Drawer Compacted Sand Filtration Technique

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Abstract— Water is an important natural resource to maintain human life. The main source of water for all day to day purposes including drinking, bathing, washing, looking and for other day to day needs is ground water source. Because of increasing urbanisation and population, the ground water source is getting polluted. By analysing the reason behind this problem, it was observed that the septic tank effluent has a major role. Various research efforts in the past have demonstrated that most of the known contaminants in the septic tank effluent –Suspended solids, BOD, bacteria, and viruses can be removed by movement through a few feet of soil under proper conditions. Septic systems that are improperly sited, designed, constructed, or maintained can contaminate ground water with bacteria, viruses, nitrates, detergents, oils, and chemicals.

A septic tank effluent (STE) is defined as the wastewater that is discharged or flows out of a septic tank. STE is a toxic mixture of various chemicals which are harmful to plants as well as animals. This harmfulness is caused from the soil or water sources to which this effluent flows.

In order to avoid or reduce this problem, it must be ensured that the wastewater discharged out from septic tank, i.e., STE, has undergone proper treatment before the discharge. The conventional technique adopted for providing this treatment is the installation of a “soak pit”. A soak pit is defined as a small, covered chamber which is constructed adjacent to a septic tank and is provided with a suitable filtration medium such as rocks or gravels and it ensures the soaking of STE to the ground. However this treatment seems to be ineffective.

The drawer compacted sand filtration technique is an innovative and a modified novel approach design to minimise the hazardous effect caused by STE. The model consists of four drawers which are having a dimension of 33x22.5x12.3 cm, which are separated by a base medium. Sand is filled at a height of 5cm in each drawer according to the particle size. The treatment was done and analysed using different samples of STE by varying the hydraulic loading rate and the pH of the influent sample.

The main aim of this project is to treat the STE more efficiently that the STE can be used effectively and sustainably for all the domestic purposes as well as for irrigation purposes without polluting the environment. The purpose of this study is to investigate the effect of a Drawer compacted sand filtration technique reactor (DCSF) consisting of four drawes which are placed vertically one above the other. These drawers are filled with sand as per their particle sizes ranging from coarser to finer from the top to bottom. Certain spacing is given between successive drawers to ensure aerobic treatment of septic tank effluent as it pmakes its way through the drawers. The HFBR module consists of corrugated PVC sheets that will place with proper spacing in between each sheet. The wastewater is allowed to flow along each drawers from onedrawer to another vertically down through the module and also considered that most of the substrates and solids would be removed in the biofilms created at the filtering sand medium provided on the individual drawers. Hybrid filter consisting of river sand has 99.96 % of Total Coliforms removal after 3 weeks .The hybrid filtration system appeared to perform better in terms of TSS, BOD, COD and nitrification.

Index Terms— BOD, COD, DRAWER , DCSF, Septic tank, TSS

1.INTRODUCTION

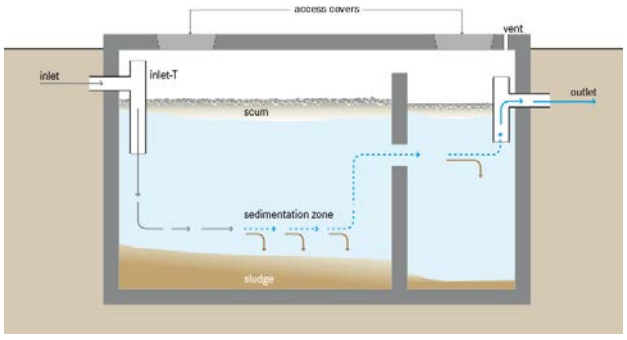
Water is an important natural resource which is strictly essential for maintaining human life. About

80% of the earth is covered with water. However this entire water is not accessible though it is present in seas and oceans. Also the rest of water present in other water resources need not be safe for usage due to rapid increase of pollution .

Generally water is used for drinking, domestic as well as for industrial purposes. Groundwater is considered as the important source of fresh water and this water is mainly used for drinking purposes. So the pollution of these sources exists as big challenge for the maintainence of human life. Unfortunately the groundwater source are also at the verge of being polluted. By analysing the reason behind the pollution of groundwater , it was observed that the septic tank has a most remarkable role. Generally a septic tank is defined as an anaerobic ecosystem in which all the biochemical reactions are carried out by anaerobic microorganisms. Since there is an involvement of anaerobic bacteria, there is a high scale generation of foul odour. Generally septic tank can be considered as a plug flow type reactor . a plug flow type reactor can be defined as a reactor in which the particles enter and leave a chamber progressivily without any mixing or heating. This absence of mixing can results in the process of stratification.

The effluent leaving the septic tank generally named as the septic tank effluent (STE) is rich in dissolved oxygen before leaving the septic tank. This DO is utilized by the microbes present in the septic tanks.

The effluent from the septic tank is really hazardous and should be treated effectively to minimize its worse effects. So before the STE is directed into the drain fields it should be treated by means of suitable arrangements. Its advised that the E. Coli and BOD removal must be ensured. However conventional method(soak pit) available for the treatment of septic tank does not ensure this treatment of removal of BOD, E,Coli and other parameters which stands as a threat of causing pollution.



Source :compendium of sanitation systems and technologies(2nd revised edition)

A soak pit is the generally available conventional technique available for the treatment of septic tank effluent. The water coming out from the septic tank have a blackish appearance due to the presence of toxic chemicals, organic matters, ions etc. In order to avoid its adverse effects on the life as well as environment, it should be treated appropriately.

The available method includes he installation of a soak pit. A soak pit is a simple model of a filtration unit. It is generally covered to prevent the odour nuisance and also to control the overflow of the contents. The filter medium consists of layers of sand as well as gravels and the walls are chambered. The depth of construction usually ranges from 1.5m to 4m. The soak pit is filled with gravels and rocks to maintain the structure from the collapsing of the wall, but also provides space for the accommodation of STE.

However the soak pit does not provide a better result in terms of the removal of organic matters, BOD, coliform bacteria. Also it has been observed that the soak pit has a disadvantage of clogging.

Advantages

1. No skilled labour is required.
2. Effective and economical
3. Cheap and simple equipment
4. Low initial and maintenance cost
5. No residuals or sludge is produced hence minimizing the disposal effort
6. No mosquito breeding
7. No odour nuisances
8. No dependence on climatic conditions
9. Easy year round operation
10. Effective removal of phosphorous and nitrogen
11. Easy design criteria

Disadvantages

1. Ineffective decomposition sometimes lead to the accumulation of organic matters
2. No effective removal of coliform bacteria
3. High cost of filter media such as gravel, sand etc.
4. Water present in the soak pit may turn toxic with respect to time
5. Insufficient availability of oxygen
6. Need of post disinfection
7. ineffective removal of BOD, ammonia and other nitrates

Characteristics of septic tank effluent

A septic tank effluent is defined as the wastewater that is coming through the outlet of the septic tank which is toxic. The STE is rich in sodium ions than that of divalent cations. The insufficient treatment of STE before its disposal can cause the sodium ions to penetrate into soil which results in the reduction of the hydraulic content of the soil by creating a block in the soil pores by penetrating into the pores The chemical and biological characteristics of a STE is as shown in the table1 .

Table 1 : characteristics of STE

Parameters	Average Concentration	Typical Concentration
Total suspended solids (mg/l)	36-85	60
BOD_5 (mg/l)	118-189	120
pH	6.4-7.8	6.5
Fecal coliform Bacteria (CFU/100ml)	10^6-10^7	10^6
Ammonium Nitrogen (mg/l)	30-50	40
Nitrate Nitrogen (mg/l)	0-10	0
Total Nitrogen (mg/l)	29.5-63.4	60
Ortho phosphate (mg/l)	10.2-12.8	12

Source: EPA Onsite Wastewater Treatment System Manual, 2002

2. Materials and methods

The drawer compacted sand filtration apparatus consists of four drawers with each drawer having a dimension of 33x22.5x12.3 cm. eeach individual drawer was provided with 12-16 number of holes having a diameter of 4mm. these holes were drilled to ensure a continuos flow of the septic tank effluent between successive drawers.

Synthetic STE was prepared by mixing the following chemicals in their respective proportions.

Table 2 Composition and concentration of synthetic septic tank effluent

Sl. No	Composition	Concentration (g/l)
1.	Peptone	0.1225
2.	Beef extract	0.0805
3.	Urea	0.1475
4.	Sodium chloride	0.059
5.	Calcium chloride	0.059
6.	Potassium chloride (KCl)	0.012
7.	$Mgso_4.7H_2O$	0.035
8.	K_2HPO_4	0.935
9.	KH_2PO_4	0.117
10	Cow dung	0.15

Source: Journal of Korean Institute ofchemical Engineers

3. RESULTS AND DISCUSSIONS

pH has been identified as one of the parameters which influence effective wastewater treatment pH is a measure of hydrogen ion concentration in water. pH is the acid or alkaline condition of water. Several factors like temperature, aeration and input from external source also interfere with the pH. pH of the effluent determines the type of treatment to be given. In waste water treatment, pH is an important criterion for coagulation of turbidity removal, disinfection, water softening and corrosion control.

DCSF was operated with varying pH of 6, 7, 8and 9 at hydraulic loading rate of 70 l/m^2/day.

Effluent was collected and characteristics of effluent were determined. Experiment data is given in the tables.

TABLE 3CONCENTRATION OF VARIOUS PARAMETERS OF SAMPLE

1.NEUTRAL P^H

Sl . No	particulars	Unit	Influent values	Effluent values
1	pH	pH units	7.31	6.89
2	Total dissolved solids	Mg/L	1070.0	1760.0
3	Phosphate	″	450.0	850.0
4	BOD_3 @ 27^oC	″	254	111.8
5	COD	″	480	160
6	Escherechia coli	Pr/ Ab	Present	Absent

2.BASIC P^H

Sl . No	particulars	unit	Influent values	Effluent values
1	pH	pH units	6.97	7.05
2	Total dissolved solids	Mg/L	875.0	1160.0
3	Phosphate	″	300.0	550.0
4	BOD_3 @ 27^oC	″	121.9	132.0
5	COD	″	176.0	176.0
6	Escherechia coli	Pr/Ab	Present	Absent

3. ACIDIC P^H

Sl . No	particulars	Unit	Influent values	Effluent values
1	pH	pH units	1.89	3.89
2	Total dissolved solids	Mg/L	2360.0	1480.0
3	Phosphate	″	900.0	350
4	BOD_3 @ 27^oC	″	142.4	121.9
5	COD	″	192.0	144.0
6	Escherechia coli	Pr/Ab	present	absent

From the above analysis it was found that the highest percentage removal of maximum number of parameters was at acidic pH .

Bacteria that treat waste water to reduce the COD and BOD, are extremely sensitive to pH! So pH can also have a huge effect on activated sludge COD and BOD reduction rates. Also, some compounds can be precipitated, or dissolved, like heavy metals or suspended solids, at various pH ranges. In some cases the increased dissolved heavy metals concentrations will be toxic to bacteria and inhibit biological BOD and COD reduction in the waste water, usually at low pH, and in some cases the heavy metals can be precipitated at high pH ranges. Therefore, pH is very important in assisting the treatment process to reduce the COD and BOD. While there are bacteria that can survive at extreme pH and temperature ranges, in general, most typical

biological waste water treatment operations operate best (reduce COD and BOD the fastest) at a pH range

4.CONCLUSION

STE is the one of the important reason for causing groundwater pollution. In order to minimise this pollution and to have pure water for drinking, domestic as well as for industrial purposes, the septic tank effluent must undergo proper treatment before its being discharged to the soil or water. Soakpit is the conventionally available technique to mitigate this problem. Anyhow the treatment results seems to be ineffective.

Drawer compacted sand filtration technique is a novel approach for negotiating this problem. The overall result indicated that the STE after the treatment using DCSF met the irrigation standards and the increased pathogen removal as well as other parameters like BOD, COD etc. to remarkable extend.

5. REFERENCES

1. Arun Mittal, 'Biological wastewater treatment', Water Today, August 2011.
2. B. Jefferson, A. Palmer, P. Jeffrey, R. Stuetz and S. Judd (2004): 'Grey water characterisation and its impact on the selection and operation of technologies for urban reuse', *Journal of Water Science and Technology*, Vol. 50, No. 2, pp.157–16 4.
3. Lehr Jay, Jack Keeley & Janet Lehr, 2005, Water encyclopedia, New Jersey, Wiley & sons.
4. EPA Onsite Wastewater Treatment System Manual, 2002, EPA/625/R-00/08.
5. Hugh Henry (1996):Treatment of Septic Tank Effluent using Puraflo Peat Biofiltrationsystem",OnlineAvailablefrom HTTP:http://www.ces.ncsu.edu/plymouth/septic/puraflo.html[15 November 1996].
6. May A Massoud, Akram Tarhins, Joumana A Nasr (2009), 'Decentralized approaches to wastewater treatment and managementb applicability in developing countries', *Journal of Environmental Engineering*, Vol.9, March 2009, pp.652-659
7. Michael Rodgers, Mark Gerard Healy, John Prendergast."Novel hybrid filters for the treatment of septic tank effluent". Journal of Environmental Engineering ASCE/July 2006132:764-768
8. Niall O'Luanaigh, Paul Johnston, Bruce Misstear, Titiksh Patel, Laurance gill (2009), 'A comparative study on the Treatment Performance of a Conventional Septic Tank System and Reed Bed-soil absorption System receiving domestic effluent', *Desalination Publications,* Vol. 4,2009,pp.45-53.