

Planning and Designing of Soil Biotechnology Plant for the Locality

Bhuvanesh Gawad¹, Swati Dhurve², Hitesh Vanmali³, Mayuresh Patil⁴

B.E.Student, Department of Civil Engineering, St. John College of Engineering and Management, Palghar(E),
Palghar -401404, University of Mumbai , India¹

Assistant Professor, Department of Civil Engineering, St. John College of Engineering and Management, Palghar(E),
Palghar -401404, University of Mumbai , India²

B.E.Student, Department of Civil Engineering, St. John College of Engineering and Management, Palghar(E),
Palghar -401404, University of Mumbai , India³

B.E.Student, Department of Civil Engineering, St. John College of Engineering and Management, Palghar(E),
Palghar-401404, University of Mumbai , India⁴

ABSTRACT: Water is becoming an increasingly scarce resource and planners are forced to consider any sources of water which might be used economically and effectively to promote further development. At the same time, with population expanding at a high rate, the need for increased food production is apparent. Whenever good quality water is scarce, water of marginal quality will have to be considered for use in agriculture. Expansion of urban populations and increased coverage of domestic water supply and sewerage give rise to greater quantities of municipal wastewater. With the current emphasis on environmental health and water pollution issues, there is an increasing awareness of the need to dispose of these wastewaters safely and beneficially. Use of wastewater in agriculture could be an important consideration when its disposal is being planned. Nevertheless, wastewater use will result in the conservation of higher quality water and its use for purposes other than irrigation. Properly planned use of municipal wastewater alleviates surface water pollution problems and not only conserves valuable water resources but also takes advantage of the nutrients contained in sewage to grow crops. The availability of this additional water near population centres will increase the choice of crops which farmers can grow. The nitrogen and phosphorus content of sewage might reduce or eliminate the requirements for commercial fertilizers. It is advantageous to consider effluent reuse at the same time as wastewater collection; treatment and disposal are planned so that sewerage system design can be optimized in terms of effluent transport and treatment methods.

KEYWORDS: Soil Biotechnology Plant, Bio Reactor, Settling Tank, Septic tank, Processing tank, Storage tank.

I. INTRODUCTION

Soil bio-technology is a system which uses living organisms for the treatment of this waste. The water which comes out after treatment is then used for agricultural, gardening & plantation purpose, the solid waste after decomposing is used as manure. Thus disposal process is completely eliminated.

SBT is the patented process developed by Mr. Biplab Patnaik (IIT-B) of Lifelink Technologies. In soil biotechnology, soil is used as a media for treating the wastewater. SBT is a synthesis process which harnesses the energy, carbon and other elements of the waste and converts them to precious "bio-energy" products like vegetation, energy rich soil, complete bio-fertiliser and water. SBT involves removal of organic matter by adsorption followed by biological degradation and oxygen supply by natural aeration to the treatment system. The photosynthetic activity of green cover serves as a bio-indicator for the kind of micro-habitat in SBT. The SBT, is designed to provide the requisite filtration, aeration and bio-chemical processing for removal of toxicity, including BOD, COD, nitrate, phosphate, suspended solids, colour, odour, and bacteria.

SBT uses only natural materials, natural agents (bacteria culture, worms) and natural processes (respiration, photosynthesis, nitrogen fixation) – it is ecologically 100% safe.



Unlike a conventional STP or septic tank where periodically the sludge has to be offloaded, everything is consumed within the plant in this SBT based STP. Raw sewage is pumped to a customised media bed for around five hours (dependent on load and capacity) and clean water flows into the collection tank.

II. METHODOLOGY

- TOTAL POPULATION: 1500 [Considering Design for an village].
- QUANTITY OF WASTE GENERATED :

There are large diurnal variations in the wastewater flow due to the time-specific nature of wastewater generating activities, with a typical peak in the morning. The total population at the Village is about 1500 people. Seasonal variation is also observed as water consumption drops during the summer. This variation combined with no metering at the Village, made it hard to estimate the wastewater volume, a fact which is crucial in order to design an appropriate treatment plant. Taking this into consideration, the average wastewater volume was estimated to be 10 KLD @ 5LPCD and thus a bioreactor of this volume was designed (BR1).

1) DESIGN OF SEPTIC TANK. (IS : 2470 {PART 2} -1985)

Number of people for the septic tank = 1500
 Period of cleaning of septic tank = 1 year
 Obtain the daily rate of water supply per day Daily rate of water supply per day
 = 5 lit/ head/ day = 5 x 1500 =7500 lit.
 Quantity of daily sewage flow in septic tank
 = 80 to 100% of total quantity of daily water supply
 = 100% = 7500 lit.
 Determine the space required for detention of sewage flow
 = (Quantity of daily sewage flow x Detention period in hrs) / 24
 =7500X0.01024/24 = 3.2 m
 Determine the space required for storage of digested sludge
 = No of people x Rate of digestion
 [Rate of digestion = 0.000533 m³ per capital]
 = 1500x0.000533 = 0.8m³
 Total space (volume) required for septic tank
 = Space required for retention of sewage flow + Space required for digestion of sludge
 = 3.2+0.8 = 4m³
 Provide septic tank of 4 m³ capacity.
 Area of septic tank = Total volume required for septic tank/Depth of liquid
 Assume depth = 2 m
 Area required 4/2 = 2m²
 Determining the size of Septic tank
 L/B = 2 (assumed). L = 2B.
 2B² = 2 m² i.e. B = 1 m.
 L = 2B = 1 X 1 = 2 m.

2) DESIGN OF SETTLING TANK OR SEDIMENTATION TANK (IS 10261:1982)

Quantity of sewage = 10KLD
 = 0.42m³/hr
 Considering detention time to be 38 hours
 Vol. of tank =Detention period × Quantity of sewage
 = 38 × 0.42
 = 16m³
 Depth of tank is 2m
 Area of tank = $\frac{16}{2}$
 = 8m²

L/B = 2 (assumed). L = 2B.
 $2B^2 = 8 \text{ m}^2$ i.e. B = 2 m.
 L = 2B = 2 X 2 = 4 m.

3) Design of Bio-Reactor Stage 1 & 2 :

By Considering the Volume of bio reactor : Volume of sedimentation tank as 6.2 : 1
 And designing the Bio reactors as
 Volume of bio reactor / Volume of sedimentation tank =6.2/1
 Volume of Bio reactor Stage 1 & 2 =99.2 m² considering it as 100 m².
 Depth =2 m.

4) Design of Processing Tanks 1 & 2 / Storage Tank :

Since design criteria is same as that of Sedimentation Tank Therefore, dimensions are also same. (The Capacity of the Processing tanks & Storage Tank = Capacity of Sedimentation tank)
 \therefore Length =4
 Breadth =2
 Depth =2

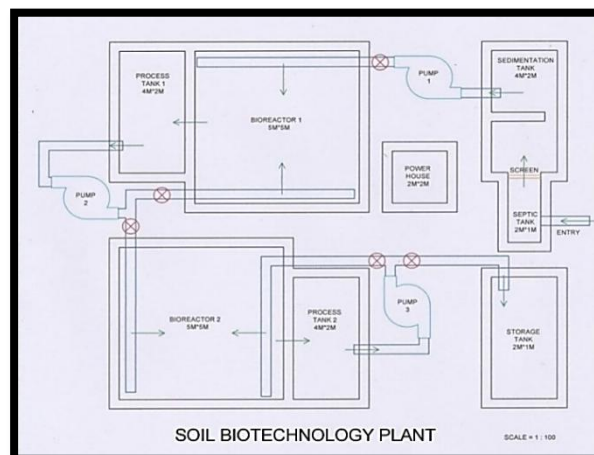
III. RESULT

AREA REQUIRED TO CONSTRUCT VARIOUS COMPONENTS:

Units	Length (M)	Width (M)	Depth (M)	Area Required (sq.m)	Volume of Unit (Cubic meter)
Septic tank	2	1	2	2	4,000
Sedimentation tanks	4	2	2	8	16,000
Bioreactor Stage 1 & 2	10	5	2	50	100,000
Process tank 1	4	2	2	8	16,000
Process tank 2	4	2	2	8	16,000
Storage tank	4	2	2	8	16,000
Free Space Around units				20%	
TOTAL AREA				100	

Table No. 1 Area Required To Construct Various Components

DETAILED LAYOUT OF THE PROPOSED STRUCTURE:



Figno.1 Layout Plan Of The Proposed Structure



QUANTITY OF MATERIALS REQUIRED AND ESTIMATED COST:

1. NAME OF UNIT: SEPTIC TANK				
B.B.M. IN C.M. 1 : 6		P.C.C. OF GRADE M15 (1 : 2 : 4)		
Materials	Quantity	Rate (Rs.)	Per	Amount (Rs.)
Excavation	6.2 m ³	800	m ³	4960
Bricks	2700	5	brick	13,500
Cement	11 bags	350	Bag	3850
Sand	1.89 m ³	3300	m ³	6,237
Aggregate	0.52 m ³	3500	m ³	1820
TOTAL				30,367

Table No. 2 Quantity Of Materials Required Septic Tank

2. NAME OF UNIT: SEDIMENTATION TANK				
B.B.M. IN C.M. 1 : 6		P.C.C. OF GRADE M15 (1 : 2 : 4)		
Materials	Quantity	Rate (Rs.)	Per	Amount(Rs.)
Excavation	17.94 m ³	800	m ³	14,352
Bricks	4000	5	brick	20,000
Cement	26 bags	350	Bag	9100
Sand	3.19 m ³	3300	m ³	10,527
Aggregate	2.08 m ³	3500	m ³	7,280
TOTAL				61,259

Table No. 3 Quantity Of Materials Required Sedimentation Tank

3. NAME OF UNIT: BIO-REACTOR STAGE 1				
B.B.M. IN C.M. 1 : 6		P.C.C. OF GRADE M15 (1 : 2 : 4)		
Materials	Quantity	Rate (Rs.)	Per	Amount(Rs.)
Bricks	10,080	5	brick	50,400
Cement	72 bags	350	Bag	25,200
Sand	6.048 m ³	3300 m ³	m ³	19,960
Aggregate	6.51 m ³	3500 m ³	m ³	22,785
TOTAL				118,345

Table No. 4 Quantity Of Materials Required Bio-Reactor Stage 1

4. NAME OF UNIT: BIO-REACTOR STAGE 2				
B.B.M. IN C.M. 1 : 6		P.C.C. OF GRADE M15 (1 : 2 : 4)		
Materials	Quantity	Rate (Rs.)	Per	Amount(Rs.)
Bricks	10,080	5	brick	50,400
Cement	72 bags	350	Bag	25,200
Sand	6.048 m ³	3300 m ³	m ³	19,960
Aggregate	6.51 m ³	3500 m ³	m ³	22,785
TOTAL				118,345

Table No. 5 Quantity Of Materials Required Bio-Reactor Stage 2



5. NAME OF UNIT: PROCESS TANK 1				
B.B.M. IN C.M. 1 : 6		P.C.C. OF GRADE M15 (1 : 2 : 4)		
Materials	Quantity	Rate (Rs.)	Per	Amount(Rs.)
Excavation	17.94 m ³	800	m ³	14,352
Bricks	4000	5	brick	20,000
Cement	26 bags	350	Bag	9100
Sand	3.19 m ³	3300	m ³	10,527
Aggregate	2.08 m ³	3500	m ³	7,280
TOTAL				61,259

Table No. 6 Quantity Of Materials Required Process Tank 1

6. NAME OF UNIT: PROCESS TANK 2				
B.B.M. IN C.M. 1 : 6		P.C.C. OF GRADE M15 (1 : 2 : 4)		
Materials	Quantity	Rate (Rs.)	Per	Amount(Rs.)
Excavation	17.94 m ³	800	m ³	14,352
Bricks	4000	5	brick	20,000
Cement	26 bags	350	Bag	9100
Sand	3.19 m ³	3300	m ³	10,527
Aggregate	2.08 m ³	3500	m ³	7,280
TOTAL				61,259

Table No. 7 Quantity Of Materials Required Process Tank 2

7. NAME OF UNIT: STORAGE TANK				
B.B.M. IN C.M. 1 : 6		P.C.C. OF GRADE M15 (1 : 2 : 4)		
Materials	Quantity	Rate (Rs.)	Per	Amount(Rs.)
Bricks	4000	5	Brick	20,000
Cement	26 bags	350	Bag	9100
Sand	3.19 m ³	3300	m ³	10,527
Aggregate	2.08 m ³	3500	m ³	7,280
TOTAL				46,907

Table No. 8 Quantity Of Materials Required Storage Tank

COST OF LABOURS:

Type	No.	Rate (Rs.)	Per	Amount(Rs.)
Head mason	1	1000	Day	1000
Mason	7	800	Day	2800
Male Mazdoor	7	400	Day	2800
Female Mazdoor	10	400	Day	4000
Helper	10	400	Day	4000
Bhisti	4	400	Day	1600
scaffolding	Lump sum			3000
Tools & Plants	Lump sum			3000
TOTAL				22,200
TOTAL COST FOR 30 DAYS				666,000

Table No.9 Cost Of Labours



MISCELLANEOUS COST:

1. MISCELLANEOUS				
Materials	Quantity	Rate (Rs.)	Per	Amount(Rs.)
PVC Pipes	40m	150	m	6,000
Rubbles	25m ³	3000	m ³	75,000
Aggregates 25 mm	7.5m ³	3200	m ³	24,000
Aggregates 20 mm	7.5m ³	3300	m ³	24,750
Aggregates 12 mm	7.5m ³	3400	m ³	25,500
Aggregates 10 mm	7.5m ³	3500	m ³	26,250
Aggregates 6 mm	7.5m ³	3600	m ³	27,000
Soil (fine sand of lateritic rock)	60m ³	3000	m ³	180,000
1HP Centrifugal pump	3m	12000	m	36,000
Earthworms	15Kg.	750	Kg.	11,250
Plants	Lump sum			20,000
Railings	Lump sum			25,000
Steel platform around bioreactors	Lump sum			30,000
Electrification	Lump sum			10,000
TOTAL				520,750

Table No. 10 Miscellaneous Cost

TOTAL COST:

Sr.No.	Particulars	Amount (Rs.)
1.	Septic tank	30,367
2.	Sedimentation tanks	61,259
3.	Bioreactor Stage 1	118,345
4.	Bioreactor Stage 2	118,345
5.	Process tank 1	61,259
6.	Process tank 2	61,259
7.	Storage tank	46,907
8.	Cost of labours	666,000
9.	Miscellaneous	520,750
TOTAL		16,84,491

Table No. 11 Total Cost

- Total cost of construction = Rs. 16,84,491 /-
- Water charges (1.5%) = Rs.25,268 /-
- Contingencies (5%) = Rs.84225 /-
- Total cost = Rs.17,93,984 /-
- Contractors profit (10%) = Rs.1,79,398.4 /-

TOTAL COST OF CONSTRUCTION = Rs.19, 73,382.4 /-

IV. CONCLUSION

Thus through the use of SBT plant the problem of disposal of the sewage water , scarcity / lowering of the ground water table , dry boreholes and wells during summer can be solved at an effective and ecofriendly way without having

any impact on environment and achieving the goal of the sustainable rural development. Where it was consider the total population to be 1500 peoples and the design area came out to be 100sqm along with the total cost of construction of the project to be 1,79,398.4/- which if compare to an traditional working sewage treatment plant is less (in respect of Maintenance, Operation and Efficiency along with the power required for functioning of the plant).

REFERENCES

- [1] BhuvaneshGawad, Swati Dhurve, Hitesh Vanmali,MayureshPatil, Study of Soil Biotechnology For Waste water Treatment. SSRG International Journal of Civil Engineering (2020) 8-12.
- [2] A.K. Upadhyay, N.S. Bankoti and U.N. Rai, Studies on sustainability of simulated constructed wetland system for treatment of urban waste: Design and operation. Journal of Environmental Management 169(2016) 285-292.
- [3] Dong Qing Zhang a, K.B.S.N. Jinadasa b, Richard M. Gersberg c, Yu Liu a, WunJern Ng a, Soon Keat Tan. Application of constructed wetlands for wastewater treatment in developing countries: A review of recent developments. Journal of Environmental Management 141 (2014) 116-131.
- [4] C. Ramprasad, Ligy Philip, Surfactants and personal care products removal in pilot scale horizontal and vertical flow constructed wetlands while treating grey water. Chemical Engineering Journal 284 (2016) 458– 468.
- [5] Samira Abidi, HamadiKallali, NaceurJedidi, OlfaBouzaiane, AbdennaceurHassen, Comparative pilot study of the performances of two constructed wetland wastewater treatment hybrid systems. Desalination 246 (2009) 370–377.
- [6] ChaniyaraEkta Arvindbhai1, Prof. (Dr.) D.S.Vyas, Treatment of petrochemical wastewater by soil biotechnology. IJARIE Vol-2 Issue-3 2016, ISSN (O)-2395-4396.
- [7] A. S. Juwarkar, B. Oke, and S. M. Patnaik, Domestic wastewater treatment through constructed wetland in India. Water Science Tech. Vol.32, No.3. pp. 291-294.
- [8] Jeevitha P, Kiran B.M, Manohara B and Sham Sundar K.M, Study on application and validation of vermifiltration in diary effluent treatment. International Journal of Innovative Research in Science, Engineering and Technology, ISSN (Online): 2319-8753.
- [9] Himanshu Gupta, A review on effectiveness of earthworms for treatment of wastewater. IJEDR | Volume 3, Issue 3 | ISSN: 2321-9939.
- [10] Maria I. Merino-solis, edgardovillegas, jose de anda and albertolopez-lopez, The Effect of the Hydraulic Retention Time on the Performance of an Ecological Wastewater Treatment System: An Anaerobic Filter with a Constructed Wetland. Water 2015, 7, 1149-1163, ISSN 2073-4441.
- [11] Amit Ghorude, AkshayChate , Tanmay Patel , Yash Patel, Swati Dhurve,Analysis and Prediction of Quality of Water Resources in Palghar City Using Excel Tool, International Journal of Scientific Research Engineering & Technology (IJSRET), ISSN 2278 – 0882 Volume 8, Issue 3, March 2019.
- [12] Jan Vymazal , “Constructed Wetlands for Wastewater Treatment: Five Decades of Experience”. Environment. Science. Technology. 2011, 45, 1, 61-69.
- [13] Rita P.Shingare, Prashant R.Thawale ,KarthikRaghunathan , Apurva Mishra and Sunil Kumar , “Constructed wetland for wastewater reuse: Role and efficiency in removing enteric pathogens”, Journal of Environmental Management Volume 246, 15 September 2019, Pages 444-461.
- [14] HinaKousar ,Pavithra M, “Utilization of Pistia Stratiotes for Textile Wastewater Nitrates and Phosphates Removal” , SSRG International Journal of Agriculture & Environmental Science, Volume 3 Issue 6 Nov to Dec 2016
- [15] Ezhilarasi.S ,Dr.S.Chandran, “Onsite Treatment of Urban Waste Water using Eco Bio-Blocks”, International Journal of Recent Engineering Science , Volume 5 Issue 4 July – August 2018
- [16] V. Poornima , Parvathi M ,Umadevi , R.Bhaviya Raj , “Improved waste water treatment by bio-synthesized Graphene Sand Composite”, Journal of Environmental Management Volume 162, 1 October 2015, Pages 299-305.
- [17] SubhankarBasu , Saurabh K. Singh, PrahladK.Tewari, VidyaS.Batra , MaliniBalakrishnan, “Treatment of nitrate-rich water in a baffled membrane bioreactor (MBBR) employing waste derived materials”, Journal of Environmental Management Volume 146, 15 December 2014, Pages 16-21.
- [18] P. H. Jones, “Wastewater Treatment Technology, Water Resources and Land-Use Planning: A Systems Approach” pp 93-132.
- [19] Task Group Report, “Sources of nitrogen and Phosphorus in water supplies”, J. A.W.W.A. 59 (1967), 344.