ISSN (Online) 2456-1290
International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 2, Issue 5, May 2017

Design of Sanitation System in a Village

[1] Mr.Jagadeesha Kumar B G ,[2] Neelesh Dindur, [3] Nikhil Jaju, [4] Pagadala Sai Koushik, [5] Pavankumar A B
[1] Associate Professor, RIT, Bengaluru [2] UG IVth year Student RIT, Bengaluru,[3] UG IVth year RIT, Bengaluru, [4] UG IVth year RIT, Bengaluru, [45] UG IVth year RIT, Bengaluru,

Abstract: -- **The project intent is to upgrade sanitation system in a village, an initiative for Welfare of the Society, primarily aimed to harness benefits for the rural people using sustainable concepts like anaerobic treatment procedures. The selected village for our project is Paduvalapattna in Mandya district, which is at a distance of 108km from Bengaluru. Key features of the proposed Sanitation System in village would include the use of Up flow Anaerobic Sludge Blanket and laying out of sewer network with assessing the water quality and best practices to improve hygienic conditions around the village. The main scope of this project is to improve the health condition of rural people.**

Key Terms—**Sludge Blanket, Sanitation, Hygiene, BOD, COD, Methane Gas**

I. INTRODUCTION

Sanitation is one of the important Millennium Development Goals. It comprises elements like management of human excreta, domestic and industrial wastewater and various hazardous substances. It comprises use of recycled products, which is an important soul of this management. In order to achieve the MDG, Government of India has been striving towards enormous policies to provide a framework for sanitation system across rural areas.

Sanitation in Rural Areas

Defecation in open fields or use of community toilets is common in rural areas. In all these cases utmost care must be taken. Ancient houses were well away from the pits with the purpose that it does not affect their day-to-day life. Even now, 52.1% of the rural area population goes for open defecation. Looking at the present scenario, where population growth has been rampant, it has put immense pressure on land in the due course of which land holding capacity has reduced on a larger context. Therefore, it is not feasible to use such open defecation concept for everyone in present world.

Sanitation in Paduvalapattana

Paduvalapattna is a small village whose Village Gram Panchayat is located in Mayigonahalli village. It is located at a distance of 10 km from Nagamagala Taluk with around 12ON and 76OE. The village characteristics are mentioned below. The village has total population of around 1200 people with around 214 households. The main sources of peoples income is agriculture.

Sanitation in Paduvalapattana includes network of open drains where waste from kitchen, toilets and bathrooms flow to the nearby Stream. There is no presence of underground sewer network along with the absence of treatment plant

II. DESIGN OF SEWAGE PIPELINE

Design of sewer pipes has been done using Manning's formula. Pipe considered for sewer network is stoneware with the Manning's coefficient of 0.012.

1 lpcd = 1 litre per capita per day
Population = 2000
(Including future growth population)
Rate of water supply = 60 lpcd
(As per Ministry of Water and Sanitation department)
Slope of the sewer = 1 in 200
Rate of supply = 60 X 2000
= 120000 lpcd
Quantity of waste water supply = 120000 X 0.8
= 96000 lpcd
Peak quantity of waste water = 2.5 X 96000
= 240000 lpcd
Peak Discharge = $2.778 \times 10^{-3}\ m^3/s$
Q = AV (n=0.012 for fair stone ware pipe.)
D = 113.53 mm < 150 mm
Hence, d= 150 mm
Using Manning's Formula
$V = (1/n) * R^{2/3} * S^{1/2}$
V = 0.67 m/s < 1.4 m/s Hence safe.
(As scouring velocity of the stoneware pipe selected for design is 1.4m/s & minimum velocity of low is 0.6m/s).

Fig 1. Layout of Manhole and Sewer Network using CIVIL 3D

ISSN (Online) 2456-1290
International Journal of Engineering Research in Mechanical and Civil Engineering
(IJERMCE)
Vol 2, Issue 5, May 2017

The village sewer network should comprise of stoneware pipe of 6” diameter or 150mm.

Length of the sewer network pipe =2170.33 m

Cost Estimation for Sewer Network and Manholes Tab 1. Scheduled rates for various works in Sewer network

Sl.no	DESCRIPTION	Rates in INR
1.	Earthwork Excavation	150 per m^3
2.	Earth filling with M sand	1200 per m^3
3.	Earth filling with excavated soil	75 per m^3
4.	Joints & Accessories (2100 in numbers)	100 per joint including cement charges
5.	PCC	3500 per m^3
6.	Iron foot steps	100 per step
7.	Manhole frame cover	500 per cover

Cross section of the sewer excavation and manholes is been provided with sketches below.

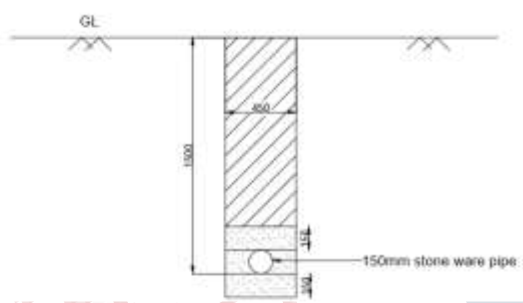

Fig 2. Cross section for pipeline excavation

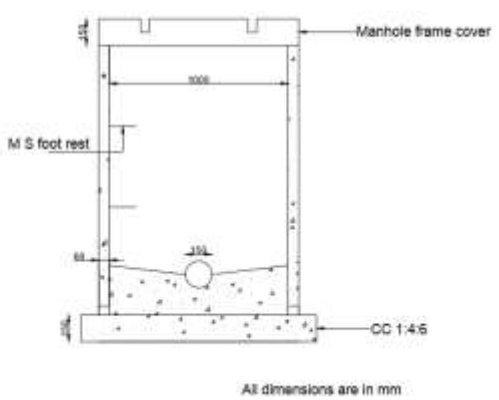

Fig 3. Typical cross section of the proposed manhole

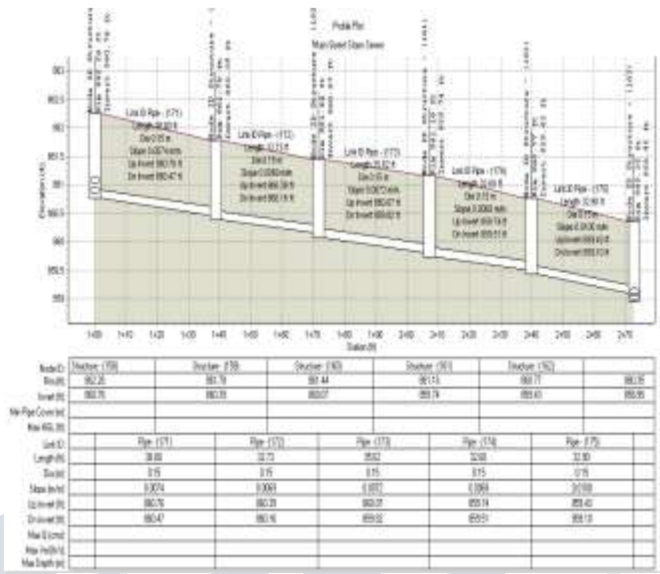

Fig 4. Manhole Invert Levels

Tab 2. Cost Estimation for various works

Sl.no	Description	Quantity	Amount in INR
1.	Earthwork Excavation	1953	292995
2.	Earth filling with M sand	439	527390
3.	Earth filling with excavated soil	1514	113535
4.	Joints & Accessories (2100 in numbers)		210000
5.	PCC and RCC works	1.72 m^3 per manhole	5996.79
6.	Iron foot steps	2 per manhole	200
7.	Manhole frame cover	1 per manhole	500

Estimated cost for individual manholes in INR = 10086.2

Total no of manholes required for the proposed = 70

Sewer network.

Total cost for the sewer network in INR =2149628

(10% charges for unforeseen items and 10% charges for contingency is been accounted).

ISSN (Online) 2456-1290
International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 2, Issue 5, May 2017

III. SUSTAINABLE METHODS IN SANITATION

Up Flow Anaerobic Sludge Blanket

In the present study, an attempt has been made to design an anaerobic digester of Up flow anaerobic sludge blanket (UASB) which is self-operative after being installed once for treatment of wastewater. Some of the major advantages of UASB treatment is that it requires low land and less power for BOD reduction, along with less maintenance and low operating cost, and above all, it has a yield of biogas, which can be used as a fuel.

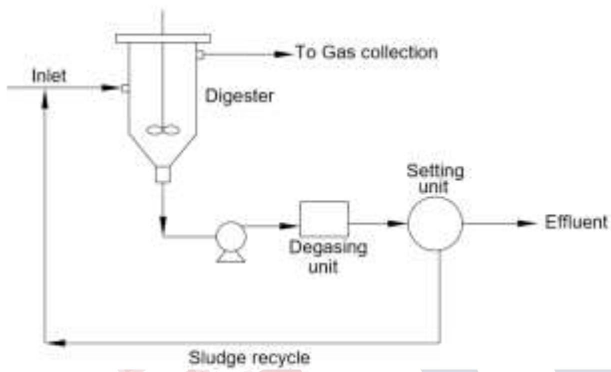

Fig 5.Flow sheet for Anaerobic Digestion of liquid wastes

Procedure

Operation of the UASB reactor starts with formation of an active sludge blanket at the bottom of the reactor, which results from the agglomerates of highly settleable granules formed by microorganism attaching themselves to one other or to minute particles of suspended matter. The gas formed causes agitation to keep the sludge bed fully blended. In the UASB treatment process, provision for inlet of the wastewater is made at the bottom of the reactor. The wastewater after flowing through a biologically formed sludge blanket granules or particles then moves upwards. Treatment occurs as the waste is exposed to the granules. The gas will be produced under anaerobic conditions because of the internal circulation. The free gas and the particles rise to the top of the reactor. The particles rising to the surface strikes the bottom of the degassing baffles, which when released gets attached to gas bubbles. The degassed granules drop back to the surface of the sludge blanket. In order to capture the gas released from the granules, gas-collection domes will be provided at the top of the reactor.

When adequate conditions are preserved in the initial phase sufficient mechanical strength will be adhered by the sludge particles. In the context of preventing an accumulation of biodegradable waste in the bottom most part of the reactor and even to ensure a proper contact between bacteria and substrate at lower hydraulic loading rates, gas recirculation is necessary. This gas re-circulation also provides mechanical agitation at the gas-liquid interface in the digester compartment. Under appropriate conditions, active anaerobic sludge can be preserved and unfed for several months without deterioration. As the waste passes through the settling chamber, biological granules containing liquid and residual solids are separated. The separated solids fall back through the baffle system to the top of the sludge blanket. Compared to the anaerobic and conventional processes, UASB treatment has several advantages. The important aspect of the UASB process is that it allows the use of high volumetric COD loadings as compared to the various conventional processes in the development of dense granulated sludge.

Data for treatment plant design:

Tab 3. Assumed data for treatment design

Sl.no	Description	Assumed Data
1.	Population	2000
2.	Per capita water demand	60 lpcd
3.	Conversion factor	0.8
4.	BOD removal efficiency factor	0.8
5.	Depth	4.5 m
6.	BOD	300mg/litre
7.	COD	450mg/litre
8.	TSS	400mg/litre
9.	VSS	270mg/litre
10.	Solid retention time	30 days
11.	Hydraulic retention time	8-10 hours/ flow
12.	Yield coefficient	0.1
13.	Up flow velocity	12 m/day
14.	COD removal factor	0.8
15.	SO4 removal factor	0.8
16.	Avg Conc of sludge in blanket	60kg/m^3
17.	Area required for treatment plant	0.2-0.3 hectare/MLD

ISSN (Online) 2456-1290
International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 2, Issue 5, May 2017

Design of the treatment plant:

Amount of sewage generated =96000 liters/day

New volatile suspended solids produced =Yield coefficient in BOD removal *BOD*efficiency

=24 mg/litre

Non-degradable residue = VSS *(1-0.4)

(Let 40% be degraded & 60% residue) =162 mg/litre

Ash received in inflow = TSS-VSS

= 130mg/litre

Sludge produced =316 mg/litre

Total sludge produced =amount of sewage*sludge produced

=30.336kg/day

Check for organic loading:

COD load =COD of the flow*total flow the sewage

= 43.2 kg of COD

Volumetric organic loading=COD load/ volume of the reactor

=1.2 kg of COD/m^3day

Total COD removed = 80% of incoming COD load

=34.56 kg/day

Sulphate removal =80% of incoming sulphate load

=6.528kg/day

COD available for methane gas production

=Total COD removed-sulphate removed

=28.032kg/day

Methane gas production per day at 25^oC

=300litre/kg of COD removed

Methane gas produced per day

=methane gas produced* COD available

=8.4096m^3/day

It has been practically observed that Methane gas leaving as dissolved in effluent =0.028m^3/m^3volume of effluent per day

Methane gas leaving = 2.688m^3/day

Methane recovered =5.7216m^3/kg of COD removed

Usable methane =recovered methane/ COD removed

=0.1656m^3/kg of COD removed

Thus, 8.598 m3 of biogas per day produces

=8.0101kwh of electricity

Reactor Dimensions:

Area of the reactor = Total flow/ up flow velocity

=8 m^2

Length of the reactor =4m

Width of the reactor =2m

Cost Calculations:

It is estimated that 2.5-3.6 million/MLD as Capital Cost for the UASB treatment plant. Approximately 65% of the total capital cost is taken as civil works, 35% is of mechanical and electrical works, about 0.08-0.17 million/MLD/year is required as operational, and maintenance cost.

Hence Capital Cost for our UASB treatment plant

=INR 345600

Civil works cost =INR 224640

Mechanical & Electrical cost =INR 120960

Operational &maintenance cost =INR 14400 per year

IV. CONCLUSION

Under the current **SWATCH BHARATH** mission of Indian government, provision is been laid for allocation of funds for the sanitation system. Government is providing a total of INR 2000000 for a population of 1000 people in a village. People should make appropriate use of the funds for the construction of sanitation system in their respective villages.

Through the implementation of sanitation system in rural areas, it is possible to attain the **Millennium development goals**. Along with the implementation of the sanitation system in rural areas, government can reduce the impact of the various diseases that arises out of the inappropriate sewage facilities provided in the rural areas. Hence, hygienic conditions of the villages can be improved. It might also prove out helpful for the De-urbanisation, as proper and sufficient facilities will be available in the rural areas.

REFERENCES

[1] Amit Dhir and Chottu Ram, “Design of an Anaerobic Digester for waste water treatment,” IJARES ISSN: 2278-6252, vol. 1, No.5 pp. 56-66, November 2012.

[2] Robert H.Wayland and Timothy Oppelt, “Onsite Wastewater Treatment Systems Manual,”US Environmental Protection Agency, EPA/625/R-00/008, February.2008.

[3] Dr.M.A.Sivasankaran and Mr.R.Saravanane, "Recent Advances In Wastewater Treatment with Emphasis On Anaerobic and Membrane Technologies," AICTE-ISTE, STTP, December 2002.
[4] B.C.Punmia, Ashok K Jain, Arun K Jain, "Water Supply Engineering," Volume-II,Nov 2011