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Reactor for online decentralized self-sustainable treatment of domestic sewage

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Abstract - Nearly 80 % of the water supply used by society returns as municipal wastewater in the sewer system as sewage. Only half or less sewage going to treatment plant and remaining to surface water. This would seriously affect the survival of all organisms in the river and oceans. So it is keen need to treat sewage before discharging into stream or river or any water body. In India, many rural and urban households do not have latrines and use open place. Large number of households does not have access to a drainage network and are connected to natural surface drains.

1.INTRODUCTION

The main wastewater treatment technologies that are commonly used are as given below: i) waste stabilization ponds; ii) wastewater storage and treatment reservoirs; iii) constructed wetlands; iv) chemically enhanced primary treatment; v) up flow anaerobic sludge blanket reactor; and vi) ASP activated sludge process . These are suitable for different conditions and have advantages and disadvantages, especially in terms of requirements for land, cost, remediation efficiency and other factors.

The most suitable wastewater treatment technique to be applied must meet the recommended microbiological and chemical quality guidelines at low cost, minimal operational and maintenance cost. Adopting a low level of treatment as possible is needed in developing countries, not only from the point of view of cost but also difficulty of operating complex systems.

There are two types of treatment system available for the treatment of the sewage:

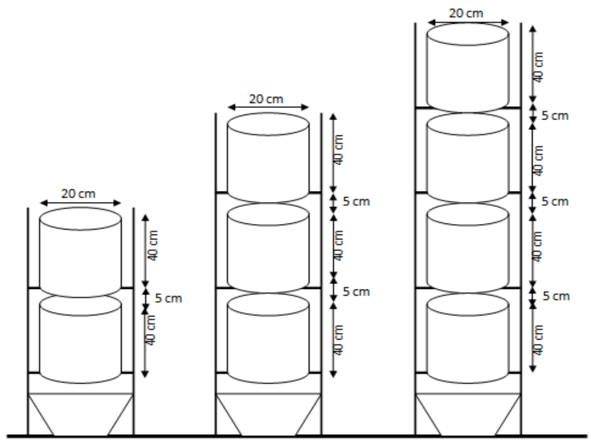
(a) Centralized sewage treatment system (CSTS)

(b) Decentralized sewage treatment system (DSTS)

2. Material and Methodology

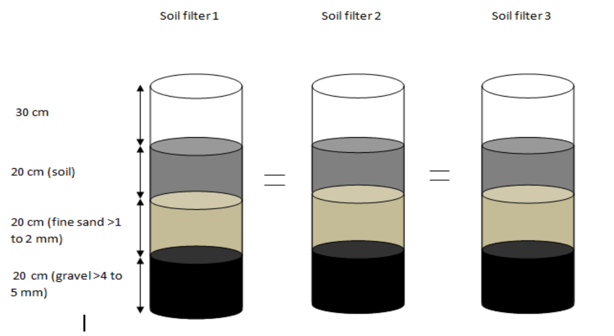
- **Sponge trickling filter (SPTF)**

There are three SPTF reactors of different dimension. As per shown in figure PVC pipe was used. In first reactor there are two modules of 40 cm height and 20 cm diameter each and also space was provided of 5 cm between each module for aeration. In second reactor there are three modules and in third reactor there are four modules and all module have same dimension. In each module sponge was filled as media of 95 % porosity, 32 kg/m3 density. Out of 40 cm height of module 30 cm height was filled by 1 inch x 1 inch x 1 inch of cubic size sponge (polyurethane).at upper most site of each reactor one perforated plate was fitted for uniform distribution of sewage on sponge media



- **Soil biofilter (SBF)**

Soil filter first, second and third have same dimension. PVC pipe was used of 90 cm total height and out of 90 cm total height 60 cm was filled by different media layer. Cap was fitted at bottom of the pipe for making a closed unit. The bottommost layer of 20 cm depth was made of coarse sand of size 4-5 mm. above coarse sand, there was a layer of 20 cm depth made of fine sand of 1-2 mm size. And top most layer of 20 cm was made of garden soil.



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- **Characteristics of synthetic sewage and raw sewage**

Raw sewage was collected from a sewage pumping station located at Nr. STP, Bhuj. Synthetic sewage was applied as per (Li. et al.,2007). The range of characteristics of synthetic sewage and raw sewage used during the study is shown in table

- Table 1: Characteristics of synthetic sewage

Characteristics	Range
Turbidity	0 (NTU)
COD	306.8 (mg/l)
Nitrate	7.3(mg/l)
Phosphate	2.36(mg/l)

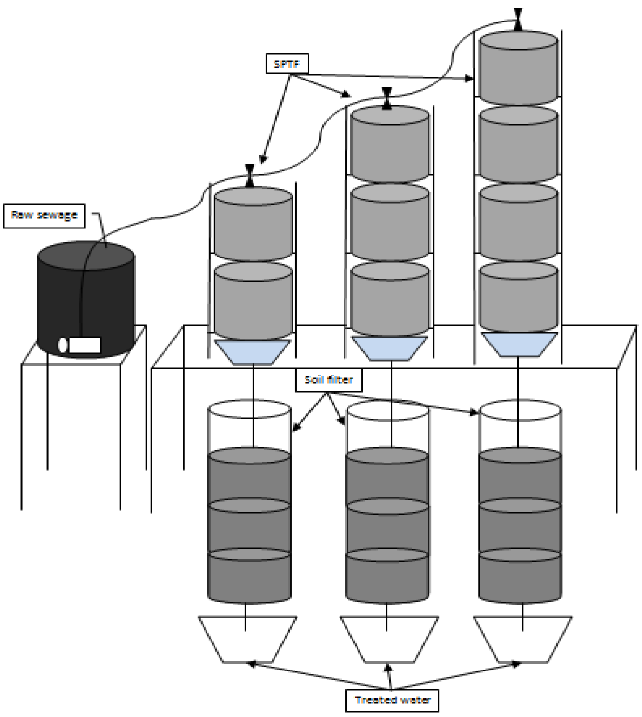
- Table 2 Characteristics of raw sewage

Characteristics	Range
Turbidity	67-95.8 (NTU)
COD	232-357.9 (mg/l)
Nitrate	0.013-1.49(mg/l)
Phosphate	0.990-1.874(mg/l)
Total kjeldahl nitrogen	19.04-30.128(mg/l)

- **Experimental procedures**

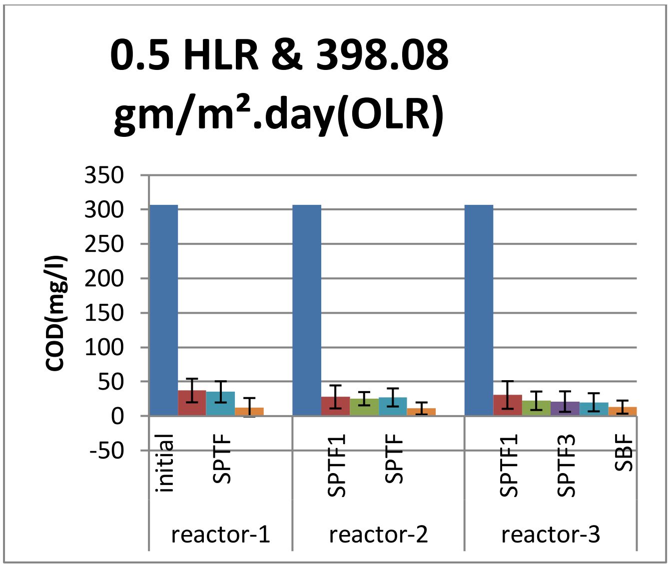
The experiment was carried out at laboratory of regional office, gpcb, bhuj. The temperature in lab was about 30-38°. Around 50 L of municipal sewage were kept in PVC drum and for more storage another drums were connected by siphon. These drums were kept on elevated platform just near the reactor, as shown in figure.

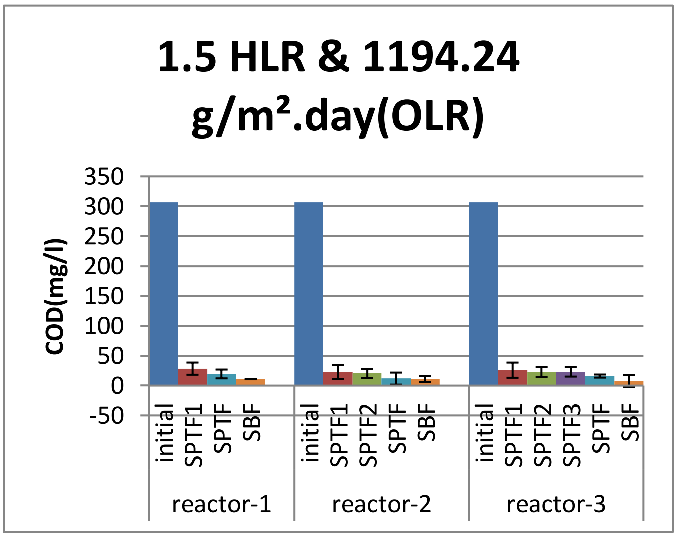
Synthetic sewage at different HLR(m^3/m^2.day)	Raw sewage at different HLR(m^3/m^2.day)
0.5	1.0
1.0	1.5
1.5	2.0



Initially for microbial growth in sponge media 15 days sludge was circulate from sewage treatment plant, Bhuj

Synthetic sewage and raw sewage were supplied to all of reactors from drum by submersible pump connected with distribution system. The distribution system consisted of simple 0.6 mm polypropylene pipe with valves for uniform flow of wastewater and perforated plastic plate was provided for uniform distribution of wastewater on the surface of bed. Sewage percolated down through the sponge layer, and at the end treated sewage was collected in small bucket given at the bottom of the SPTF which was opened through outlet pipe on the SBF. The treated sewage of SPTF was percolated down through various layer of the SBF. At every 24 hours treated wastewater was collected in collection tank. This treated wastewater from all three reactors was analyzed for COD, turbidity, nitrate nitrogen, phosphate and TKN.





	HLR(Hydraulic loading rate) , m3/m2.day											
	0.5			1.0			1.5			2.0		
	R1	R2	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3
Avg inlet COD(mg/l)	306.8	306.8	306.8	306.8	306.8	306.8	306.8	306.8	306.8	306.8	306.8	306.8
Avg outlet COD(mg/l)	18.79	23.51	20.20	4.80	5.92	5.40	10.12	6.69	13.70	2.70	0.539	2.22
Avg % removal	93.87	92.33	93.41	98.43	98.06	98.23	96.70	97.81	95.53	99.1	99.82	99.2

3. CONCLUSIONS

Irrespective of HLR all the SPTF systems achieve about 90% COD removal from raw sewage without any primary treatment, COD removal of 90% in reactor-1(two modules) increased to 95% in reactor-3(four modules) irrespective of HLR, COD was further reduced in SBF by 5%, at all HLR SPTF system was achieved COD less than 50 mg/l which is under norms as per new CPCB standard (Draft notification 24th November 2015)

The first module in all the SPTF reactor contributed to 80-85% COD removal from raw sewage at all HLR however nitrification and TKN removal increased with increasing in number of modules.

TKN removal was about 85 % average at 1.0 HLR in SPTF systems from raw sewage it was decreased to 75 % average at 1.5 HLR and 2.0 HLR in SPTF system

Irrespective of HLR all SPTF system achieve about 90% COD removal from synthetic sewage, COD removal of 90% in reactoe-1(two modules) increased to 95% in reactor-3(four modules) irrespective of HLR, COD was further reduced in SBF by 5%

The first module in all the SPTF reactor contributed to 80-85% COD removal at all HLR in synthetic sewage, however nitrification increased with increasing in number of modules.

More than 99% of turbidity removed from raw sewage in SPTF and SBF system irrespective of HLR, more than 90% turbidity removal was achieved in the first module of each reactor

Initial DO in the raw sewage was 0 mg/l which increased to 3.5 to 4.5 mg/l in the first module in SPTF further increased to 5 to 6.5 mg/l with the increase in number of modules

The SBF reactor work continuously without any chocking. However at HLR of 2 m/d the SBF over flown enhance soil in SBF was replaced with sand (0.1 to 1 mm) was only during HLR of 2 m/d.

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