Global Journal of human-social science: H Interdisciplinary
Volume 15 Issue 2 Version 1.0 Year 2015
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-460X & Print ISSN: 0975-587X

Performance Study of Filler Materials Used in Anaerobic Baffled Reactor

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GJHSS-H Classification: *FOR Code: 090499*

Strictly as per the compliance and regulations of:

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I. Introduction

In an Anaerobic Baffled Reactor (ABR) a series of baffles is used under which the waste water is forced to flow. The general tradition of treating wastewater is mainly sanitation purpose commonly sewage by septic tank. Anaerobic Baffled Reactor has been recently introduced in low income country like Bangladesh, mainly introduced to village for better performance in treating sewage. Due to the lack of centralized sanitation, residents of rural areas have little capacity to invest in infrastructure and a lack of technical understanding to drive implementation (Tonetti et al. 2012),wherean Aerobic Baffled Reactor (ABR) is working as an improved septic tank having filler materials facilities as a filter medium. Different materials have been studied to replace traditional materials such as crushed stone, gravel, coconut shells & ceramic bricks (Tonettiet al.2011, Chernicharo et al. 2006).Such filler materials are widely available and cheap in many countries, especially in developing countries like India, Bangladesh, Philippines, Sri Lanka, and Thailand etc.

In developing countries a large portion of their waste is discarded in local bodies of surface water or surface soil. During the dry season water is scarce in most of the areas in Bangladesh. Sometimes cultivation is hampered due to scarcity of water. Moreover the groundwater table is undergoing day by day due to very frequent use of groundwater. To overcome the consequences of water scarcity, the concept of wastewater reuse may be a solution besides rainwater harvesting and other conservation methods. It has been estimated that water savings in the range of 18%-29% for an average household could be achieved by reusing drainage water (Lechte, 1992). In this sense, reuse of kitchen wastewater should be a good trend for cultivation. Kitchen wastewater contains a large amount of oil and grease, detergent or soaps. In most cases household kitchen waste water is deposited as untreated to the open drain which occurs contamination of surface water such as canal water or river water and increases the volume of waste water. In the municipal area like Dhaka metropolitan city kitchen waste water is directly disposed to sewerage line, so it increases the volumetric pollution only. So, initially making a treatment to the kitchen wastewater which is less polluted can fulfill purposes like irrigation, road wash etc. For improving better performances of Anaerobic Baffled Reactor filler materials as a filter medium has been introduced in this study.

In this limited study the Aerobic Baffled Reactor (ABR) with filler medium is introduced is case of kitchen waste water. Four different types of filler materials have been used here. Selected parameters were measured to check out the water quality before and after filtration through filter medium. The best fit filler material was evaluated on the basis of laboratory analysis. It is found that each filler material is separately effective for the treatment of particular warer parameter.

II. Study Area

The study area is the residential student hall named 'Amar Ekhusey Hall, Khulna University of Engineering & Technology (KUET)' which is located at khulna, Bangladesh, South Asia.

III. Methodology

a) Water sources to be treat with ABR

In this study, kitchen wastewater was used to treat with ABR model.

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b) Materials selection for filler materials

The filler materials were selected on the basis of low cost, locally availability and which can be easily affordable by the household owners. Four types of filler materials were selected in this study. They are-

i. Sand
   a) Fine sand (Local sand/ Kustia sand)
   b) Coarse sand Sylhet sand)
ii. Brick Khoa (aggregate)
iii. Stone Chips
iv. Coconut Shell

c) Methodologyadopted

Four small model of Anaerobic Baffled Reactor (ABR) each contains 2.5 liters of waste water were made with plastic container to perform the study and completed it with proper placement of filler materials and sample water. Given flow chart will be the best description of study strategy-

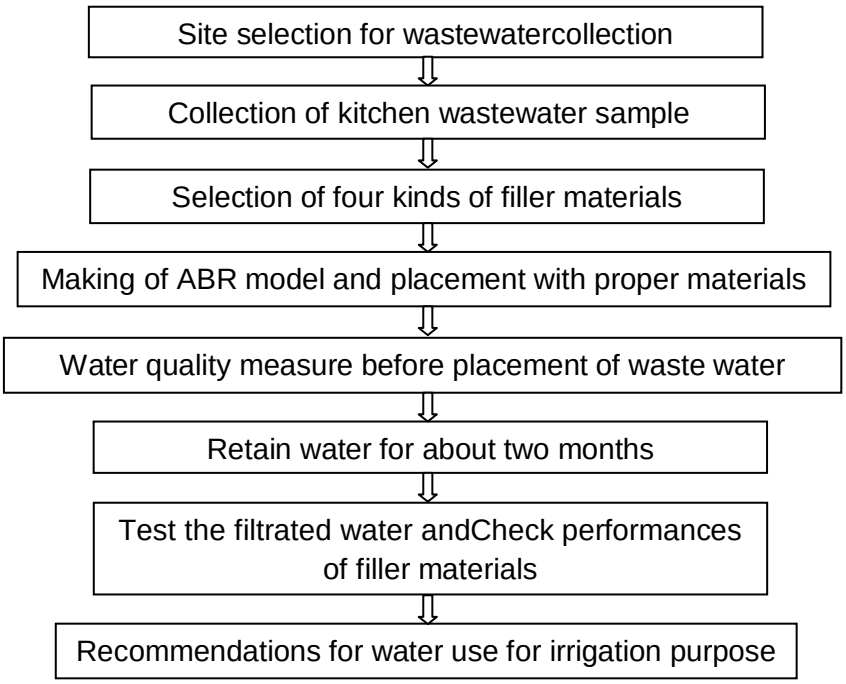

Figure 1 : Schematic diagram of ABR model

d) ABR model preparation

In this research, four ABR model was built with available plastic water bottle. Porous tin sheet was used here to retain filling materials above it; being porous, it is capable to pass water through it. The materials were about 50 mm in thickness.

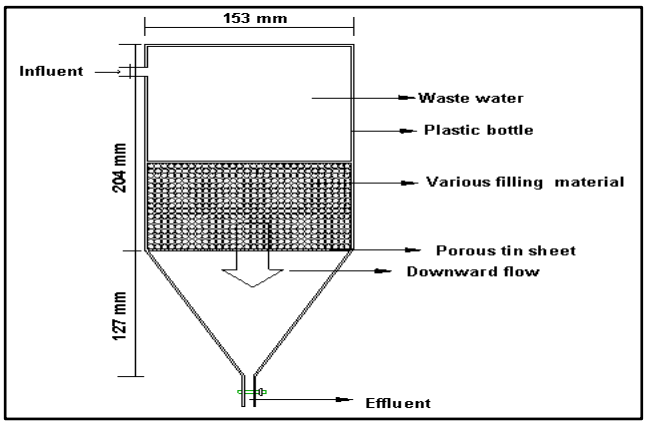

Figure 2 : Schematic diagram of ABR model

Perforated tin sheet was galvanized but its cover condition was as semi galvanized. The sheet was circular and its diameter was slightly less than diameter of ABR model.For sand fillerover perforated sheet a piece of permeable layer was used. Here, water was to retain for only two months, so a piece of clean cloth was used here.But it is recommended to use permeable synthetic polymer as permeable layer.

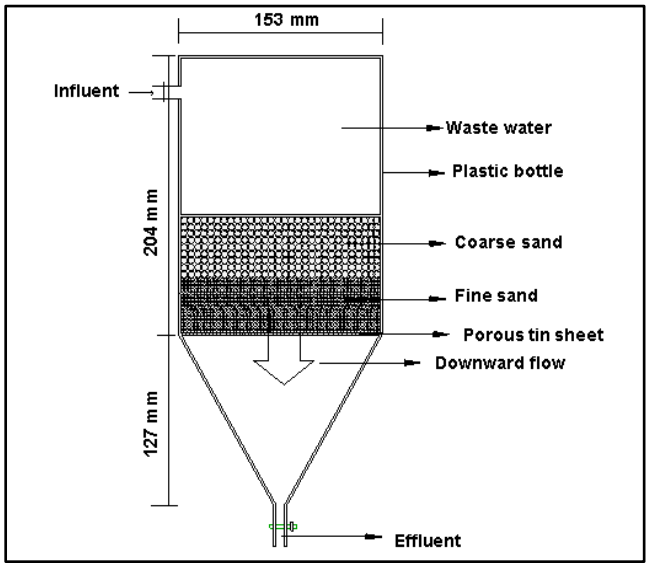

Figure 3 : Schematic diagram of ABR model for sand filter only

Figure 4 : After placing sample water andmaking anaerobic conditiononly

e) Placement of ABR model

In this study, the gravity flow is used as water flow to retain. So ABR model had been placed as upside-down. So, retaining holders was made.

Because of limitation, retaining time for water was kept for about two months.

f) Laboratory Analysis

Standard Methods for the Examination of Water and Wastewater (APHA, 1998) was followed for the analyses of all the physical parameters.

Figure 5 : Pre-placement of ABR modelsin holders

IV. Result and Discussion

Table 1 : The properties of raw and filtrated water

Parameters	Unit	Before Fitration	After filtration using filter materials			
			sand	coconut shell	stone	brick
Total Coliform (TC)	nos/ml	1300	130	320	300	250
Faecal Coliform (FC)	nos/ml	110	10	16	8	8
pH	-	7.05	7.27	6.98	7.59	6.98
Turbidity	NTU	500	308	90	149	102

Tolal Solid (TS)	mg/L	464	393	303	320	231
Dissolved Solid(DS)	mg/L	435	270	12	276	198
Suspended Solid(SS)	mg/L	29	123	291	180	33
BOD_5	mg/L	2.33	1.77	1.35	1.45	2.11
COD	mg/L	46	16	28	28	45
CO_2	mg/L	55	27	44	21	10
Iron	mg/L	.1	.48	.85	.33	.70
Alkanility	mg/L	300	160	240	160	250
Color	pt-Co	425	305	202	225	100
Hardness	mg/L	1598	385	487	412	204
Chloride(Cl-)	mg/L	1400	1150	1205	1345	893

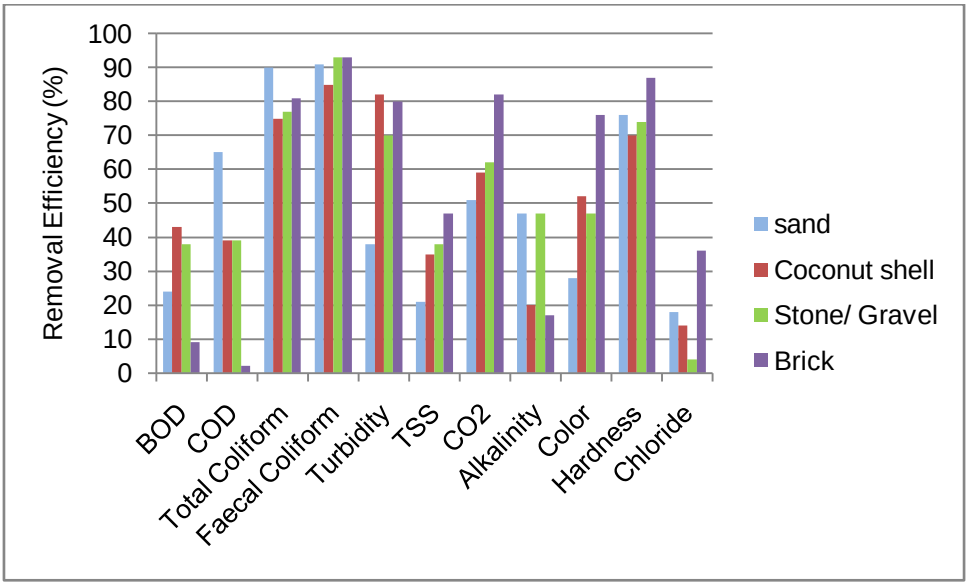

Figure 6 : Removal efficiency of filler materials

TC removal efficiency is 90%. If we convert the 1 ml test result to 10 ml or 100 ml test results then it is inferred that, the TC doesn't remove up to desire rate. This pathogenous water can't be used for drinking purpose at all and another treatment process is necessary to use it for irrigation purpose or disposal to canal or river as it cause no harm to fish or watery animal. In case of pH all the values satisfies the standard limit for drinking and irrigation purpose both. From the performance of the test turbidity doesn't satisfy the goal after treatment. Coconut shell filler had shown better removal of turbidity than others. To remove turbidity should use alum as treatment. Alum helps to remove soap and turbidity. Brick as filler showed best result for SS. The result for brick khoa filler and stone filler were within permissible limit but sand filter exceed slightly limiting value and coconut shell exceeds highly. For total dissolved solid (TDS), the larger dissolved particles is trapped in the pores of the filter media, thus reduce the dissolved solids. It was also observed that the TDS removed mostly by the sand filter media.BOD5 removal efficiency is best 43% sowed by coconut shell filter. BOD removed in filter significantly, because the large chain of the organic matter cannot pass through the small pore of the aggregate and also adsorbed in the filter media. BOD value is within range for irrigation purposes.COD mostly (65%) removed in sand filter significantly, because the large chain of the organic matter cannot pass through the small pore of the aggregate and also adsorbed in the filter media. In case of CO2 brick filler materials showed better performance than other filler materials. It removed about 82% CO2 where coconut shell filler showed only 20%.Here, iron is increased in a huge range. This is occurred due to use semi galvanized perforated tin sheet. Tin made reaction with wastewater with oxygen gas produced by bacterial activity and amount of iron in wastewater is increased. So, it is recommended not to use tin sheet. And for this sample water secondary treatment is necessary. Alkalinity removed for sand filter, coconut shell, stone chips and brick are 47%, 20%, 47% and 17% respectively. The color removal efficiency is better for brick filler. There are several causes behind the color removal. These are the adsorption in the brick chips, reduction of the organic matter, reduction of dissolved solids and mechanical staining that remove colloidal particles and removed color. All four filler showed significant removal of hardness. Brick khoa filler showed

better removal efficiency than others because it has absorption capacity. On the other hand chlorine removal rate is low.

V. Proposed Anaerobic Baffled Reactor (ABR)

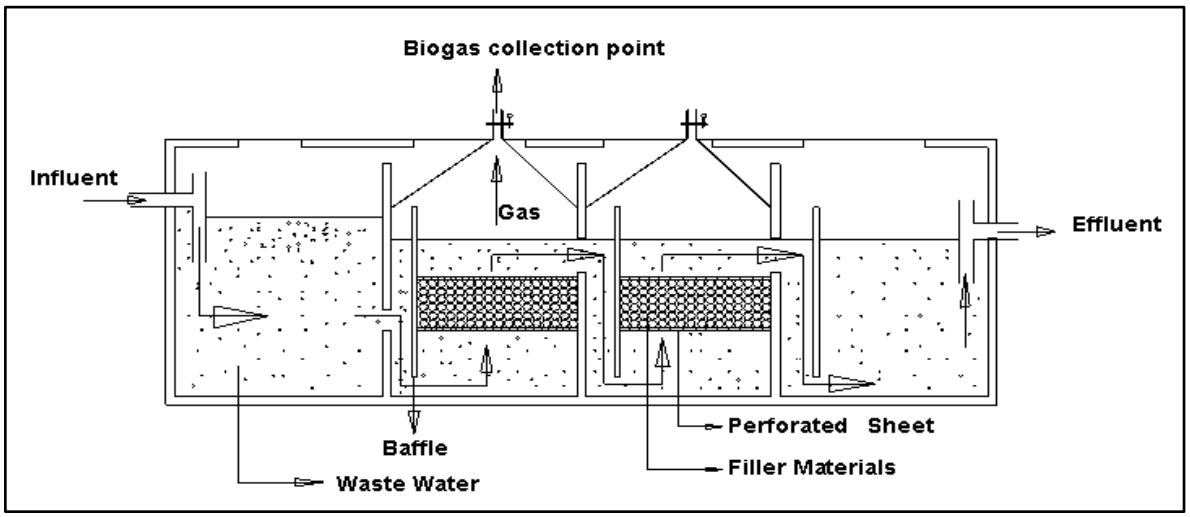

Figure 7 : Schematic diagram of proposed ABR

VI. Conclusion

In case of BOD removal coconut shell possess better result where sand filler is better for COD removal. Brick khoa shows better results for color, hardness and CO2 removal. However each filler materials shows different result for different tests. So, it is difficult to say which is better for use. But if furthur treatment can be initiated then water can be easily be used for irrigation purpose, gardening water, urinal flushing etc. It is verified from the study that ABR with a portion of filler materials even if it is sand filler, can perform better than without filler materials.

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