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Study of Fluidised Bed Bioreactors (FBBR) based Sewage Treatment Plants

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A B S T R A C T

Sewage treatment is the process of removing contaminants from wastewater, including household sewage and runoff (effluents). It includes physical, chemical, and biological processes to remove physical, chemical and biological contaminants. Its objective is to produce an environmentally safe fluid waste stream (or treated effluent) and a solid waste (or treated sludge) suitable for disposal or reuse (As a farm fertilizer or garden fertilizer). Waste water treatment using Fluidised Bed Bioreactors (FBBRs) are advanced technique in biological treatment operations become increasing widely and popular to treat various types of effluents with very different operating status. The basic concept of the process consists of passing wastewater up through a packed bed of particles at a velocity sufficient to fluidize the particles. As the flow of the wastewater passes upward through the biological bed, very dense concentrations of microorganisms growing on the surface of the bed particles consume the biodegradable waste contaminants in the liquid. Various types of packing materials can be used. e.g. sand, glass beads, plastic, etc. FBBR combines the best features of activated sludge and trickling filtration into one process. It is a combination of two separate processes suspended and attached growth systems for the treatment in order to minimize the concentrations of the contaminated parameters at the required level for reuse or final destination. The FBBR has been proved to be effective in great removing biochemical oxygen demand (BOD) and chemical oxygen demand (COD) with nutrients (N and P) from the effluent stream simultaneously. It provides additional capacity of wastewater treatment technology with high treatment efficiency; low capital, operational, maintenance and replacement cost; single reliable and robust operation procedure. This process can be used for new sewage treatment works or for modifying (upgrading) existing wastewater treatment plants as it is efficient, compact and easy to operate. The efficiency of FBBR depends on the filling percent of biofilm carriers to be provided inside the tank, surface area of the biocarrier, diffused aeration supply and the organic loading. In this paper, the FBBR is reviewed along with its advantages disadvantages, types and applications. Also a study of performance of 5 Nos of FBBR is reviewed in brief. The comparative study of parameters of the resulting effluent of various Fluidised Bed Bio reactors in the City proved that they are well within the limits prescribed by Tamlinadu Pollution Control Board (TNPCB) norms.

Keywords: Fluidised Bed Bioreactors, Biochemical Oxygen Demand , Chemical Oxygen Demand

1. Introduction

Sewage treatment is the process of removing contaminants from wastewater, including household sewage and runoff (effluents). It includes physical, chemical, and biological processes to remove physical, chemical and biological contaminants. Its objective is to produce an environmentally safe fluid waste stream (or treated effluent) and a solid waste (or treated sludge) suitable for disposal or reuse (As a farm fertilizer or garden fertilizer).

Wastewater is term that is used to refer to any water that is affected by human use; Waste water is liquid waste discharged by domestic residences, commercial properties, industry, agriculture, which often contains some contaminants that result from the mixing of wastewater from different sources. Based on its origin wastewater can be classed as sanitary, commercial, industrial, agricultural or surface runoff. Domestic wastewater can be

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broadly categorized into two classes: Sewage and Sullage. Sewage is the waste water generated in toilets carrying human excreta; Sullage refers to the waste water from all other sources in household.

1.1.1 Characteristics Of Sewage

The general characteristics which determine the effluent quality are as follows.

Table 1.1 General Characteristics of effluent

S.No	Characteristic	Description
1.	pH	Porosity of the Hydrogen and ion concentration
2.	BOD	Bio Chemical Oxygen Demand
3.	COD	Chemical Oxygen Demand
4.	TSS	Total Suspended Solids
5.	O&G	Oil and Grease

1.1.1.1 pH:

The negative logarithm of the hydrogen ion concentration expressed as pH, is a valuable parameter in the operation of biological units. The pH of the fresh sewage isslightly more than the water supplied to the community. However, decomposition of organic matter may lower the pH, while the presence of industrial wastewater may produce extreme fluctuations. Generally the pH of raw sewage is in the range 5.5 to 8.0.

1.1.1.2 Bio-Chemical Oxygen Demand (Bod):

The BOD of the sewage is the amount of oxygen required for the bio-chemical decomposition of biodegradable organic matter under aerobic conditions. The oxygen consumed in the process is related to the amount of decomposable organic matter. The general range of BOD observed for raw sewage is 100 to 400 mg/L.

1.1.1.3 Chemical Oxygen Demand (Cod):

The COD gives the measure of the oxygen required for chemical oxidation. In general, the COD of raw sewage at various places is reported to be in the range 200 to 700 mg/L.

1.1.1.4 Total Suspended Solids (Tss)

The TSS of the sewage was to measure the amount of MLSS bugs in the final effluent and amount of the inlet natural fecal contamination present inside the process. By TSS estimation quality of the treated effluent will be extracted. High TSS in the treated effluent will lead to short span of the treated effluent life.

1.1.1.5 Oil And Grease (O&G):

Quantity of the O&G was measured to obtain the good result and expand the life span of the activated carbon filter. High oil contaminant in the raw effluent will affect the MLSS concentration which will arrest the cell maturity

1.1.1.6 Characteristics of Raw Sewage:

In general, the common characteristics of the raw sewage will be in the range as given below. Hence, the below said range will be consider for the bioreactor design.

Table 1.2 Inlet Parameters Limits

S.No	Parameters	Raw Sewage Inlet Limits
1.	TSS	400 mg/lit
2.	pH	6 to 8
3.	BOD	200 to 300 mg/lit
4.	COD	350 to 450 mg/lit
5.	O&G	30 mg/lit

1.1.1.7 Characterestics of Treated Water as Per Tamil Nadu Pollution Control Board Norms:

As per the norms of the Tamil Nadu Pollution Control Board, the characteristics of the treated water must be as follows:

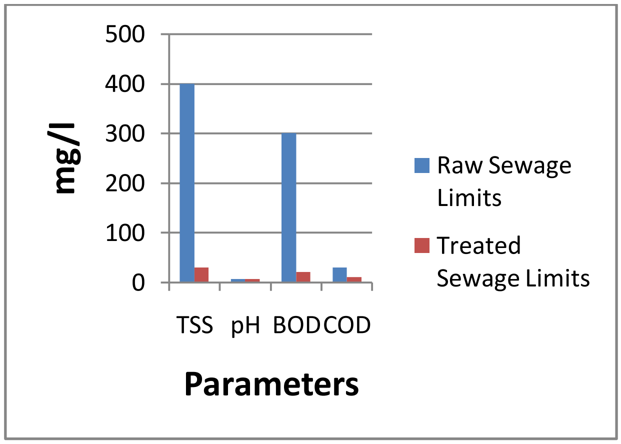


Fig 1.1. Raw & Treated Sewage Limits

Sewage Treatment:

Sewage treatment generally involves three stages, called primary, secondary and tertiary treatment.

- ***Primary treatment*** **consists** of temporarily holding the sewage in a quiescent basin where heavy solids can settle to the bottom while oil, grease and lighter solids float to the surface. The settled and floating materials are removed and the remaining liquid may be discharged or subjected to secondary treatment.
- ***Secondary treatment*** removes dissolved and suspended biological matter. Secondary treatment is typically performed by indigenous, water-borne micro-organisms in a managed habitat. Secondary treatment may require a separation process to remove the micro-organisms from the treated water prior to discharge or tertiary treatment.
- ***Tertiary treatment*** is sometimes defined as anything more than primary and secondary treatment in order to allow rejection into the ecosystem. Treated water is sometimes disinfected chemically or physically prior to discharge into a stream or a river. If it is sufficiently clean, it can also be used for groundwater recharge or agricultural purposes.

1.1.2 Sewage Treatment Methods

Sewage could be treated under the two principles such as anaerobic treatment system and aerobic treatment system.

ANAERAOBIC TREATMENT SYSTEM [ANTS]:

ANTS is the process of treating the sewage under the anaerobic condition [absence of oxygen in the air], the general system used in worldwide was septic tank for an individual residential houses or for limited communities. In Tamilnadu till 37 units we can use septic tank for treating the waste effluents. Septic tank was established in the effectively by L.H Mouras, France 1860 s. Upflow Anaerobic Sludge Bio-Blanket (UASB), was an common successful anaerobic treatment system used to treat the effluent and for the extraction of the Methane.

AEROBIC TREATMENT SYSTEM [AETS]:

AETS is the process of treating the sewage under aerobic condition [presence of the oxygen], general principle under the process was endogenous respiration. The conventional treatment system was been established since 1890's. As a theory of the evolution many system has been upgraded based on its space, quality of the effluent, temperature etc. Generally there are two types of the bio-reactors are used based on its working principle. They were called as continues flow bio-Reactor and sequential batch bioreactor. Here with find some of the aerobic treatment system which consider and studied for our projects. Such as,

Table 1: Various types of Treatment Process

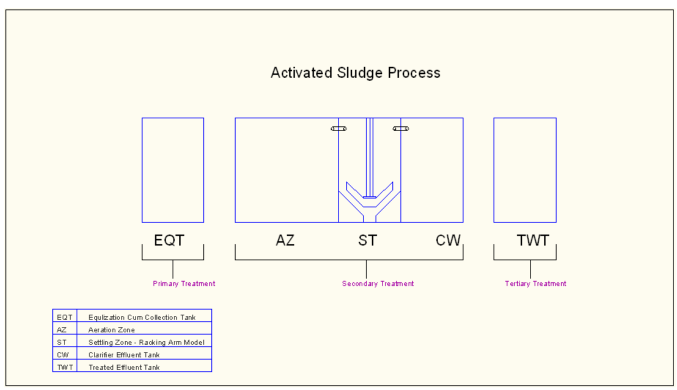
S.No	Observation	Description
01.	**ASP**	Activated Sludge Process
02.	**MBBR**	Moving Bed Bio Reactor
03.	**SBR**	Sequential Batch Reactor
04.	**FBBR**	Fluidized Bed Bio- Reactor
05.	**MBR**	Membrane Bio-Reactor

1.1.3.1 Activated Sludge Process [Asp]

This is the process based on suspended growth system. Microbial population which will reduce the ammonia by the process of denitrification, the bugs in the aeration tanks will undergo for the process of endogenous respiration by the microbes of bacteria and protozoa and as a resultant to reduce the NPK. ASP is a tradition technology to treat the sewage in the process of diffused aeration system. The system consist of the Equalization tank, Aeration Tank, Settling Tank, Filter Feed Tank, Treated Effluent tank and Sludge holding tank with drying bed as shown in fig 1.2

Table 1.3 : Treated Sewage Limits as per TNPCB norms

S.No	Parameters	Treated Sewage Limits
1.	TSS	< 20 mg/lit
2.	pH	6.5 to 9.0
3.	BOD	< 10 mg/lit
4.	COD	< 50 mg/lit
5.	O&G	< 10 mg/lit



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1.1.3.2 Moving Bed Bio- Reactor [Mbbr]

This process is based on several synthetic bio-film carrier elements [patented and non patented] developed for use in the aeration tank of the ASP and are suspended in the activated sludge mixed liquor in the aeration tank. These process are intended to enhance the activated sludge process by providing a greater surface area to unit volume of metabolism and hence, the biomass concentration in the tank and offers the potential to reduce the basins volumes. They are used to improve the volumetric nitrification rates and to accomplish the denitrification in aeration tank by anoxic zones within the bio film thickness.

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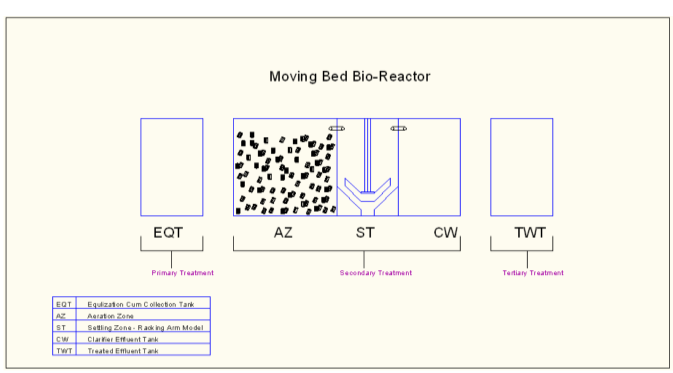
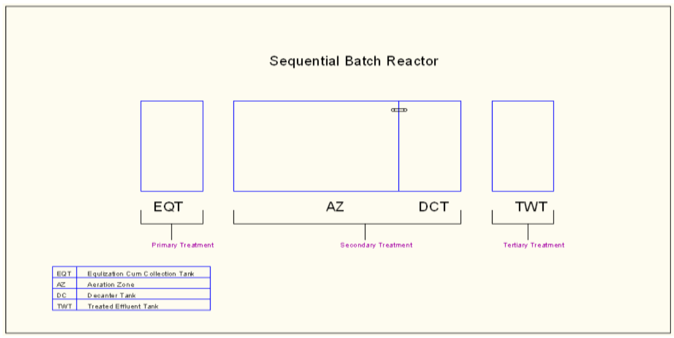


1.1.3.3 Sequential Batch-Reactor [Sbr]

The process utilizes a fill and draw reactor with complete mixing during the batch reaction step (after filling) and where the subsequent steps of the aeration and clarification occur in the same tank. All SBR system has common steps as

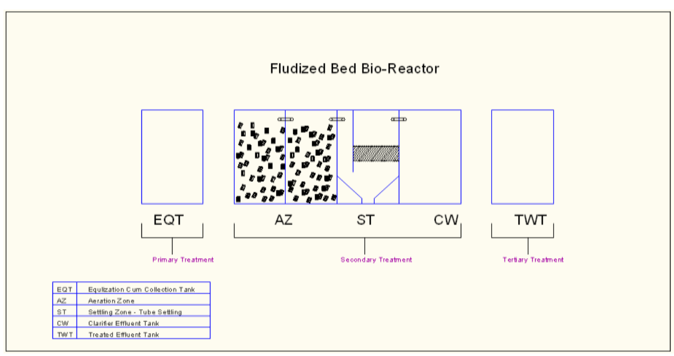
1. Fill
2. React [Aeration]
3. Sedimentation
4. Decant
5. Idle

For continues flow application, at least two SBR tanks are provided in parallel so once receives the sewage and complete the treatment cycle. Several process modification have been made in the time durations associated with each step to achieve nitrogen and phosphorus removal.



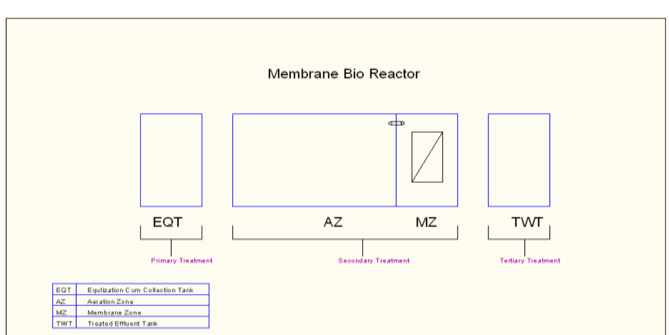
1.1.3.4 Fluidized Bed Bio-Reactor [Fbbr]:

The principle of this process was based on the combination of the ASP and MBBR. For the better DO, the depth was scrutinized and designed the reactor for the fluidization process. The FM ratio was maintained in large volume for the higher digestion rate to reduce the oxygen demands. As the reactor was focused on the MLSS concentration of the bugs, its do not required and return sludge recirculation.



1.1.3.5 Membrane Bio-Reactor [Mbr]

This process is a sort of aeration tank and secondary clarifier being a two in one. The secondary clarifier is avoided by filtration of mixed liquor by membrane modules either immersed into the aeration tank mixed liquor or externally fitted and the mixed liquor routed through these. Essentially it has suspended solids free treated sewage retains higher MLSS and reduces the volume of aeration tank.



Fluidized Bed Biofilm Reactor (Fbbr)

Various types of methods are in use for the Wastewater treatment The Fluidized Bed Biofilm Reactor (FBBR) is a recent process innovation in wastewater treatment, which utilizes small, fluidized media for cell immobilization and retention. Main application of the fluidized bed biofilm reactor is in the field of biological treatment of wastewater. Aerobic as well as anaerobic fluidized bed biofilm reactors (FBBRs) have received increasing attention for being an effective technology to treat water and wastewater

Its most important features are - the fixation of microorganisms on the surface of small-sized particles, leading to high content of active microorganisms and large surface area available for reaction with the liquid; the high flow rate (low residence time) which can be achieved, leading to high degree of mixing (decreased external mass transfer resistances) and to large reduction in size of the plant.

Hence the design and study of Wastewater treatment using Fluidised Bed Biofilm Reactor (FBBR) and its advantages over the conventional Activated Sludge Process is taken up in this project.

1.4 Advantages:

- The surface of the media available for the development of microorganisms is quite large which leads to high concentration of microorganisms and thus high flow rate can be achieved.
- The presence of high concentration of microorganisms makes possible high potential for the removal of COD,BOD,Nitrogen, etc.
- Size of the plant is small and less space requirement compared to other type of plants.
- The process is economical where land cost is high.
- The treated water can be used for greener purposes of growing plants
- Decreases the water usage considerably
- Domestic wastewater treatment plants require less maintenance.

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2. Design Of A Stp Using A Fluidised Bed Bio Reactor

2.1. Description of FBBR

The exploitations of a ceaselessly moving little suspended carrier parts in Fluidised bed bioreactor (FBBR) is a new approach in biological sewage treatment technology for the preservations of water and is gaining momentum worldwide. However, in this method (FBBR) carrier parts are fashioned to be somewhat heavier, but most times lighter density of the containing water, but often made with an oversized extent that allows it free movement with the water of the reactor. This system of free circulatory movement of suspended carrier parts in the water allows the biomass to be fully grown on those carriers. The system of operations of the FBBR is likewise identical with the Integrated Fixed-film Activated Sludge (IFAS) method , although the IFAs presents a slight different approach in that the arrangement of the IFAS systems comprise of a return activated sludge stream which is essential to the IFAS process. In the FBBR method, more than 90% of biomass are likely trapped and cultivated in the media instead of being suspended in the liquid.

This can be associated with the facts that

(i) the carriers are made to remain in suspensions within the reactors by giving air through submerged air diffusers

(ii) the carrier is deliberately designed with a small polyethylene cylinder- like materials with potentials to have a high specific surface area to accommodate biofilm growth. This therefore further eliminates the requirement for the reactor to have a sludge recirculation to achieve the specified optimum biomass concentrations while allowing only the surplus biomass to be separated with ease from the effluent and

(iii) the additional advantage of the FBBR over the typical activated sludge system is seen in the high Solids Retention Time (SRT) that can be realized thence usually quantity of sludge production be below this typical activated sludge process and implying a lower cost of sludge disposal in FBBR relative to the typical activated sludge systems.

2.2 Growth And Detachment of Biofilm in Wastewater

There are several benefits of using biofilm in wastewater treatment system in comparison with suspended growth systems, such as flexible procedures, smaller space demand, lower hydraulic retention time, increased resiliency, higher biomass retaining period, increased of active biomass clusters, improvement of recalcitrant substance degradation as well as decreased rate in microbial proliferation. Apart from that, the application of biofilm systems also increases the ability in controlling the frequency of reaction and population mechanisms. The application of fixed and moving bed processes is distinguished by the quality of the support components on which biofilm is configured on static platforms such as rocks, plastic profiles, sponges, granular carriers or membranes. The development and formation of biofilm are grown in a five stage process and the early level consists of bacterial attachment to medium. Bacterial proliferation then leads to colonisation of the enclosing space and forms biofilm after dispersion.

Bacterial growth in a batch reactor can be characterized by four distinct phases and represented by the Monod growth curve . Batch growth is a process in which a culture is grown in a vessel of fixed volume and the contents are removed after a measured amount of time. The growth conditions within the vessel are constantly changing. Batch growth undergoes four distinct stages: lag phase, exponential growth phase, stationary phase, and death phase.

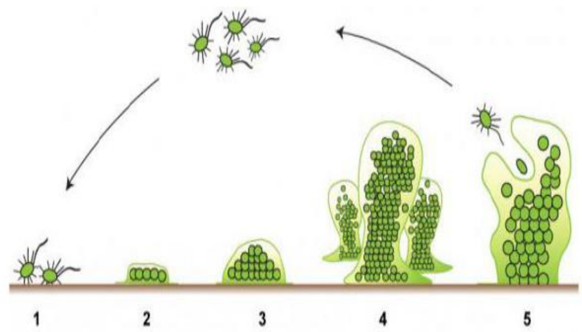


Fig 4.1 The stages of biofilm formation

Description of the four phases of bacterial growth in a FBBR.

Phase	Description
Lag	Acclimatization stage where cells adapt to their new environment; could be very long depending on inoculum age
Exponential	Nutrients and substrates are in excess; cells have adapted to their environment and grow rapidly; no inhibitions
Stationary	Net biomass growth is zero; nutrients and substrates become limited; growth rate is offset by death rate; cell lysing may be occurring; inhibition may be occurring
Death	No or little growth is occurring; biomass concentration declines at a first order rate

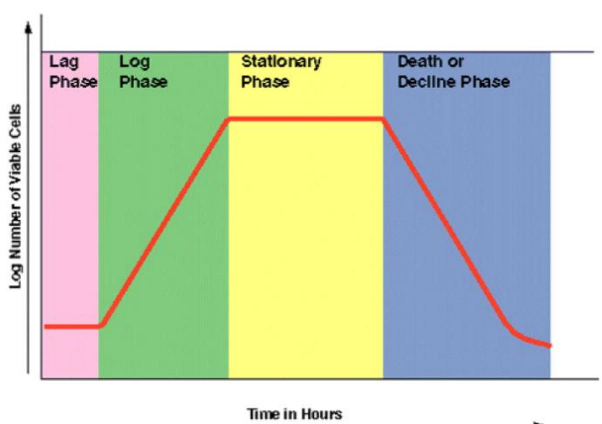


Fig. 4.2. Monod growth curve characterized by four phases.

2.3 Working Methodology

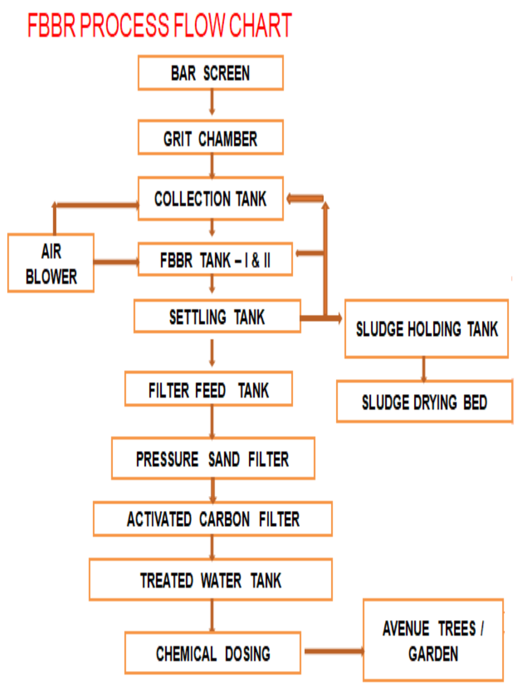
The functioning of this sewage treatment plant begins with the raw sewage flowing via gravity through a bar screen chamber & Grit Chamber to an Equalization Tank. A bar screen will be provided at the inlet point in the bar screen chamber and the waste raw influent will flow through this bar screen in to the Grid chamber. Bar screen will be so designed that it can be cleaned manually from outside the tank. The sand, mud and minute particles from the Grit Chamber would have to be removed manually. Waste influent from the equalization tank will be transferred by means of pumps into the Bioreactor tank where it will be mixed with micro organism also called MLSS (Mixed Liquor Suspended Solids) in presence of air. Air will be introduced through submerged air diffusers. MLSS in aeration tank will be maintained at the range of 250-300 mg/L based on FM ratio. The domestic effluent is treated by the process of aerobic treatment system through the principle of endogenous respiration. We used virgin poly propylene media to support the growth of microorganisms which in turn helps us to reduce the ammonia in very high level.

The final organic and inorganic excreta quantity was estimated and treated the same to use as a bio fertilizer for all kinds of plant system.The Bioreactor system will be designed in a way so as to achieve complete mix of organisms with raw sewage. After achieving a complete mixing of organism over a retention time of 6 to 8 hrs, the effluent will flow by gravity into the Settling Tank. In the settling tank, Tube Settler Media will be provided to enhance the settling of the sludge. With the help of the baffle wall, the sewage is made to flow to the bottom slowly and then rise to the top, which allows the solids to settle to the bottom for collection. The settled solids know as “Sludge” will be constantly pumped in to the sludge digester tank by sludge recycle pumps. This return sludge undergoes further digestion in the aeration tank and also provides the active organism needed to digest the incoming raw sewage.

The supernatant effluent then moves to the Filter Feed Tank. Processed water from the filters will then be made to flow into the Treated effluent Tank.

From here, the water can be supplied for gardening, flushing, Car wash, ground water recharge, agriculture industries purposes. The water can also be disinfected by chlorine dosing using a solution of Sodium Hypochlorite or ultra violet rays through the ultra violet lamp. The final organic and inorganic excreta quantity was estimated and treated the same to use as a bio fertilizer for all kinds of plant system.

We stabilized the design, operation and utilisation of the final products for flushing, gardening, car wash, ground percolation to recharge the ground water to maintain the ground water table etc. We recorded the result of utilisation and operation from the sewage treatment plant based and named it as **FBBR System with Bio media.** To observe the nature of MLSS under extended aeration and the production of sludge henceforth, we have not allowed the pumping back of the sludge into the FBBR/Aeration Tank.



2.4 COMPONENTS OF FLUIDISED BED BIO REACTOR

The important materials required to run a designed sewage treatment plant are as follows.

2.4.1 BAR SCREEN:

The bar screen is a coarse screen with uniformly spaced bars which is installed at the inlet to the equalization tank. This is used in removal of coarse particles such as plastic wares, gunny bags, waste clothes, bones, vegetable waste, twigs, leaves etc. This type of screen will have to be manually cleaned on a daily basis.

2.4.2 GRIT CHAMBER:

It is a compact chamber to remove the grit i.e. sand, mud and other minute particles is installed at the outlet of the screen. This chamber will have a peak flow retention time of 2 minutes. The grit settled will have to be removed manually once in a week.

2.4.3 PRIMARY COLLECTION - EQUALIZATION TANK:

This tank is used to collect the sewage where the variations in flow and characteristics are dampened and also allows a constant flow rate downstream. Here the sewage is kept in mixed condition by means of coarse air bubble diffusion. The primary collection tank will be constructed in RCC. The collected sewage will be pumped continuously at a steady rate to the FBBR Reactor.

2.4.4 RAW SEWAGE TRANSFER PUMP:

The collected sewage from the primary collection tank will be pumped in to the FBBR Reactor tank using a pump. Another additional pump is also provided as stand-by.

2.4.5 BIOREACTOR – AERATION TANK:

The equalized sewage from the primary collection tank will be pumped to the Fluidized Bed Bio Reactor (FBBR) where the reduction of BOD and COD of sewage takes place. This is made possible by the action of microbes. Two FBBRs are provided for this process, which would be running in series. The microbes get attached the bio pack media provided in the FBBR. The oxygen required for this process is supplied through air diffusers located at the bottom of the FBBR. The FBBRs are constructed using RCC.

Bio Pack Media

2.4.6 AIR BLOWERS:

The air diffusers are connected to the air blowers. The air blowers supply air to the diffusers which in turn supplies the necessary oxygen to the microbes.

2.4.7 SETTLING TANK:

The sludge produced in the FBBRs will be separated in this downstream tube settler tank. This tank consists of a baffle wall and a hopper bottom which assists in the settling of the sludge. Tube settler media are also used to help in the settling of the sludge.

2.4.8 SLUDGE TRANSFER PUMP:

The sludge settled at the bottom of the settling tank will be pumped out using a pump. This pump is known as Sludge Transfer Pump. The sludge is either carried back to the FBBR, collection tank or the sludge holding tank. An additional pump is provided as stand-by.

2.4.9 SLUDGE HOLDING TANK:

This tank is used to collect the sludge from the settling tank. This tank is built using RCC.

2.4.10 FILTER FEED TANK:

This tank will collect the processed sewage from the settling tank that flows by gravity. From this tank, the processed sewage is pumped into the Pressure Sand Filter and then in to Activated Carbon Filter for the removal of excess suspended solids, turbidity, color and odor.

2.4.11 FILTER FEED PUMPS:

The processed sewage stored in the Filter feed tank is pumped into the filtration units using the Filter feed pump. Additional pump is provided as stand-by.

2.4.12 PRESSURE SAND FILTER (PSF):

The Pressure Sand Filter consists of 4 layers viz. Anthracite coal grains of size 0.5 – 1.2 mm, fine sand 0.4 – 0.6 mm, fine gravel and large gravel. Processed sewage flows through this Pressure Sand Filter and then passes to the Activated Carbon Filter.

2.4.13 ACTIVATED CARBON FILTER (ACF):

After the processed sewage passes through the PSF, it then enters the Activated Carbon Filter. It consists of 5 layers viz. Activated carbon, ¼"fine silex, ½" coarse silex, ¾" pebbles and 1" pebbles.

2.4.14 TREATED EFFLUENT TANK:

This tank is used to collect the treated and filtered sewage to be used for various purposes like gardening and toilet flushing. It can also be used for percolation into the ground for water table maintenance. It is built using RCC.

COMPARATIVE STUDY OF THE EXISTING FIVE FBBR SITES IN THE CHENNAI CITY

a. VGN AIVA COURT – 60 KLD STP
b. PRESTIGE CYBER TOWER – 150 KLD
c. IMPERIA PHASE 1 – 110 KLD
d. IMPERIA PHASE 2 – 45 KLD
e. VGN PINNACAL – 25 KLD

A. VGN Aviva Court

Site Name:	M/s VGN Aviva Court
Plant Capacity:	60 KL/D
Area:	Govardhanagiri
System:	FBBR

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Flow Rate, Sludge & MLSS Concentration in site A

S.No	Flow Rate Per Hour in lit	Sludge Concentration mg/lit	MLSS Concentration mg/lit
1	2500	10000	600
2	2500	10000	1000
3	2500	10000	1000
4	2500	9500	1000

B. Prestige Cyber Tower

Site Name: M/s Prestige Cyber Tower
Plant Capacity: 150 KL/D
Area: OMR
System: FBBR

Table 7: Flow Rate, Sludge & MLSS Concentration in site B

S.No	Flow Rate Per Hour in lit	Sludge Concentration mg/lit	MLSS Concentration mg/lit
1	6250	8000	2000
2	6250	8000	2500
3	6250	10000	1900
4	6250	9500	1500

C. Imperia Phase 1

Site Name: M/s Imperia Phase 1
Plant Capacity: 110 KL/D
Area: Thiruverkadu
System: FBBR

Flow Rate, Sludge & MLSS Concentration in site C

S.No	Flow Rate Per Hour in lit	Sludge Concentration mg/lit	MLSS Concentration mg/lit
1	4500	7000	2200
2	4500	8000	2000
3	4500	9500	1900
4	4500	9500	1800

D. Imperia Phase 2

Site Name: M/s Imperia Phase 2
Plant Capacity: 45 KL/D
Area: Thiruverkadu
System: FBBR

Flow Rate, Sludge & MLSS Concentration in site D

S.No	Flow Rate Per Hour in lit	Sludge Concentration mg/lit	MLSS Concentration mg/lit
1	1875	9500	2800
2	1875	9500	2500
3	1875	6000	1800
4	1875	6000	1500

E. VGN Pinnacle

Site Name: M/s VGN Pinnacle

Plant Capacity: 25 KL/D

Area: Moulivakkam

System: MBBR

Flow Rate, Sludge & MLSS Concentration in site E

S.No	Flow Rate Per Hour in lit	Sludge Concentration mg/lit	MLSS Concentration mg/lit
1	1045	8000	2800
2	1045	8000	2500
3	1045	6000	1800
4	1045	6000	1500

Treated Effluent Test Report As Per Government Lab

S.No	pH	TSS	TDS	BOD	COD	O&G
Site A	7.2	20	654	20	46	0
SiteB	8.0	18	800	18	50	0
SiteC	7.5	09	955	15	60	1
SiteD	6.5	20	1200	20	30	2
SiteE	6.5	20	800	19	40	1

3. Conclusion

From the comparative study of the Fluidized Bed Bio-Reactors it is realized that the raw influent was effectively treated and desired end result was obtained. The obtained result was matches with the Tamil Nadu Pollution Control Board norms. The Fluidized Bio-Reactor's aim is to reduce the surface area of the treatment with less rejected product. Fluidized Bioreactor sludge digester system was used to treat end product slurry. From the slurry the concentrated sludge was digested and the digested sludge was transformed into the bugs. The bugs were recommended for the Agriculture field as a bio-fertilizer. The treated effluent was recommended to use for the car wash, toilet flushing, and ground water recharge with the natural filtration method etc. From this research it was found that the Fluidized bio-reactor operation obtained the high success rate. Hence this system could be recommended for the urban flats following reason, such as

a. Less retention time for the bioreactor.
b. Obtained high reduction of the BOD, COD and other parameters.
c. Easily handling system
d. Hazardous free system
e. Bio-reactor size was very compact which helps in high fluidization
f. System could be operated with less MLSS
g. High settling ratio at the rate of 12 minutes per sample collection because of the matured MLSS concentration.
h. The operation cost can be sufficiently reduced by introducing Solar power with the system.

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