treatment of wastewater. It becomes as more efficient technology in treating wastewater rather than the conventional methods. Efforts to involve and encourage people in the shaving of freshwater and recycle, reuse of wastewater it makes an impact on water conservation.

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