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

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***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 metro rail stations up to around 23km stretch. Fluidized aerobic technology was used to assess the performance of reducing, recycle and reuse of wastewater.**

***Keywords: Fluidized Aerobic Reactor-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 Ground Water Depletion*

The resource is depleting at faster pace and in future will become a critically scarce resource, particularly in urban sprawls. The report gives a picture of ground water in the city which shows how the resource is depleting and which are the critical areas. The unscientific & unregulated ground water extraction in urban centers is almost reaching to unsustainable levels, the emerging situation is very disturbing. Thus it is considered that the only robust way to face the future urban water-supply challenge is to look towards a more integrated and harmonized conjunctive use of surface water and groundwater sources.

### *1.3 Water environment in Metro Stations*

The hydro-geological system characterized by quartic weather rocks and alluvial formation. It controls the level of groundwater availability. Water environment consists of water resources and its quality. Its study is important from the point of view to assess the sufficiency of water resources for the operational stage and also to assess the impact on water environment. It is estimated that ground water availability in Lucknow is 292 $Mm^3$.

### *1.4 Water demand*

The water demand will increase during regular cleaning, flushing's, routine works and domestic water requirement for commuters using metro stations. Sufficient water made available by LWSU as it is responsible for water supply in Lucknow. Water requirement for Metro stations met through this public supply. In metro Station, water is very much needed for drinking, toilet cleaning and other purposes like Coaches cleaning. 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. The need of the study is to improve the waste water treatment and reuse the treated effluent in the metro stations of Lucknow by using fluidized aerobic bed reactor.

## 2. LITERATURE SURVEY

Biofilm reactor provides proven and Emerging Technologies with latest standard practice methods for

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moving bed [1]. In the study, bio carrier made up of low-density polypropylene and density of 870 kg/m^3 and 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 bed reactor 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 Fluidized Aerobic Bed Reactor*

Performance evaluation of the STP at metro stations was carried for installed STP in the field by collecting influent and effluent samples periodically from the inlet and outlet of the constructed STP. Assessing waste water characteristic is essential for the choice of treatment method, extent of treatment, beneficial use of the wastewater and cost of treatment required. By collecting samples of raw waste water for determination of pH, TSS, TDS, BOD & COD as per standard methods. Physico-chemical characteristic of the waste water confirmed the waste water as medium strength as BOD varied from 400-550 mg/l. The pH value of 8.48 indicates alkaline nature of the waste water. Average BOD and COD 198 mg/l and 525 mg/l with BOD/COD ratio of 0.511 indicating that the waste water is biodegradable.

The Fluidized Aerobic Bed Reactor process is the latest advance in attached growth aerobic biological treatment technology. The Fluidized Aerobic Bed Reactor (FAB) is an advance hybrid biological system primarily designed to reduce the footprint area required and to make effortless installation and trouble free operation while increasing the treatment efficiency. This type of treatment depends primarily on the use of air that is introduced into the waste water treatment plant for keeping alive the bacteria. When air diffusion is done, it promotes the growth of organisms that break down the organic solids.

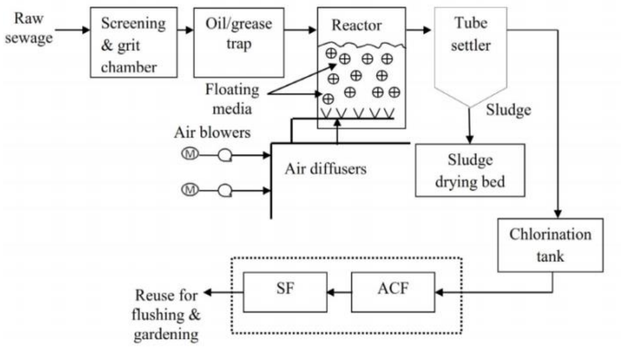


Figure 1: Design of STP based on FAB

### ***4.2 Fluidized aerobic bed reactor operation***

The clarified effluent enters into the FAB reactor, which contains the FAB media. The FAB media significantly increases the surface area for bacterial growth. Air is supplied through fine bubble diffusers. Bacteria oxidize the organic matter present in the waste water. Oxidized waste water overflows out of the FAB reactor, into the secondary settling tank. The fluidized Aerobic Bio-Reactor includes a tank in any shape filled up with small carrier elements. The elements are specially developed materials of controlled density such that they can be fluidized using an aeration device. A bio-film develops on the elements, which move along with the effluent in the reactor. The movement within the reactor is generated by providing aeration with the help of diffusers placed at the bottom of the reactor. The thin bio-film on the elements enables the bacteria to act upon the bio-degradable matter in the effluent and reduce BOD/COD content in the presence of oxygen from the air that is used for fluidization.

Technological Stage-1

- ✓ Bar Screen Treatment
- ✓ Oil and Grease Removal
- ✓ Equalization Treatment by maintaining the pH.

First stage of treatment where physical impurities are removed. This stage includes removal of stone, food, polythene, plastic, Oil, Grease and maintaining the pH of water. It involves Oxidation that reduces the biochemical oxygen demand of wastewater, and may reduce the toxicity of some impurities. Secondary treatment converts some impurities to carbon dioxide, water, and bio solids. Thus removing the foul odour in the waste water by increasing

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the amount of oxygen in the water. Removing the sludge from the waste water.

Technological Stage-2

- Aeration Treatment
- Flocculation & Coagulation through Poly electrolyte (Alum, Ferrix)
- Clarifier / Tube Settler: Settling Tank where solids called Sludge are removed from water that settles at the bottom of Tank.

This involves the disinfection of water. Disinfection by chemical oxidation kills bacteria and microbial pathogens by adding ozone, chlorine or hypochlorite to wastewater.

Technological Stage-3

- Chlorination
- Multi Grade Filtration
- Activated Carbon Filtration.

After the waste water pass through the Activated Carbon Filter, it may be collected in the Tank for further use for flushing, irrigation, gardening etc. or directed into the drain.

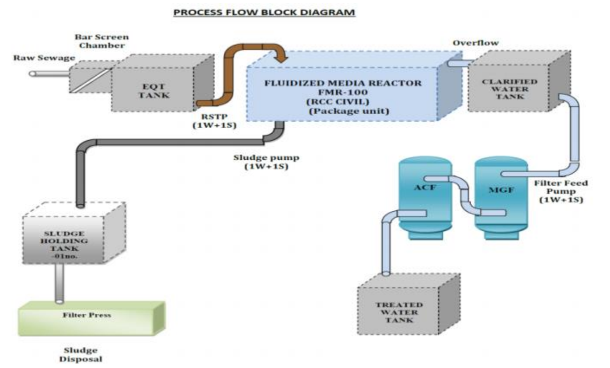



Figure 2 Treatment Process flow

### *4.3 Parameters Consideration for STP based FAB*

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: Parameters Considered for STP based FAB

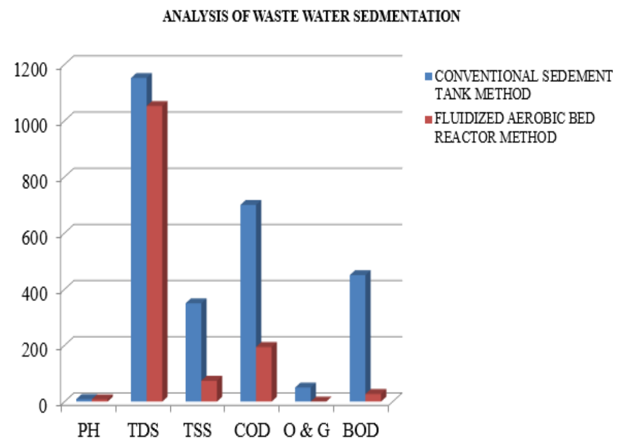
| S.NO | PARAMETER | VALUE |
|---|---|---|
| **SCREEN CHAMBER (FINE SCREEN)** | | |
| **A** | Velocity, m/min | 2.0 |
| **B** | Head Loss, m | 0.8 |
| **C** | HRT, min | 3.0 |
| **D** | Peak Factor | 3.0 |
| **GIRT CHAMBER** | | |
| **A** | Detention Time, s | 60 |
| **B** | Horizontal Velocity m/sec | 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 Degree | 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

Table 2 shows the results of parameter achieved before and after FAB process. The removal efficiency of the FAB 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 FAB efficiency is high and consistent, compact and controllable as compared to the conventional system.

Table 2: Achieved parameters

| S. No | Parameters | Before FAB process (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 |



## 6. CONCLUSION AND RECOMMENDATIONS.

FAB methodology removes pollutant and increases the quality of water more effectively. Fluidized aerobic bed reactor 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 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 at metro stations. This invention of technology significantly decreases the uses of fresh water and delivers water as required standards, can be used for cleaning toilet and sanitary purposes, etc.

FAB technology has been an effective method and has a potential scope for future improvement in treating wastewater. Effective design of reactor may help 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 saving of freshwater and recycle, reuse of wastewater it makes an impact on water conservation.
Building up a proper wastewater treatment plant in order to mitigate the catastrophic effects of the wastewater can help in applying the sustainable development concept and converting these negative effects of the wastewater into water reuse and other purposes.

The competent authorities should do the necessary measures to reduce the fresh water utilization, indeed, it to treat the wastewater instead of relying on ground water and public water utilities.

The Multi-source pollution issue that affect groundwater must be taken into account in the future studies in the study area.

Further similar researches are required in order to study the wastewater flow of metro rail cities to control the overburden of wastewater.

## REFERENCES

[1] Tertiary nitrifying moving bed-biofilm reactor: A study of carrier and loading effects on nitrifying kinetics, biologically produced solids and microbial community D Forrest - 2014 - ruor.uottawa.ca
[2] W.Sokol, M.R.Halfani, Hydrodynamics of a gas, liquid, solid fluidized bed bioreactor with a low density biomass support, Biochemical Eng. J, 1999:3:185-92.
[3] L.S. Fan, W.T.Tang, Gas–liquid mass transfer in a three phase fluidized bed containing low density particles, Ind. Eng. Chem. Res. 1990:29: 128–33.
[4] V. Nikolov, I. Farag, Gas–liquid mass transfer in bioreactor with three-phase inverse fluidized bed, Bioprocess. Eng, 2000:23: 427–9.
[5] V Sivasubramanian, Gas-liquid mass transfer in three-phase inverse fluidized bed reactor with Newtonian and non-Newtonian fluids, Asia-Pacific J Chem Eng, 2010:5:361-8.
[6] K .Haribabu, V.Sivasubramanian, Determination of Mass Transfer Coefficient in an Inverse Fluidized Bed Reactor using Statistical and Dynamic Method for a Non-Newtonian Fluid, J. scient. Indus. resear, 2013:72: 485-90.
[7] P.Castilla, M.Meraz, O.Monroy, A.Loyola, Anaerobic treatment of low concentration wastewater in an inverse fluidized bed reactor, Water Sci. Technol, 2000:41: 245–51.
[8] W.Sokol, A. Ambaw, B.Woldeyes, Biological wastewater treatment in the inverse fluidized bed reactor, Chem. Eng. J, 2009:150:63-8.
[9] David Escudero and Theodore J Heindel, Bed Height and Material Density Effects on Minimum Fluidization Velocity in a Cylindrical Fluidized Bed, 7th International Conference on Multiphase flow, ICMF 2010.
[10] W.Sokol, B.Woldeyes, Evaluation of the Inverse Fluidized bed reactor for treating high strength Industrial Wastewaters, Advance. Chem. Eng. Sci, 2011:1:239-44.