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PERFORMANCE OF SEPTIC TANK FOR THE TREATMENT OF HOUSEHOLD WASTE WATER: CASE STUDY

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ABSTRACT-
this study was aimed at developing a rational approach to septic tank study in order to reduce health risks associated with improperly treated effluent especially in semi urban area. To this end, several research tools including questionnaires, on site study. Questionnaires were used to conduct a preliminary study with a view to ascertaining people's perception with regard to septic tank design, use and maintenance. This preliminary study revealed that the septic tank is a poorly designed and grossly overlooked but indispensable waste management facility. On site studies were conducted to monitor physicochemical parameters. All parameter were analysed on weekly basis as per the standard methods given in american public health association (1989)

KEYWORDS- *Effluent, BOD, COD, Suspended Solid.*

INTRODUCTION

Most of the population living in rural and peri-urban areas of developing countries like India depends upon onsite systems for the managing of domestic wastewater. The conventional septic tank (CST) is the oldest and the most popular mode of onsite wastewater treatment in such areas. According to the census of India 2011, sanitation coverage is 50.2%, 87.4 and 32.7 for total, urban and rural respectively; which comprises 22.2%, 38.2% and 14.7% septic tank, 11.9%, 32.7 % and 2.2% piped sewer system and 15.4%, 16.5% and 15.8 % other different options (pit toilets with or without slab, public toilets and others) for total, urban and rural,respectively)(Census,2011).

SCOPE OF STUDY

Many small communities in developing countries like India face significant barriers to building and maintaining effective and efficient wastewater treatment services, such as limited financial resources, dispersed settlement, geographic isolation and extreme climatic conditions. Selection of Appropriate technology is interrelated with financial, technical as well as environmental aspects. Therefore, the objectives of present study are to review

1. The study various technological options for the on-site rural household wastewater management

2. Evaluate the performance of Septic tank in terms of treatment efficiency located at Nasrapur & Bhor Tal: Bhor Dist: Pune Maharashtra

MATERIALS AND METHODS

Chemicals, Glassware and Instruments Used
All glassware used was of Borosil make and the instruments used for conducting different tests were listed in the Table 3.1. All the chemicals used were either of analytical grade (AR) or laboratory grade (LR).
Filter paper: Whatman glass fiber filter paper No. 42 (pore size 0.45µm) was used for the analysis of suspended solids (SS) and volatile suspended solids (VSS). A4 size sheets were cut into circles of 47 mm diameter for the analysis.
Distilled water: Distilled water, prepared from glass distillation, was used for preparing standard solutions and for rinsing glassware after cleaning. Distilled water was having an average pH of 6.80 ± 0.1, average hardness 0.6 mg/L, chlorides 1.3 mg/L, and conductivity 2µs/cm.

Instrument /Equipment	Parameter Tested/Measured	Model/Manufacturer, Specifications
COD Digester	COD	BT-05 Bio-Tech Instrument
Digital pH Meter	pH	LT-II LABTRONICS
Electronic Balance	Weight	PGP-200 WENSER
Muffle Furnace	VSS	Jai Ganesh Scientific Mumbai – New Techno lab Instrument.
Oven	SS, Drying	B II – Bio Technique India
Spectrophotometer	For measuring COD	Model-301 Electronk India

Table No. 1: Instruments used for the analysis Consumables

Analytical Methods

Different analytical techniques and methodologies used for present investigation have been described. In general, standard techniques as detailed in standard methods (APHA, 1998) have been followed unless otherwise specified.

The pH

The pH was measured using digital pH meter with a sensitivity of 0.01 and having temperature correction facility. The pH was measured by placing electrode in the sample. The instrument was calibrated periodically with standard buffer solutions. This analysis was done to monitor the health of biological process, as excessive fermentation will produce acids, which may alter the process performance.

Alkalinity

As there was no hydroxide alkalinity in the synthetic or actual sewage, bicarbonate alkalinity in the sewage was determined using titrimetric method. 20 ml of ordinarily filtered sample was taken in conical flask and 2 to 3 drops of methyl orange indicator was added. The solution was titrated with 0.02 N H_2SO_4 solution until the colour of solution changes from yellow to pinkish orange, which is end point of titration.

Suspended Solids (SS) and Volatile Suspended Solids (VSS)

Appropriate sample was taken based on suspended solids present in the sample. The sample was filtered through initially dried 0.45µm whatman glass fiber filter paper at 105º C, cooled in dessicator and weighed. The filtration was carried out using vacuum filtration apparatus. Again the filter paper was dried at 105 ºC, cooled down to room temperature in dessicator. The increase in weight represented suspended solids and it is expressed as mg/L. The weighed filter paper with sample was put in muffle furnace at 550 ºC for 15 to 20 minutes, cooled down in dessicator, and weighed. The weight loss on ignition is expressed as volatile suspended solids. To avoid any loss of weight during handling, porcelain crucible was used along with filter paper. The effluent SS and VSS were determined once in a week

Chemical Oxygen Demand (COD)

Closed reflux colorimetric method was used for analysis. Refluxing was done for 2 h in capped hach tubes with potassium dichromate in a hatch digester, and the oxygen consumed was measured against standards at 600 nm with a spectrophotometer as given in the Table 3.3. For experiments using synthetic sewage the settled effluent COD was measured with a settling time of 20 to 30 minutes, and raw influent was used for COD analysis. Whereas, for actual sewage, settled COD for both influent and effluent was taken. The COD determination of influent and effluent to ML-MFCs was carried out every alternate day.

Total Dissolved Solids (TDS)

TDS concentration in the influent and effluent samples was measured each day with the help of Digital TDS meter (Unitech, Model MS CD 610622) by placing TDS electrode in the samples. The instrument was calibrated with known standards before TDS measurement.

LITERATURE REVIEW

SEPTIC TANK

A septic tank is a watertight chamber commonly used for the treatment of household as well as community gray and/ or black wastewater with high percentage of settleable solids (Sasse, 1998). In India about 14 % of rural population is covered by septic tank systems (Census 2011).The main purpose of conventional septic tanks is to physically remove suspended solids (SS) and biologically remove dissolved organic compounds which are cost effective treatment operation/process. It is a combined sedimentation and anaerobic digestion treatment unit where the

retention time of sewage is one to two days. During this period, settleable solids settle down to the bottom of tank and lighter impurities, such as oil, rises to the top to form the scum layer, which produces thick blanket at top and helps to maintain completely anaerobic condition. This settled solids are generally organic in nature and anaerobically digested, reducing the volume of solids. The intermediate liquid component flows through the dividing wall in to second chamber, where further settlement of solids takes place (Figure 2.1). The excess liquid, now in a relatively clear condition, left the septic tank from the outlet into the septic drain field, such as a leach field, drain field or seepage field, depending upon locality (Sasse, 1998; Tilley et al., 2014; Tilley et al., 2008). Quality of septic tank effluent depends on the nature of influent, hydraulic retention time and temperature. The treatment performance of septic tank with proper design and septage removal frequency in terms of BOD and SS removal efficiency ranges from 40-50 % and 50-70 % respectively (CPHEEO, 2013). Typical design criteria for septic tank is as follows

Table 2.2 Design criteria for septic tank (compiled from IS 2470-1, 1985)

Minimum surface area of tank required	0.92 m^2 for every 10 lit. of peak flow
Minimum depth of sedimentation zone	250-300 mm
Volume required for sludge digestion	0.033m^3 per capita per day
Volume of digested sludge	0.00021m^3 per capita per day
Hydraulic detention time	24-48 hrs based average daily flow

Applicability

The conventional septic tank system is particularly applicable for:

1. Primary treatment of wastewater from individual houses.
2. It is suitable even for high water table areas where drainage facility for effluent discharge is available.
3. Septage/Sludge collection and treatment facility is available nearby.

OPERATION AND PERFORMANCE OF THE SEPTIC TANK SYSTEM

The septic tank is a primary settling tank as well as an anaerobic reactor. The influent wastewater is interrupted by the concrete splash baffle and is scattered 11 on the surface of the tank¨s content disturbing the scum layer and settled sludge. But in tanks using tee pipes as inlet, the part of the pipe pointing downward is made to dip into the liquid at mid depth to provide minimal disturbance of the content. Settling starts at the inlet of the tank. Given enough detention time, the septic tank can achieve as much as 81% total suspended solids removal, 68% BOD removal, 65% phosphate removal and 66% fecal coliform removal (Seabloom *et al.*, 1982; Rahman *et al.*, 1999). These values are not fixed; they could be more or less depending on design, construction, maintenance and modification. A malfunctioning septic tank will cause damage to the drain field if the issue is not addressed.

Ideally, the septic tank operates as a plug flow reactor (fluid and particles enter and exit the tank is progressive sequence), so there is usually no mixing or heating, particles ascend or descend and stratification develops (Bounds, 1997). The septic tank is primarily a sedimentation tank. The low rate of biodegradation in the septic tank is as a result of insufficient oxygen in the tank. The tank consists of four zones viz:

1. ***The sludge zone*** – this is the lowest portion of the tank where particles denser than water settle given a sufficient detention time.

2. ***The clear zone*** – this is just above the sludge zone where clarified wastewater is retained for a while before discharge into the drain field. Detention of waste tends to homogenize the flow of waste water to the drain field (Baumann *et al.*, 1978). Detention also provides some time for biodegradation by anaerobic micro-organisms.

3. ***The scum layer*** - this is the top layer just above the clear wastewater where materials lighter than water rise to form a thick layer of about 3cm. Trojan *et al.* (1985) and Winneberger (1984) estimated the rate of sludge and scum accumulation at 40 l/c/yr. The scum layer has the undesirable effect of hindering the diffusion of air into the septic tank content. The dissolved oxygen concentrations in septic tanks have been found to average 0.3mg/l (Winneberger, 1984).

4. ***Air / Reserve Space*** – this is an empty space above the sum layer. This provides a factor of safety against clogging of septic tank pipes. It is recommended that the air space be equivalent to one day detention time to provide enough time for repairs before the tank fills up completely.

CONCLUSIONS

From the present study it appears that the septic tank effluent quality varies significantly with the

composition of domestic wastewater. For septic tanks treating wastewater was relatively poor.

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