Bio-filter


Gharda Institute of Technology
Biofilter Plant
CAPACITY: 30 KLD
DATE OF INSTALLATION: 17/01/2014
INSTALLED BY:
Transchem Agritech Limited

INTRODUCTION

Water is becoming limited resource in the world. International Water Management Institute (IWMI) predicts that per capita domestic water demand in India is likely to increase from the estimated 31 m^3/person/year in 2000 to about 46 and 62 m^3/person/year by 2025 and 2050 respectively.

Water scarcity and sewage disposal has become a worrying issue in India. Treatment of wastewater using a simple, decentralized, environment friendly method using minimum energy which is applicable to rural as well as urban areas at a low cost is need of the present.

More than 70 % of our fresh water bodies are polluted today. Groundwater table is depleting rapidly and the country is facing a major problem of groundwater contamination affecting as many as 19 states. Multiple sources have been identified to be responsible for this situation. Discharge of untreated sewage in surface and sub-surface water courses is the most important water polluting source in India. One should also note that while the industrial sector only accounts for three per cent of the annual water withdrawals in India, its contribution to water pollution, particularly in urban areas, is considerable. With only four cities in India having 100% treatment capacity installed, there is a large gap between generation and treatment of wastewater in India. Conventional treatment techniques of wastewater are expensive, since they have large requirements of land and continuous supply of electricity, both of which can be premiums in developing nations across the world. In such a scenario, domestic wastewater recycling is an attractive option. Alternatives are needed urgently for treating domestic wastewaters which are low cost and having any significant negative impacts on the environment.

The reuse of sewage water for non-potable water application is a potential solution for water deprived region world-wide. Due to rapid industrialization and development, there is an increased opportunity for sewage water reuse in developing countries such as India.

BIOFILTER

It is an aerobic treatment which uses filtration technique called vermifiltration. Vermifiltration is emerging out low cast sustainable technology for liquid waste treatment. In vermifiltration earthworm body works as a bio-filter and extends the microbial metabolism by increasing their population. During this process, the important plant nutrients such as nitrogen, potassium, phosphorus and calcium present in the feed material are converted through microbial action into forms that are much more soluble and biologically available to the plants. The treated water is almost disinfected during the process. Earthworms hosts millions of decomposer microbes in their gut and excrete them in soil along with nutrients nitrogen and phosphorus in their excreta. Since the intestine of earthworms harbor wide range of microorganisms, enzymes hormones, etc., this half-digested substrate decomposes rapidly and transformed into a form of vermin-compost within a short time.

Effluent resulted will be extremely rich in nutrition and can be reused as earthworms are versatile waste eaters and decomposers. It also grinds, aerate, crush, degrade the chemicals and act as biological stimulator. Microbial and vermin processes will simultaneously work by treating the wastewater using earthworms. Microbial activity will be stimulated and accelerated by earthworms through developed aeration and also by improve the soil microbe population. This treatment has additional advantage as absence of sludge formation compared to conventional treatment. Vermitechnology is found to be suitable for decentralized treatment of wastewater. Diverse experiments had been carried out on vermin filtration and found it highly efficient in removing Chemical oxygen demand (COD), Biochemical oxygen demand (BOD) and suspended solid (SS) and some N and P.

MATERIALS AND METHODS

A small scale Bio-filter plant was set up for treating of 30 m^3/day of domestic wastewater in the campus of Gharda Institute of Technology, by M/s Transchem Agritech Ltd, Vadodara, Gujrat. The size of the bio-filter plant is 9 m x 5 m x 1.75 m. At the bottom of the plant the earth soil is rammed well and 100 mm PCC and 150 mm RCC bed is layered above the soil. The bottommost layer is made of gravel aggregates (rubbles) of size 75–100 mm. The depth of the layer is 300 mm; above this lay the aggregates of 40 to 60 cm sizes filled up to another 400 mm. On the top of this is the 350 mm layer of aggregates of 8-10 mm sizes mixed with sand. The topmost layer of about 650 mm is Bio-filter media which consists of pure soil and wooden chips along with cow dung in which the earthworms are released.

As the earthworms play the critical role in wastewater purification their number and population density (biomass) in soil, maturity and health are important factors. This may range from several hundred to several thousands. There are reports about 8000 numbers of worms per square meter of the worm bed and in quality (biomass) as 10 kg per m^3 of soil for optimal function.

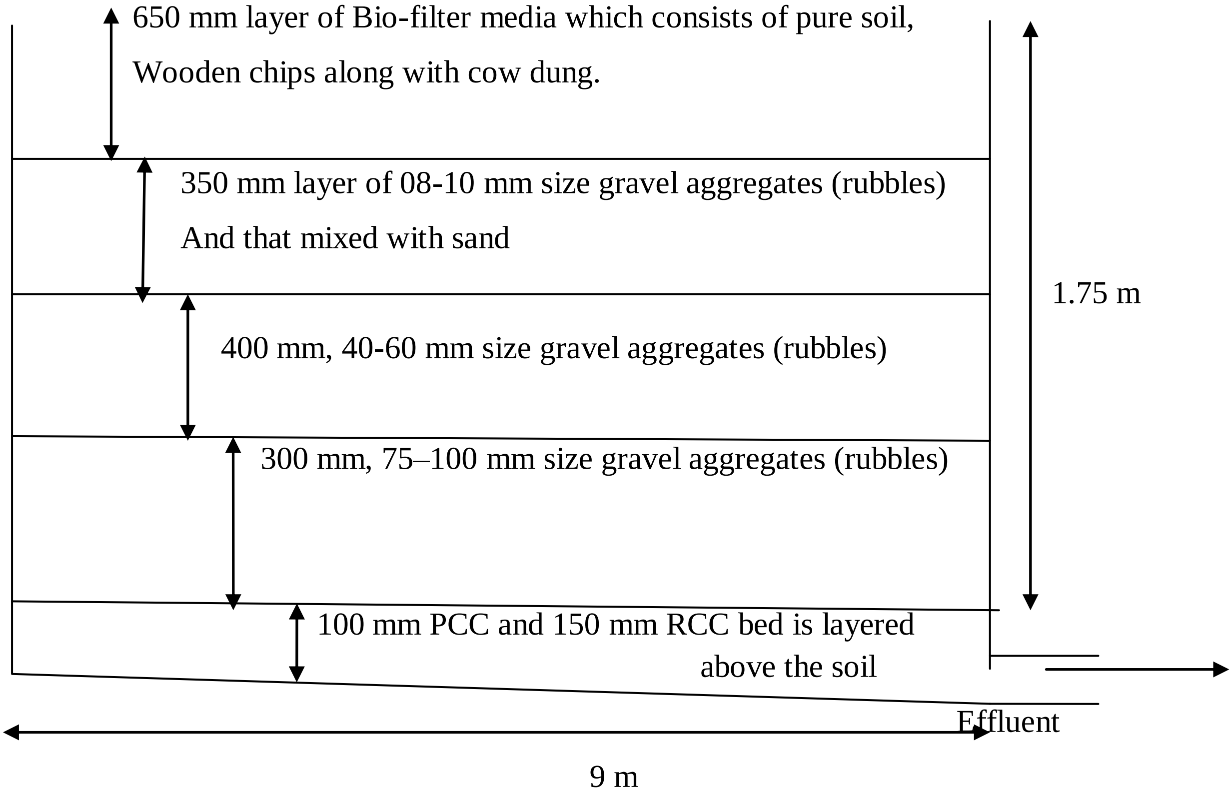

Fig.:-Layers of Biofilter plant

Bio-filter plant of Ajinkyatara Girl's hostel

<u>Design of Bio filter plant for 'Ajinkyatara' girl's hostel:</u>

Daily water requirement of each girl is 127 lit/day.

In Ajinkyatara girl's hostel approximately 190 girl's can accommodate.

Therefore,

Daily total water requirement for 190 girls is determine as,

$$= 127 \times 190$$

$$= 24130 \text{ lit/day}$$

By adding 20% of total water requirement,

$$= 24130 + 4826$$

$$= 28956 \text{ lit/day}$$

Therefore, design of bio filter is done for 30,000 lit/day i.e.30 KLD.

Also, The cross sectional area of the plant is rectangular.

Therefore, Volume of rectangular cross sectional plant is determine by using following formula as,

$$\text{Volume} = l \times b \times h$$

$$= 9 \times 5 \times 1.75$$

$$= 78.75 \text{ m}^3$$

Flow rate of the input pump is 30 lpm

Also, Hydraulic Retention Time (HRT) is determine by using Following formula as,

$$\textbf{HRT} = \frac{\boldsymbol{Volume}}{\boldsymbol{Flow}} = \frac{78.75}{30} = 2.6 \text{ approximately, 3 days}$$

Water Samples of Inlet and Outlet

Treated Water used for plantation purpose

DO'S:-

1) Ensure that the plant is operated on 24 hour basis to avoid any peak load to the plant.
2) Sprinklers: - If chocking observed, stop the inlet and remove sprinklers and clean it properly.
3) Check for even distribution of input water on micro-organism bed.
4) If water clogging is observed on the micro-organism bed, stop the inlet feed and let the water pass out.
5) Tilling of media should be done in every 15 days or (as and when required).
6) Take the observation of Earthworms with regards to its growth and activity.
7) Harvest the top layer of media if high casting observed on the bed (Minimum period every: 6-8 months).
8) Top up organic media once in a year of approx. 200 mm thickness to maintain the top layer.
9) Harvested quantity of the organic media should be top up by fresh media.
10) Strictly maintain the inlet parameter as given above.
11) Use of personal protective equipments on the plant like gum boots, hand gloves, face mask etc.
12) Good housekeeping in and around the plant should be encouraged at all time.

DON'T'S:-

1) Avoid water clogging on the micro-organism bed.
2) No choke up in the sprinklers.
3) Don't increase the flow rate.
4) No toxic or hazardous material is to be added in micro-organism bed.

ANALYSIS METHOD OF BOD

The Biochemical Oxygen Demand (BOD) is a measure of oxygen utilised by microorganisms during the oxidation of organic materials. It is the most widely known measure for assessing the water pollution potential of a given organic wastes. On an average, the demand for oxygen is directly proportional to the amount of organic waste which has to be broken down. Hence, BOD is a direct measure of oxygen requirements and indirect measure of biodegradable organic matter.

Background Information:

- Microorganisms such as bacteria are responsible for decomposing organic waste. When organic matter such as dead plants, leaves, grass clippings, manure, sewage, or even food waste is present in a water supply, the bacteria will begin the process of breaking down this waste.
- When this happens, much of the available dissolved oxygen is consumed by aerobic bacteria, robbing other aquatic organisms of the oxygen they need to live. Biological Oxygen Demand (BOD) is a measure of the oxygen used by microorganisms to decompose this waste.
- If there is a large quantity of organic waste in the water supply, there will also be a lot of bacteria present working to decompose this waste. In this case, the demand for oxygen will be high (due to all the bacteria) so the BOD level will be high. As the waste is consumed or dispersed through the water, BOD levels will begin to decline.
- Nitrates and phosphates in a body of water can contribute to high BOD levels. Nitrates and phosphates are plant nutrients and can cause plant life and algae to grow quickly. When plants grow quickly, they also die quickly. This contributes to the organic waste in the water, which is then decomposed by bacteria. This results in a high BOD level.
- When BOD levels are high, dissolved oxygen (DO) levels decrease because the oxygen that is available in the water is being consumed by the bacteria. Since less dissolved oxygen is available in the water, fish and other aquatic organisms may not survive.

Microorganism Bed

Required chemical reagents for laboratory analysis:

- Phosphate buffer solution
- $MgSO_4$ solution
- $Cacl_2$ solution
- $Fecl_3$ solution
- Conc. H_2SO_4 acid
- $MnSO_4$ solution
- Alkali –Azide solution
- Starch indicator
- Std. $Na_2S_2O_3$

Glass wares:

Conical flask, 10 ml pipette, 50 ml measuring cylinder, BOD bottles.

Preparation of dilution water:

- Take 2 lit. D.M. water then add 1 ml Phosphate Buffer solution.
- Add 2 ml of $MgSO_4$ solution, 2ml $Cacl_2$ solution, 2 ml $Fecl_3$ solution.
- Aerate this water in a container by bubbling compressed air for 45 minutes.

Analysis procedure:

- First sample pH maintains 7 pH on digital pH meter.
- After 7 pH is maintain take sample in BOD bottle according to it's range as follows:

Range of BOD values to be determined	Sample volume (ml)	Dilution water Volume (ml)	Dilution factor
0-6	Undiluted	0	1
4-12	500	500	2
10-30	200	800	5
20-60	100	900	10
40-120	50	950	20
100-300	20	980	50
200-600	10	990	100
400-1200	5	995	200

- Take 300 ml dilution or aerated water in two bottles, 6 ml inlet sample out of 300ml aerated water in two bottles, 16ml outlet sample out of 300ml aerated water in two bottles for blank, inlet and outlet respectively.
- Then final 3 bottles put into BOD incubator for 5 days ($26°c$). And titrate after 5 days.
- Take initial sample bottles blank, inlet and outlet respectively.

- Then add 2 ml $MnSO_4$, 2ml Alkali-Azide solution, Stirring and then settled it. And then add 2 ml Conc. H_2SO_4 to dissolve the ppt.
- If the color is white then Dissolve oxygen is zero. If color yellow then take 200 ml sample in 500 ml conical flask and titrate against $Na_2S_2O_3$(0.025N). Then add starch indicator into that sample.
- End point: Yellow to Colorless

Calculation:

Analysis of Dissolve Oxygen,

$$\textbf{DO (ppm)} = \frac{BR \times N\ of\ Na2S2O3 \times 8 \times 100 \times 10000}{1000 \times Taken\ sample}$$

- After 5 days take final BOD sample bottles and titrate against $Na_2S_2O_3$ solution as above procedure.

Calculation:

$$\textbf{BOD (ppm)} = \frac{Final\ reading - Initial\ reading}{Dilution\ factor}$$

$$\textbf{Dilution factor} = \frac{Volume\ of\ sample}{total\ volume\ of\ diluent\ water}$$

ANALYSIS METHOD OF COD

In the COD test, the oxidizing bacteria of the BOD test are replaced by a strong oxidizing agent under acidic condition.COD describes how much oxygen is required to oxidize all organic and inorganic matter found in waste water sample.

Required Chemical Reagents:

- 0.25N Potassium Dichromate solution ($K_2Cr_2O_7$)
- Std 0.1 N Ferrous Ammonium Sulphate (FAS)
- Mercuric Sulphate ($HgSO_4$)
- Sulphuric acid solution (H_2SO_4)
- Ferroin indicator

Analysis Procedure:

- Take 3 COD bottles washed them with distilled water. Take samples in three bottles for blank, inlet and outlet.
- For blank sample, take 20ml distilled water, 10 ml $K_2Cr_2O_7$, 30 ml H_2SO_4 and pinch of $HgSO_4$.
- For inlet sample, take 10 ml untreated sample, 10 ml $K_2Cr_2O_7$, 10 ml distilled water, 30ml H_2SO_4, pinch of $HgSO_4$.
- For outlet sample, take 20ml treated sample, 10ml $K_2Cr_2O_7$, 30ml H_2SO_4, and pinch of $HgSO_4$.
- Those three COD bottles put into holes of digestion block which has attained 150°c temperature. Also put air condenser on the reaction vessels. Reflux the contents for two hours.
- Cool the contents and titrate the excess potassium dichromate with standard Ferrous Ammonium Sulphate using 4 to 5 drops of Ferroin indicator. Colour changes from yellow to reddish brown.

Calculation:

$$\textbf{COD in ppm} = \frac{(\boldsymbol{Blank\ Reading - Sample\ reading}) \times \boldsymbol{N of\ FAS} \times \mathbf{8000}}{\boldsymbol{Volume\ of\ sample}}$$

ANALYSIS METHOD OF TOTAL DDOLVE OXYGEN

- This method can be work out with the help of TDS meter.
- Take both samples of inlet and outlet.
- Then take conductivity cell and connect it to TDS meter.

- Then sensor is deep into the sample. With the help of TDS meter it get direct reading in ppm

ANALYSIS METHOD OF pH OF WATER SAMPLE

- Take both the samples of inlet and outlet.
- Wash the pH meter sensor with Distilled water.
- Wipe it with tissue paper.
- Dip the meter in beaker containing sample.
- Note the reading.

Note: Calibrate the meter daily with buffers of pH4, pH7and pH 9.2

ADVANTAGES

1. Simple and easy operations.
2. Low operating and maintenance costs.
3. Low energy input.
4. No sludge formation.
5. Aerobic & hygienic process hence no odour.
6. Able to handle to high COD/BOD load.
7. All contaminants (dissolved and suspended) are converted into a valuable product.
8. Enabling the reuse of treated water for gardening, landscaping, farming and other non- potable purpose.
9. It permits higher crop yields, year-round production, and enlarges the range of crop that can be irrigated, particularly in arid and semi-arid areas.
10. Reduces the use of synthetic fertilizer.
11. It improves soil properties and can recharge aquifers.
12. It offers additional benefits such as greater income generation from cultivation and marketing of high value crops, which contribute to improved nutrition.

CONCLUSION

Conclusion:

At the completion of this project, our aim to reduce BOD, COD, Dissolved Oxygen (DO), Total Dissolved Solids (TDS) and maintaining of pH of water is achieved. This treated water can now be used for agriculture and plantation and other Non-Potable purposes.