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Wastewater Treatment in Rural Area by Using Agriculture Wastes

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***Abstract*: Waste products from agricultural sectors have been recognized as a sustainable solution for wastewater treatment. They not only helps in achieving the removal of pollutants from wastewater but also contribute to the waste minimization, recovery and reuse. Wastewater treatment using agricultural waste materials (corncobs, corncob charcoal, sugarcane bagasse, soil and aggregates) in the form of multilayer media for Khodala village was investigated. The removal of Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and pH were evaluated for the multilayer wastewater treatment system. The treated wastewater can be used for irrigation and horticulture instead of directly discharging it on land.**

***Keywords*: Agricultural waste and aggregates, Multilayer media, Reuse, Wastewater treatment.**

1. Introduction

Study of water bodies reveal that the major source of pollution is the discharge of sewage [2]. Improper disposal of wastewater onto land can result in loss of ecosystem productivity (e.g. due to salinization) and pollution of groundwater resources. Human activities affect quality and quantity of existing fresh water resources. Consequently, water resources continue to deteriorate. Conventional wastewater treatment technologies as adopted in the industrialized nations are expensive to build, operate and maintain. Natural systems like constructed wetlands work as an integral part of the surrounding environment to provide tertiary treatment [9]. Similarly, land treatment provides only tertiary treatment [6,14].

As a society, we produce many types of waste in different sectors, which can be broadly classified into three categories: agricultural, industrial, and domestic waste. In agricultural sector, wastes are generated at production, post-harvest and processing stages [10]. It is also important to maintain environmental and economic benefits while investigating material recovery concepts [3]. Therefore, either disposal or use must be considered to ensure an economical design approach. These waste materials are of no use but they play the role of good adsorbents which gives them importance for wastewater treatment in different ways.

Recently, low cost materials, including rice husk, maple sawdust, soya cake, coal ash, peat and bone char, have been investigated as adsorbents for wastewater treatment [4], [5], [8], [11]. Although there has been research on the use of these materials, it has been limited to single medium and very less information is available on multilayer medium.

In present study, wastewater treatment with multilayer media comprised of waste materials like corncobs, corncob charcoal, slag, sugarcane bagasse, naturally available soil and aggregates were investigated.

2. Materials and Methods

A. Survey of wastes and wastewater discharging sites

The Gram Panchayat officials were informally interviewed to study the existing agricultural waste generation and disposal technique, current wastewater discharging sites and drawbacks were noted. Corn and sugarcane are the major crops taken by villagers and types of wastes generated is based on their harvesting. Corncobs, sugarcane bagasse, soil and aggregates required for study are collected from the farms. There are two main outfall sites present for wastewater disposal in the village from where the samples are collected for the analysis. The site consists of wastewater originating only from domestic activities.

B. Laboratory sample analysis

The collected wastewater samples from the site were brought to institute for their analysis. Parameters like BOD, COD and pH were investigated so as to provide feasible solution for wastewater reuse and disposal. The average concentrations of these parameters at two different site locations are calculated as follows:

Table 1
Wastewater parameters before treatment

S. No.	Wastewater Parameters	Site Sample 1	Site Sample 2
1	COD (mg/lit)	273.39	292.92
2	BOD (mg/lit)	100.39	112.33
3	pH	7.3	7.1

C. Media preparations

The corncobs used in this study were collected from village. Their average moisture content was 8.71%. The corncobs were firstly washed with tap water and dried in an oven at 100 °C for 2 hours. The dried corncob was then crushed and sieved to a

size of 15 - 20 mm. The corncob biochar BCC was prepared by heating it under slow pyrolysis at 400°C for 2 hours in a muffle furnace [15]. These two are the main media which work as adsorbent and activated carbon in wastewater treatment. Soil samples were taken randomly and bulk samples were extracted from two levels: one at 0–10 cm and other at 20–30 cm. Samples were air dried and mixed in equal proportion to obtain homogenous sample [13]. Soil samples were then subsampled. Air-dried soil was then passed through 2 mm sieve. Aggregates of size approximately 8 mm to 10 mm are taken for filter so as to work as a supporting media.

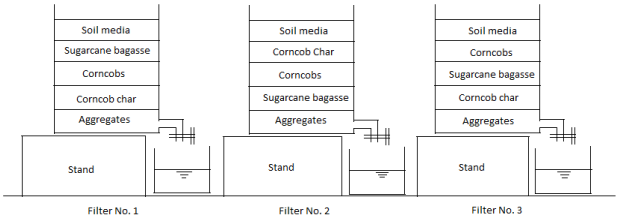

Fig. 1. Layout of multilayered filters showing different combinations of media

For filters, Initial weight of corncobs is W1 = 80.00 gm

Final weight of corncobs after oven dry process is W2 = 60.00 gm

Hence moisture content (mc) is found out as,

$$Mc = W1 - W2 / W2$$

$= 80.00 - 60.00 / 60.00 = 33.33$ %

Weight of corncob charcoal is Wc = 25.00 gm

Initial weight of aggregates is Wa1 = 410.00 gm

Final weight of aggregates after oven dry process is Wa2 = 400.00 gm

Hence moisture content (mc) is found out as,

$$Mc = W1 - W2 / W2$$

$= 410.00 - 400.00/400.00 = 2.50$ %

All these prepared media are arranged approximately in equal proportions by volume and fed into the tanks. The principle behind this study is based on trickling filter mechanism. The fundamental mechanism for the treatment in the present work is filtration and physical adsorption.

The efficient removal of COD by charcoal may be attributable to the effective adsorption of organic substances onto the large surface of the charcoal materials and the affinity between organic carbon and the surface carbon. In the multilayer treatment, each medium acts effectively for the removal of pollutants in wastewater and BOD is removed by corncobs. pH of the sample is lowered because corncob charcoal plays the role of activated carbon which turns alkaline sample into slightly acidic condition.

Reduction of Suspended Solids (SS) plays a significant role in modern wastewater treatment, since the SS serves as an adsorbent for heavy metals and polychlorinated biphenyls (PCBs) [12]. Suspended Solids were removed by filtration and settling. The bed is then left to rest for regeneration for 10–16 hours (drying cycle) prior to next cycle of use [13].

D. Filter Dimensions

The amount of water required per capita as per IS 1172:1993 is 135 lpcd. Out of this, 75 – 80 % of water is converted into wastewater due to daily human activities.

Hence amount of wastewater per capita is, 0.80 x 135 = 108 lpcd.

As this amount of wastewater is flowing, certain additions and losses occurs in the form of evaporation, spreading on nearby area, etc.

Assuming 10 – 15% reduction in amount of wastewater, i.e. 0.15 x 108 = 16.2 lpcd. Hence, net amount of wastewater generated is 108 – 16.2 = 91.8 lpcd.

As per information given by the Panchyat officials, Khodala's population is nearly 3178. On an average there were four number of persons in a family.

Hence total amount of wastewater generated is 91.8 x 4 = 367.2 lit/day.

Now, the height of tank is assumed to be 1 m and its sides are also assumed as 1 m each.

Thus, volume of tank is 1 cum or 1000 lit.

From this it is understood that one family can use it twice in a day.

E. Working of Filters

Initially the outlet of the filter is kept closed and wastewater is passed over the filters at the rate of 100 ml/min. During this time, the water percolates through the filter media but remains retained on the filter. To enable this, the hydraulic retention time is kept at 2 hrs. Once the outlet is open, the effluent water is collected in a tank and is recirculated through the filter media again to improve the water quality. The water is then recirculated till desired quality is achieved.

3. Results and Discussions

The effluent water is tested for COD, BOD and pH before being discharged. Following are the results obtained in COD, BOD and pH test respectively.

Table 2
Removal of COD from wastewater with multilayered media treatment

S.No.	Filter No.	Sample No.	Influent COD (mg/lit)	Effluent COD (mg/lit)	Percent reduction in COD
1	1	1	273.39	234.34	14.28
		2	292.92	253.86	13.34
2	2	1	273.39	214.81	21.43
		2	292.92	234.34	19.99
3	3	1	273.39	253.86	07.14
		2	292.92	273.38	6.67

From above experimental analysis it was seen that the second filter (soil media, corncob charcoal, corncobs, sugarcane baggase and aggregates) gives better result as compared to other two filters. The suggested wastewater treatment system is easy to construct and handle as well as economical when compared

to other conventional treatment units. It is feasible to treat wastewater rather than discharging it freely on land, which reduces the impact of waste on surrounding environment. There are some disadvantages as well such as the treated water has to be recirculated till desired quality is achieved. Also, it is necessary to change the media after two to three times of its use to avoid odour problems.

Table 3
Removal of BOD from wastewater with multilayered media treatment

S.No.	Filter No.	Sample No.	Influent BOD (mg/lit)	Effluent BOD (mg/lit)	Percent reduction in BOD
1	1	1	100.39	93.67	09.83
		2	112.34	103.00	08.28
2	2	1	100.39	88.00	12.26
		2	112.34	96.34	13.96
3	3	1	100.39	93.00	07.01
		2	112.34	102.00	09.08

Table 4
Reduction in value of pH from wastewater with multilayered media treatment

S.No.	Filter No.	Sample No.	Vol. of sample (ml)	Initial pH	Final pH	Percent reduction in pH
1	1	1	100	7.3	7.1	2.74
		2	100	7.1	7.0	1.41
2	2	1	100	7.3	7.1	2.74
		2	100	7.1	6.9	2.82
3	3	1	100	7.3	7.1	2.74
		2	100	7.1	7.1	0.00

4. Conclusion

Wastewater treatment with multilayer media using waste materials such as corncobs, corncob charcoal, sugarcane bagasse, natural soil and aggregates was investigated for the removal of COD, BOD and pH. Following are the conclusions based on this study.

1. The main components and media required for the construction of multi-layered filter are easily available in the villages. Hence, the filter is easy to construct.
2. The main filter media materials are waste products of agricultural activities which have no economic value but are very good adsorbents. Hence, the construction of proposed filter is economical.
3. As disposal of agricultural wastes is easy, this filter plays an active role to treat the discharged wastewater and its use for different purpose.
4. Based on the results obtained, construction of type - 2 filter will give good results for a contact time of 120 min.
5. However, high rate of recirculation is required and hence the process becomes time consuming.
6. As reduction in wastewater parameters is comparatively less, hence this treated water is used for irrigation and horticulture purpose only.

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