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Decentralized Low Cost Wastewater Treatment Plant Based on Phytoremediation and Bagasse Fly Ash as Natural Filtering Media

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Abstract: ***The decentralized waste water treatment technique provides check to the over exploitation of available fresh water by providing a sustainable and eco-friendly method of treatment of the wastewater with zero energy inputs and lesser complex machineries. The DEWATS can be implemented at location where the centralized treatment facility is not feasible, also it can be implemented at commercial, industrial and residential areas where the sewage and sullage can be treated and reused for various purposes. Natural filtering materials such as Bagasse and Jatropha seeds are used and compared against BOD and COD removal. This paper illustrates the basic design criteria of DEWATS, its functioning and application in various areas.***

Keywords: Wastewater, Eco-friendly, BOD, COD, Recycle and reuse, Zero energy, Bagasse fly ash

1. Introduction

The utilization of water is overwhelming day by day and is directly proportional to the population growth. Due to over exploitation of freshly available water resources the ground water table is lowering at an exponential rate. If the present consumption is continued at this rate then our future generation would face all the consequences. To prevent the over usage of water certain technological and social measures have to be taken. The DEWATS (Decentralized waste water treatment plant) is a best solution that can be implemented at any place with some modifications. It is a technique for treating the domestic waste water generated from kitchen, toilets and bathrooms.

The onsite or decentralized treatment is the best alternative to the centralized system as it does not require complex machineries and equipments, skilled labour supervision and the plant can run on a little knowledge of the process. The waste generated can be used as a bio manure and the gas obtained can be used as an effective fuel for cooking and other purposes. The DEWATS system is highly efficient in treating waste water at almost low cost and requires no energy for the treatment of waste water and the obtained water can be effectively used for agricultural purpose, fishing, gardening, car washing, chillers, boilers etc. The concept of RECYCLE, REUSE, & REDUCE can be defined by the decentralized treatment system. This system is highly cost effective in nature and requires less initial, operational and maintenance cost. It can treat water from 1KLD to 1000 KLD.

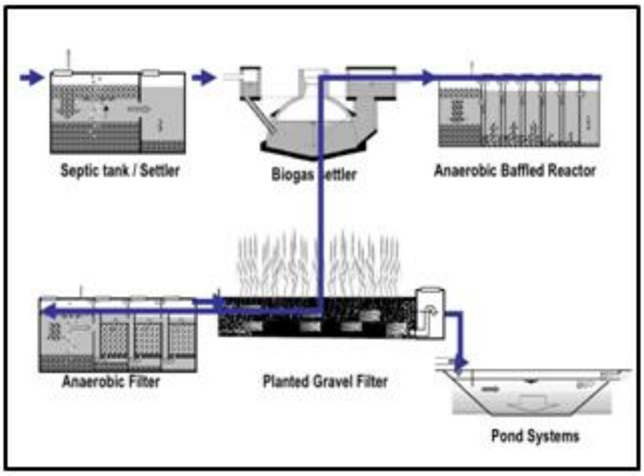

Figure 1: Basic components of DEWATS system

2. Proposed Work

A working model has been prepared consisting of multiple flow system of about 33KLD capacity with different units with different specifications. The model is designed and operated with specified joints to examine working of each unit with assembly pipe networks, and holes of known diameter. The plant is experimentally set up for the analysis of the DEWATS system with different configuration and different samples of waste water from different outlets are treated and their influent and effluent parameters are experimentally performed and compared in terms of BOD & COD. The filter media used is basically made up of bagasse fly ash and Jatropha seeds placed between coarse and fine aggregate to trap the particles and to increase the removal efficiencies and to decrease the biological oxygen demand of waste water. The BOD removal in this process is almost about 75-80%. The water is then sent through a common pipe consisting of partly treated grey water and sullage to a PLANTED BED FILTER which mainly consists of plants like *Canna indiaca*, *Typa*, and reeds followed by 300x300 mm spacing. The water is here treated for the removal of pathogens and for removing the extra nutrients present in the waste water. The filter media is usually graded gravel (equal layers of 40mm and 20mm thickness). The planted bed consists of mud/ soil of 20cm thickness placed between the layer and the laying of the plants are done. The slope is provided so that water can flow from one part of the planted bed filter to another end of the filter. The water obtained is free from pathogens and free of excess nutrients. The BOD removal at this step is usually 85-95% and the obtained water is then collected to a common collecting unit where pump of about 1-2 HP is used for pumping the water for various purposes. The pumps require electricity which may be replaced by the solar pumping units. The water thus obtained does not require any type of complex machinery and is totally free from moving parts and hence the amount of water obtained after the treatment is so large that it can be used to fulfill the demand of horticulture and for supplying water for cooling purposes like chillers and can be strongly recommended for re-flushing system in toilets and floor cleaning purposes by imparting a very small change in the plumbing system.

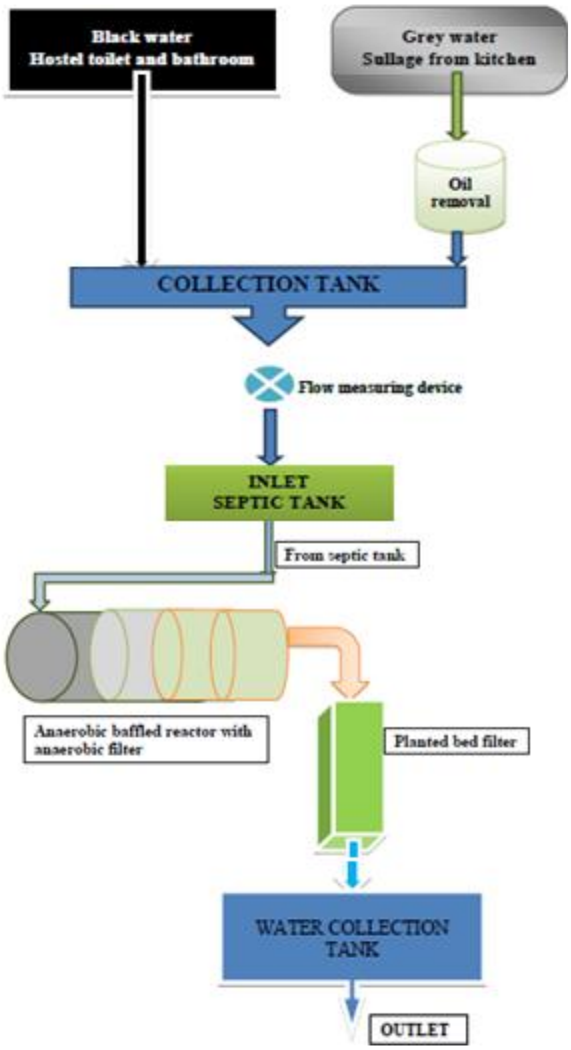

Figure 2: Flow chart of the designed DEWATS Plant

3. Design Methodology

3.1 General design parameters for 30KLD plant

HRT (hydraulic retention time) **=** 8 – 10 days
Average sewage generated =30KLD
Average sewage generated per hour is 30/ 24= 1.25 cum /day
Average sewage generated per day is 1.25 X 60 =75 cum/day
Peak factor is taken as 1.2 so, 1.2 X 75 = 90 cum/day
Assume flow per day 100cum/day
Total capacity of plant (V) = flow per day x HRT
= (100 X 8)/24 = 33.33m^3
Inlet, outlet and other pipes = 1% slope between outlet and inlets. Minimum pipe size 100mm Diameter provided in staggered manner.
Free board = 0.30m to 0.45m above the suggested depth
Manholes = minimum 450mm wide above each separated area of tanks

3.1.1 Pre-treatment (Anaerobic settling tank)

Capacity (V_1) = 5% of total capacity = 5 X 33.33/100
= 1.66 m^3 or 2 m^3
Depth (D) = 1 m
Breadth (B) = Minimum 1.2 m (for O&M)
Length = V_1 / (DB) = 1.66 /1.2x1 = 1.38m or 1.5 m
D=1m, B= 1.5m, L= 1.5m
Baffles = 1 nos (Volume of tank -50:50)
Opening between baffles = bottom of baffle

3.1.2 Primary treatment (Anaerobic septic tank)

Capacity (V_2**) =** 30% of total capacity => 9.99 m^3 or 10 m^3
Depth = 3m Breadth = minimum 1.2m (for O&M)
Length = V_2/DB =10/ 3x1.2
=2.77m or 3m (say)
D = 3m, B= 1.2m, L= 3m
Baffles = 1 nos (Volume of tank -50:50)
Opening between baffles = middle of baffle

3.1.3 Secondary treatment (Anaerobic baffle reactor)

Capacity (V_3) = 30% of total capacity of plant => 10 m^3
Depth = 3m
Breadth = min 1.2 for (O&M)
Length = V_3 /(DB) = 10/3x1.2
=2.77m or 3m (say)
D = 3m, B= 1.2m, L= 3m
Baffle = 4 no. equally spaced
Connection between baffles by PVC pipe positioned in baffles carry influent below filter media
Filter media as Stones 20-30 cm size and grave layer of 40mm and 20 mm over it

3.1.4 Tertiary treatment (Planted bed filter)

Capacity (V_4) = 30% of total capacity of plant = 10 m^3
Depth = 1.5m
Filter media as Graded gravel (equal layers of 40mm and 20mm thickness)
Plant bed made of mud/ soil balls of 20cm thick placed between the gravel layer
Type of plants used are Canna Indiaca, Typa, Reeds at (300X300) mm spacing

3.1.5 Final treatment (storage tank or polishing pond)

Capacity (V_5) = 5% of total capacity of plant => 1.66 m^3 or 2 m^3

Figure 3: Working model on Dewats of 8.5 L Capacity

Figure 4: Anaerobic Filter with bagasse fly ash and sand

As filtering media used in the working model

Figure 5: Planted bed filter used for treating the wastewater by phyto-remediation technique

4. Result and Discussion

Table 1: Variation in BOD by changing the filter media

The working of the filter media is checked by taking sewage samples from different localities, and calculating the BOD of the respective units.

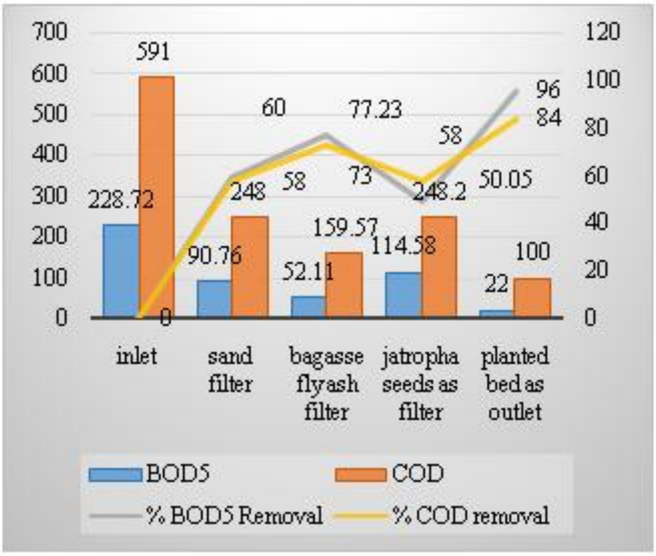

Figure 5: Variation in BOD by using bagasse and Jatropha seeds as filtering media

The correlation graph shows the variation of BOD and COD for sewage sample collected at Uthrathia Lucknow. All the

$BOD_{5\ MG/L}$	University Sewage	Uthrathia Sewage
Inlet	183.2	229.5
Slow Sand Filter	68.3	82.62
Bagasse Fly Ash	not used	52.6
Jatropha Seeds	not used	114.8
Planted Bed Filter As Outlet	26.2	22

Rise and fall in the values of BOD and COD can be seen with change in different parameters like filter materials, anaerobic conditions etc. The maximum removal of pollution is found to be maximum in the case of bagasse fly ash which has high trapping efficiency as compared to the sand and Jatropha filtering media.

5. Conclusion

On the basis of the study done on waste water generation and treatment it is observed that a large amount of water is exploited and as a result of which there is imbalance in the ecological cycle, scarcity of water and poor conditions of river and natural bodies. The water which is dumped untreated into the natural bodies like river, lakes, ponds etc. tends to deteriorate the quality of the fresh water disturbing the aquatic system. Even after there is huge amount of capital investment the sewage treatment plants are not running to their full efficiencies due to various miscellaneous reasons. It is therefore required to bring an alternative option for the above stated problem so that sustainable solution can be implemented and administered.

The efficiency of decentralized waste water treatment plant is observed as high as 96% and it is therefore required to install DEWATS plants at small level as well as at large institutional level, such as governmental and industrial areas. For preventing the over exploitation of fresh water these plants are proved to be very efficient, the idea of DEWATS should be advertised by governmental and non-governmental organizations through various plans and schemes so that its efficacy can be understood by local people.

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