Domestic Wastewater Treatment by Low-Cost Natural Adsorbents

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Abstract— Water is one of the most important elements involved in the creation and development of healthy life. As demand for water increased whiles the water resources is limited, there is a growing awareness to treat the domestic waste water and make more efficient use of the domestic waste water. The conventional methods for treating waste water are expensive. Consequently, the search for contrarily but effective, efficient and economic methods has been on the increase in recent times. Thus, the use of biomaterials, such as agricultural waste as adsorbents for organic and metal ions is being exploited due to their availability and low cost. Filtration technology is the simplest and low cost treatment technology based on the principle of attached growth process. Multimedia Filters represent a significant improvement over single media filters. A multimedia filter model was developed by G.I. sheet for treatment of domestic wastewater. Different packing media are used such as Activated carbon, sugarcane bagasse, Rice husk, Sand and Grass mulch. The waste water samples were physio-chemcially characterized before and after treatment according to standard procedure using these adsorbents. The results obtained from the various pollution indicators show an appreciable improvement on the quality of the water. The pH value changed from 7.9 to 7.1, the colour changed from soapy and cloudy to colourless, Turbidity was reduced from 163.7 to 28.3NTU while the biochemical oxygen demand BOD was reduced from 117mg/l to 69.3mg/l and chemical oxygen demand COD was reduced from 232mg/l to 115.7mg/l. This paper intense to provide an overall vision of multimedia filter technology an alternative and conventional method for treating waste water. Treated water use for Irrigation, toilet flushing, car washing, gardening, firefighting, etc.

Key words: Activated Carbon, Sugarcane Bagasse, Rice Husk, Domestic Wastewater and Multimedia Filter

I. INTRODUCTION

Waste water pollution is one of the serious problems that the world is facing in this era. In India, major problem leading to waste water pollution is increasing population, industrialization and urbanization. Collection, treatment and disposal of domestic and industrial Waste water are the serious issues to be handled for preventing damage to the environment. A 2007 study finds that discharge of untreated sewage is single most important cause for pollution of surface and ground water in India. Besides that, the purpose of wastewater treatment is to remove pollutants that can harm the aquatic environment if they are discharged into it. Wastewater generated in these areas normally traditional waste water treatment plant includes processes like primary sedimentation, aeration, secondary treatment and chlorination. This form of treatment plants requires high initial investment. Moreover their maintenance cost is high and treatment plant requires large land area. For the functioning and proper maintenance of the plant skilled labors are required. Overall the treatment plants are costly affair and results are not up to the mark. The main objective of this study is to develop cost effective treatment technology for waste water treatment.

Wastewater treatment may include mechanical, biological, and physical-chemical methods. Selection of a wastewater treatment method depends on pollutant origin. One wastewater treatment using physical-chemical methods is adsorption, which has the advantages of being fast, cheap, and universal. For removing organic pollutants from water, different low-cost materials are used as adsorbents, including agricultural products, industrial wastes, and activated carbon.

Besides that, the purpose of wastewater treatment is to remove pollutants that can harm the aquatic environment if they are discharged into it. Because of the deleterious effects of low dissolved oxygen concentrations on aquatics life, wastewater treatment focused on the removal of pollutant that would deplete the DO in receiving water. Filtration is one of the oldest and simplest methods of removing those contaminants. Generally, filtration methods include slow sand and rapid sand filtration. Reliable operation for sand filtration is possible when the raw water has low turbidity and low suspended solids. For this reason, when surface waters are highly turbid, ordinary sand filters could not be used effectively. Therefore, the roughing filters are used as pretreatment systems prior to sand filtration. Furthermore, roughing filters could reduce organic matters from wastewater. Therefore, roughing filters can be used to polish wastewater before it is discharged to the environment.

In general domestic waste water includes black water (fecal sewage) and grey water (wash water from dishwashers, washing machines sinks and bath tubs etc.). Black water accounts 32.5% of domestic waste water while grey water accounts for 67.5%. Domestic waste water is categorized as organic pollutant.

The main advantage of filtration process is that they maintain high concentration of microorganism resulting in high removal rate. Filtration technology is a low-cost treatment technology based on physical process to treat wastewater contaminants like colour, odour, hardness, BOD, COD and suspended solid etc. for a wide range of application in domestic as well as industrial application research on alternate filtration media has expanded the options available for improving excellent quality. The low cost filter is a household point-of-use water treatment system, and has been identified as a sustainable and suitable water treatment technology in rural remote areas in developing countries. It is a modified intermittently operated sand filter capable of filtering pathogens, suspended solids and decreasing turbidity levels through physical, physio-chemical and biological processes.

II. PRACTICAL EXPERIENCES OF THE RELATED WORK

A. Simonis in (2012)

Studied the manufacturing a low-cost ceramic water filter and filter system for the elimination of common pathogenic bacteria and suspended solids**.** A micro porous ceramic water filter in which clay was mixed with rice husk in a ration 2:1 by weight and a cylindrical shaped filter was manufactured by tradition oven drying and then burning in kiln at specified sintering temperature. After being coated with silver nitrate solution for preventing the growth of microbes, the filter was tested for removal of suspended solids and pathogens.

B. Hamid Sarkheil, Javad Tavakoli, Reza Behnood (2014)

Oil by-Product Removal from Aqueous Solution using Sugarcane Bagasse as Absorbent. International Journal of Emerging Science and Engineering (IJESE) ISSN: 2319–6378, Volume-2 Issue-9, July.

C. Hussam and Munir, Huqetal, Bangladesh (2010)

Reported that a two-bucket system filter (one bucket filled with coarse and fine sand and the other with wood charcoal and brick chips) produced arsenic-free safe drinking water approved by the Bangladesh Government.

D. Rehman et al. (2012)

Aimed towards designing and construction of efficient plastic media-trickling filter (TF) for the treatment of domestic wastewater. A shower rose was used as wastewater distribution system supported on the top of stone media bed. A net distance between the bottom of shower rose and top of filter bed surface was 9 inches. It was run under different treatment times (12, 24, 36 and 48 hrs) at 5-15ºC. After 48 hrs HRT, treated wastewater was then passed through SF. Parameters like COD, BOD5, TSS, turbidity, NO_3, NO_2, SO_4, PO_4 and pathogenic indicator microbes were monitored after treatment of 12, 24, 36 and 48hrs. Maximum efficiency of TF was observed after 48 hrs treatment viz. 93.45, 93, 86.25, 57.8, 63.15, 25, 32.43, 99.95 and 86.3% reduction from the zero time value for BOD5, COD, TSS, PO_4, SO_4, NO_3, NO_2, turbidity and fecal coliforms respectively. Finally 48 hrs treated sample was passed through sand filter (SF) for further final polishing and approximately, 95.72, 95, 100, 73.5, 65.8, 58.3, 37.83, 100 and 91.5% reduction in BOD5, COD, TSS, PO_4, SO_4, NO_3, NO_2, turbidity and fecal coliforms was observed. This study showed that plastic media-trickling filter along with sand filter is a promising technology for wastewater treatment and can be scaled up for small communities in the developing countries.

*E. Milan. M. Lakdawala*1 and Yogesh. S. Patel (2009)*

The effect of low cost material Bagasse Fly ash to the removal of COD Contributing component of combined waste water of Sugar Industry. The study aimed towards to minimize the industrial pollution, advanced wastewater treatment techniques, such as adsorption, are economically and environmentally essential in the removal of organic and inorganic compounds from industrial wastewater. The present study focuses on the use of low cost adsorbent sugarcane bagasse fly ash to adsorb COD content of the combined wastewater of sugar industry. Bagasse Fly ash with specific surface area of 2637.784cm2/gm is used as a clarifier to the combined waste water of Sugar mill at room temperature. The different dosage of bagasse fly ash is kept in contact for 24 hours and analyzed before and after treatment. The results of COD removal is up to 27.04% and is follow the Freundlich and Langmuir adsorption isotherm.

F. Dr. Ravindra Gaikwad Pravara (2007)

Rural Engineering College Loni Removal of Dyes from Dye Effluent by Using Sugarcane Bagasse Ash as an Adsorbent. Sugar cane bagasse ash, an agricultural by-product, acts as an effective adsorbent for the removal of dyes from aqueous solution. Batch adsorption study was investigated for the removal of Acid Orange-II from aqueous solution. Adsorbents are very efficient in decolorized diluted solution. The effects of bed depth on breakthrough curve, effects of flow rate on breakthrough curve were investigated. The removal of dyes at different flow rate (contact time),bed height, initial dye concentration, column diameter, pH &temperature by Sugarcane Bagasse Ash as an adsorbent has been studied. It is found that percent adsorption of dyes increases by decreasing flow rate from 2 lit/hr to 1 lit/hr, by increasing bed height from 15cm to 45cm, by decreasing initial conc.150mg/lit to 100mg/lit, by increasing column diameter from 2.54cm to 3.5cm,by maintaining neutral pH& at temperature 450C than 25ºC & 35ºC.The result shows that, bagasse ash is a good adsorbent for dye effluent treatment.

G. Sarkheil, JavadTavakoli, Reza Behnood (2014)

Oil by-Product Removal from Aqueous Solution using Sugarcane Bagasse as Absorbent. International Journal of Emerging Science and Engineering (IJESE)ISSN: 2319–6378, Volume-2 Issue-9.

H. Rasima Abdul Rasid (2011)

Department of Chemical and Process Engineering, Faculty of Engineering Universiti Kebangsaan Malaysia (UKM) Biofilm and Multimedia Filtration for Rainwater Treatment Based on the results of this study, it has shown that the biofilm and multimedia filters are effective, since the filtration media combine the filtration properties of several materials. It has shown in the results that with a biofilm attached to the GAC surface which consists of bacteria held in an excreted polysaccharide coating, the uptake rate and quantity of metal ions extracted from the samples can be significantly increased. This system is ideally suit from economic point of view for locations being a low cost technology requiring low initial expenditure, zero power need, no maintenance cost and self-dependent operation even for areas where there is normal seasonal rains.

III. AIMS AND OBJECTIVES

The aim of the study toward the designing the Low-cost sand filter model and treatment of sample by filtration process using low-cost natural adsorbents and study the performance of multimedia filter with different packing media such as Activated carbon, sugarcane bagasse, Rice Husk sand and grass mulch was the objective of the experimental study. The removal efficiency of physic-chemical parameters was studied. Treated water use for Irrigation, toilet flushing, car washing, gardening, firefighting, etc.

IV. EXPERIMENTAL WORK

A. Materials and Methods:

1) Collection of Adsorbents:
The adsorbent used for this study are Activated Carbon, Sugarcane bagasse, Rice Husk, Sand and Grass mulch and was collected from the local market.

B. Preparation of Adsorbent:

1) Adsorbent of Sugarcane Bagasse (SB):
The sugar cane bagasse was soaked in 0.1 M HCl solution for 18 hours and then washed with distilled water to ensure complete removal of all the dirt particles, lignin and coloring materials present. After that the Bagasse was dried in oven at 120-130°C.

2) Adsorbent of Rice Husk (RH):
The rice husk was washed with distilled water to ensure complete removal of all the dirt particles after that the rice husk was dried in sunlight and grinded with home mixer.

3) Adsorbent of Activated Carbon (AC):
The activated carbon was collected from the market.

4) Adsorbent of Grass Mulch:
The grass mulch was collected from the market and washed prior before and used as screening in this filter.

Fig. 1: Sugarcane Bagasse

Fig. 2: Rice Husk

Fig. 3: Activated Carbon

Fig. 4: Grass Mulch

C. Sand Filter Design:

1) Filtration Model:
The multimedia filter of GI sheet was designed for a family and then developed. The filtration tank was constructed from metal plate precisely gauge 22. The rectangular filtration tank is 1 m high, 0.3 m long and 0.3 m wide as shown in Figure. The tank has a compartment of the filter medium where various filtering materials were placed.

2) Analysis and Working of Model:
The domestic wastewater was collected from local drainage system. The wastewater from inlet tank enters the inlet chamber and flows in sequence. The compartments were packed with Sugarcane Bagasse, Rice Husk, Activated Carbon, Sand and Grass mulch in down flow regime respectively. The wastewater was collected in the collecting chamber with chlorination and after reaching the outlet level the treated effluent was collected in the outlet tank.

V. RESULTS AND DISCUSSION

It was observed that those adsorbent materials such as Sugarcane bagasse, Rice Husk, Activated Carbon media may prove to be more efficient in improving the effluent quality in terms of its phsio-chemical content. It was also observed that the experimental filter model will significantly assist in the removal of BOD, COD, TSS, TDS, DO, Hardness, EC and will also improve the pH quality of the effluent. Hence, the results of present investigation that this filter will be found to be an effective adsorbent filter for the removal of impurities from the domestic waste water and the treated waste water use for Irrigation, toilet flushing, car washing, gardening, firefighting, etc. with proper maintenance and care.

A. Comparison of Parameters Before & After Filtration:

S. No	Parameters	Units	Before Filtration	After Filtration
1	Ph	------	7.9	7.1
2	Color	hazen	Soapy and Cloudy	Colourless
3	Odor	------	non offensive	non offensive
4	BOD	mg/l	117	69
5	COD	mg/l	232	115
6	DO	mg/l	2.9	2.1
7	Hardness	mg/l	286	113.9
8	Turbidity	NTU	163.7	28.3

9	TDS	mg/l	598	402
10	TSS	mg/l	113	47
11	Alkalinity	mg/l	112	43.7

Table 1: Comparison of Parameters Before & After Filtration

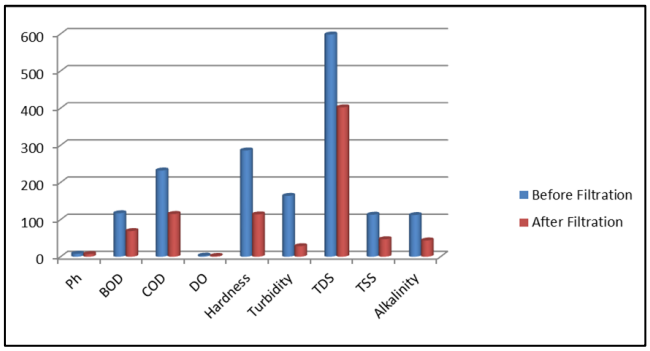

Fig. 5: Graph Before & After Filtration

VI. CONCLUSIONS

Based on the results of this study, it can be concluded that sugarcane bagasse and Rice Husk have good performance to adsorb of oil by-product from polluted water especially for high concentration of pollutant and the Multimedia Filter process had given an excellent results and significantly assist in the removal of Ph, TDS, BOD, COD, TSS, TDS, DO, hardness, and will improve the physio-chemical quality of the effluent. It can also be concluded from the study that the Multi – Media filter may be considered as efficient pre-treatment process for wastewater treatment. Also, the above media may enhance the performance of the treatment system. The study revealed that the system will performed well for the future need and has less cost of production and maintenance. This project will help to understand a new approach of an environmental friendly low cost filtration technique which can be used commonly in the every household. Hence, this technology is environment friendly and cost effective.

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