Treatment of Industrial Effluent with Coir pith and Charcoal Infused Soil Media

Aravind M. A and Rahna L

Abstract—. Disposal of industrial waste is one of the major problems for soil pollution. These pollutants can cause threat to both human and the environment. It also affects and alter the chemical and biological properties of soil as well the ground water. Depending on its source, the sewage may also contain a range of chemicals and specialized wastes including industrial chemicals. The effluent collected from one of the major Industries in Trivandrum was used for the study. This paper describes the potential of coir pith and charcoal in eliminating the harmful material from the industrial effluent along with different soil media. The column study was conducted by passing the effluent through coir pith, charcoal, rock sand and well graded soil in isolation and 10 % by total weight of rock sand and well graded soil is replaced by coir pith and charcoal. The quality and properties of the treated effluent water is tested and compared with the original. It has been shown that coir pith and charcoal absorbs the harmful contaminants present in the industrial effluent.

Index Terms— Industrial effluent, Coir pith, Charcoal, Rock sand, well graded soil.

I. INTRODUCTION

Rapid industrialization has led to the generation of enormous quantity of wastes. These industrial wastes, either solid or liquid pose severe disposal problems. Normally, these wastes are disposed on land and water bodies. As a result, land becomes unfit for any other activity. Severe would be the case where hazardous waste is disposed because the soil in the vicinity becomes environmentally unsafe for human activities. Alternative techniques have been developed in order to conserve the available land and water resources. This industrial waste must be treated before disposing into environment.Filtration is one of the water treatment processes to ensure water is safe from physical contamination. The present study is to find out the potential of rock sand and well graded soil as a bio filter with addition of natural materials like coconut coir pith and charcoal to reduce harmful contaminants in industrial waste. The focus of this study is to investigate the filtration efficiency of coir pith, charcoal, and rock sand and well graded soil in isolation and also rock sand and well graded soil with 10% of coir pith or charcoal. The parameters analyzed are pH, Conductivity, Biological Oxygen Demand (BOD) & Chemical Oxygen Demand (COD). The use of natural materials for filtration seems so effective and eco friendly. Studies have been reported on the use of natural materials as a filter media for the filtration of industrial waste water. Shilpa and Nimisha, (2014) has studied the sand filtration process by utilizing activated carbon (AC) derived from coconut shell. It is reported that finer grade activated carbon showed the maximum iron removal (95%). It also reported reduction in COD, BOD and to some extent turbidity compared to traditional sand filtration process. Azhar et al. (2011) carried out a study on a new composite adsorbent made from rice husk ash. Results indicate that the new composite adsorbent is able to absorb both ammonia and COD compared to commercially activated carbon. A study was reported by Siong et al. (2013) about the performance of activated carbon in water filtering system. In this paper, two types of granular activated carbon are used. Prototype is being made by using activated carbon and ultraviolet radiation system for water treatment. Surface area and porosity analysis is done on two activated carbons. The results obtained from the water analysis shows that one of the Granular activated carbon will reduce turbidity, total suspended solid, BOD and COD. However the ultraviolet radiation reduced the BOD and COD of the water.

II. II. OBJECTIVES

The main objectives of the study are;

- To study the effectiveness of coir pith in filtration characteristics in comparison to charcoal.
- To study the effectiveness of Rock sand and well graded soil in filtering industrial waste.
- To evaluate the effectiveness of Rock sand and well graded soil combined with charcoal and coir pith as a filter media for treating industrial waste.

III. III. EXPERIMENTAL STUDY

A. Materials used

a. Well graded soil

Well graded soil passing through 4.75mm sieve is used for the initial filtration process. The soil was collected from the campus of Rajadhani College of Engineering and Technology. Gradation curve of the well graded soil is shown in Figure 1.

b. Rock sand

Rock sand was collected from the campus of Rajadhani College of Engineering and Technology. Rock sand is of uniform sized particles of less than 600 micron.

Revised Manuscript Received on June 23, 2018.

Aravind M. A, PG Student, Department of Civil Engineering, Rajadhani Institute of Engineering and Technology, India.

Rahna L, PG Student, Department of Civil Engineering, Rajadhani Institute of Engineering and Technology, India.

c. Charcoal

Charcoal was selected as another suitable natural filter media for the filtration purpose. Charcoal is a highly porous and brittle material whose properties are determined by the condition of the carbonization processes. In this experiment, wooden charcoal is collected by burning wood pieces and crushed them with the help of wooden hammer. The crushed powdered charcoal passing through IS 4.75 mm sieve has been used for the experiment. The physical properties of charcoal are given in Table 1.

d. Coir pith

Coir pith finds better absorption characteristics and eco friendly. Coir pith has got a blackish brown color. It was collected from District Government Fertilizer store, Trivandrum. The physical properties of coir pith are presented in Table 2.

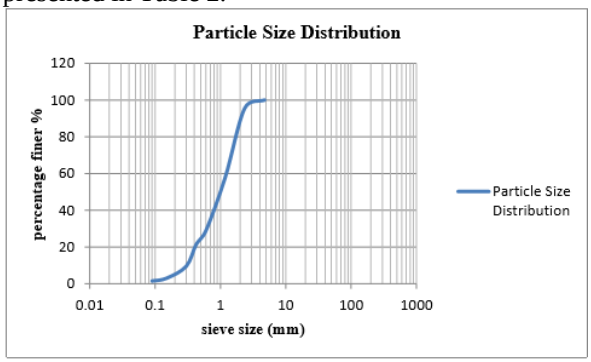

Fig. 1. Gradation curve of well graded soil

Table 1. Physical properties of Coir pith

Sl No.	Properties	Values
1	Appearance	Blackish brown
2	Moisture content	10.1-60.2 %
3	Particle size	0.098-0.925 mm
4	Porosity	0.623-0.862
5	Density	0.939-0.605 gm/cc

Table 2. Physical properties of Charcoal

Sl No	Property	Values
1	Colour	Dark black
2	Surface area/gm of Charcoal	500-1400 sqm
3	Density	0.2-0.6 t/m3

B. Methodology

A square column of 0.30 m x 0.30 m x 1.0 m with bottom enclosed using Perspex sheet (Acrolithic tube) was used as the experimental set up. Bottom face is provided with a number of 1cm holes in rectangular arrangement to provide drainage of waste water oozing out from filter media. The apparatus is fixed vertically in a stand with adequate support. A square piece of stitched blanket of coir fibre layer 0.30 m x 0.30 m and 1cm thick is inserted into bottom of tube to prevent runoff of filter media along with filtered industrial waste water. The coir layer is shown in Figure 2.

Fig 2.Stitched coir blanket

C. Tests performed

a.Test series 1

The tube is filled with a bed of rock sand or well graded soil up to 0.30 m and weighed accurately to maintain the density of fill. An additional layer of Perspex sheet with 1cm holes in rectangular arrangement is placed on top of rock sand/soil layer in order to distribute effluent or waste evenly throughout tube and to reduce disturbance in rock sand/soil while pouring waste into it. The assembly is shown in Figure 3.

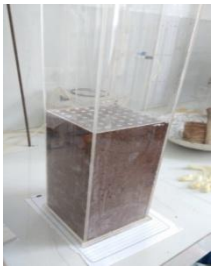

Fig.3.Filter media placed inside column

The industrial waste shown in Figure 5 is evenly poured into the filter column. The waste water coming out from the bottom of the column is collected (Figure 6) and transferred to fresh bottles (Figure 7). Later these samples were tested at the Laboratory of Pollution Control Board, Trivandrum.

b. Test series 2

Next series of filtration is conducted using rock sand/soil mixed with 10% of coir pith. The total weight of filter bed is kept constant. The volume of the bed is adjusted so as to keep the relative density of the filter media constant. The filter bed is initially soaked well to remove finer impurities. The layer of Perspex sheet was placed on top to distribute waste water evenly.

Fig.5. Industrial waste sample

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

Fig.6. Filtration and collection

Fig.7. Collected samples

c. Test series 3

In this series of experiment, the filter media consists of rock sand/soil mixed with 10% charcoal. Here also the relative density kept constant. The filtration took much more time than the previous two cases.

d. Test series 4

In this series of experiment the filter media consists of coir pith alone, as to know the efficiency of coir pith in isolation to absorb suspended particles from the waste water. The coir pith mainly constitutes of fine organic fibre particles which may supposed to absorb and retain finer particles from the waste water effectively. The coir pith alone consumes more time than the previous tests to get filtered because of the fine organic content.

e.Test series 5

This series of experiment was using wood charcoal powder in isolation to serve as filter media. This experiment is conducted to compare the effectiveness of charcoal in filtering the harmful contaminants from waste and efficiency of that compared with coir pith. This experiment took greater time in filtration compared to the previous experiments.

IV. IV. RESULTS AND DISCUSSION

The following parameters of the filtered sample were studied namely, Biological Oxygen Demand (BOD),Chemical Oxygen Demand (COD), pH and conductivity. The chemical testing are done at the pollution control board (PCB), TVM laboratories. The results from the chemical analyses of filtered water are discussed below.

A. pH TEST

All the leachate samples are tested to check the pH of each one with initial sample and are presented in Figures8 and 9 for rock sand and well graded soil respectively.

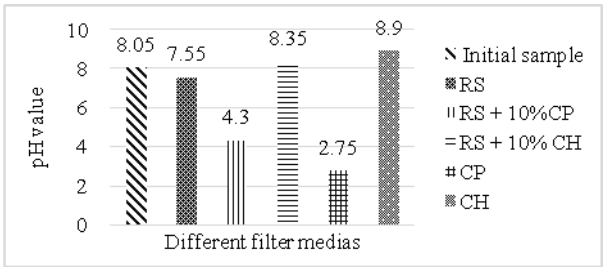

Fig. 8. Variation of pH in filtered water in rock sand media, coir pith and charcoal

The pH of the industrial waste was 8.05 which is alkaline. When the leachate is filtered through rock sand it comes down to 7.55, whereas in well graded soil it is 5.47. Rock sand brings the leachate much nearer to neutral condition. In the case of rock sand/soil along with coir pith and coir pith in isolation, the pH comes to acidic range. Since, charcoal being alkaline, addition of charcoal brought the sample to alkaline condition in rock sand, whereas in soil it comes near to neutral condition. Further treatments are needed to bring the sample to the neutral level.

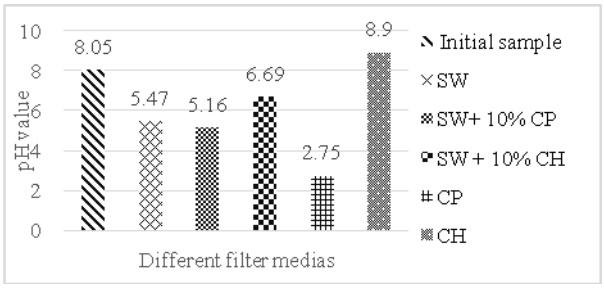

Fig. 9. Variation of pH in filtered water in well graded soil, coir pith and charcoal.

B. Conductivity test

Conductivity of a media/material measures the material's ability to conduct an electric current through it. The conductivity test results of leachate obtained from each sample are presented in Figures10 and 11 for rock sand and well graded soil respectively.

The conductivity of initial sample is very high. All the filter medias are effective in reducing the conductivity. Charcoal in-isolation or in combination with rock sand or well graded soil is more effective in reducing the conductivity than coir pith in-isolation or its combination.

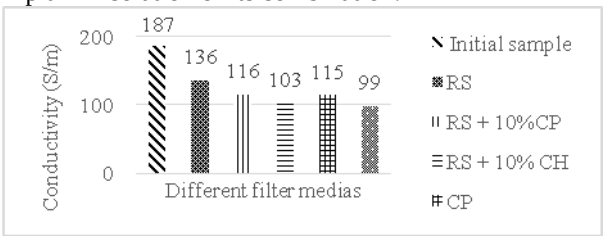

Fig. 10. Variation in conductivity of filtered water in various filter medias with rock sand.

Conductivity is reduced by 27% when the leachate is filtered through rock sand, whereas it was only 11% in well graded soil. Coir pith in-isolation or in combination with rock sand reduced the conductivity by 38% compared to 42% in coir pith mixed soil media.

Charcoal in isolation or in combination with rock sand reduces the conductivity by 47%, as against to 49% in soil media. Well graded soil alone is not ideal in reducing the conductivity.

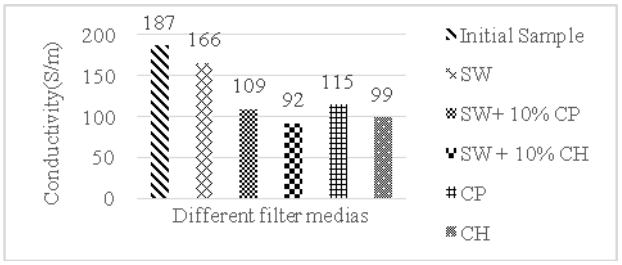

Fig. 11. Variation in conductivity of leachate in various filter medias with soil

C. BOD

The BOD value is most commonly expressed in milligrams of oxygen consumed per litre of sample and is used as a surrogate of the degree of organic pollution of water. Most pristine water will have a 5-day carbonaceous BOD below 1 mg/L. Moderately polluted water may have a BOD value in the range of 2 to 8 mg/L. Water sample may be considered severely polluted when BOD values exceed 8 mg/L. Municipal sewage that is efficiently treated by a three-stage process would have a value of about 20 mg/L or more. The BOD of residue of leachate obtained through rock sand and soil are presented in Figures 12 and 13.

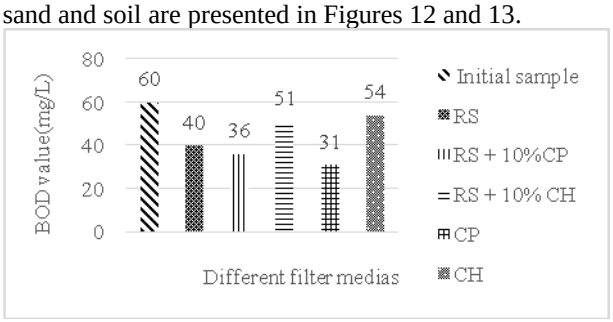

Fig.12. Variation of BOD of filtered water in different filter medias with rock sand

Rock sand is found to be better in reducing the BOD compared to well graded soil. In the additive material, coir pith in isolation is found to be the best compared to other medias in reducing the BOD. Coir pith reduces the BOD by about 48%. Though coir pith in isolation is better, when it is mixed with well graded soil, the reduction in BOD is drastically reduced 48% to 22%. This may be due to the organic materials present in the coir pith. This shows a better performance of coir pith in filtration aspects. The successful removal of BOD by CP is either due to more amount of oxygen present in the organic fiber content in the coir pith and soil or the abundant presence of aerobic biological organisms in the coir pith.

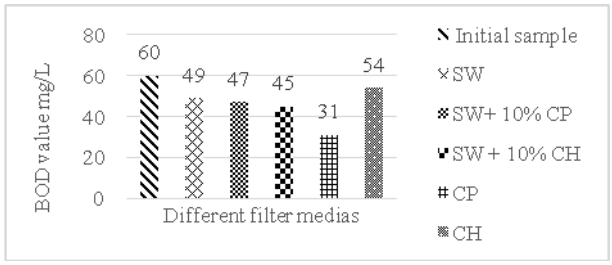

Fig. 13. Variation of BOD of leachate in different filter medias with soil.

d. COD

The result of a chemical oxygen demand test indicates the amount of water-dissolved oxygen (expressed as parts per million or milligrams per litre of water) consumed by the contaminants. The most common application of COD is in quantifying the amount of oxidizable pollutants found in surface water (e.g. lake sand rivers) or wastewater. The COD test results are shown in figures 14 and 15.

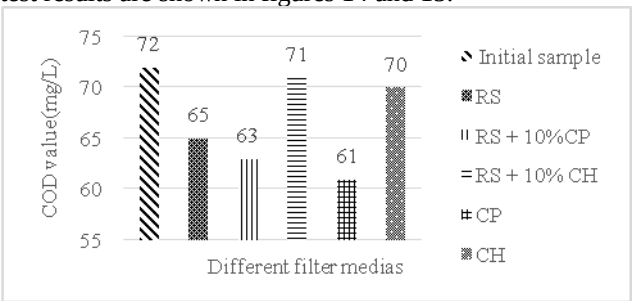

Fig.14. Variation of COD of filtered water in different filter medias with rock sand

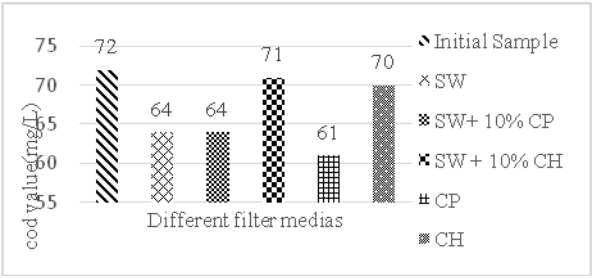

Fig. 15 Variation of COD of leachate in different filter medias with soil

Initial solution had a COD value of 72mg/L. Rock sand and well graded soils in isolation are equally good in reducing the COD. COD has been reduced by 9.7% and 11.1% respectively by rock sand and well graded soil. Rock sand with 10% CP is the ideal combination for reducing COD, and was found to be 12.5%. Addition of coir pith in well graded soil doesn't have any influence in controlling the COD. Coir pith alone is ideal for removing the COD from the effluent, i.e., nearly 15.2%. Charcoal is not at all effective in controlling the COD. The effect of coir pith in removing significant amount of COD might be because of the successive decomposition of organic matter or sufficient oxidation of inorganic chemicals present in the leachate or availability of fibrous coir pith material to consume excess oxygen.

V. CONCLUSION

Based on the chemical analysis of effluent filtered through various medias, the following conclusions were drawn:

- The use of natural materials like coir pith and charcoal as a filtering material introduces an environmental friendly method for filtration and further can reduce the use of chemicals.
- From the column filtration and results obtained, it is observed that Coir pith is very effective in removing the BOD, COD and also brings down the conductivity of waste water to a greater amount.
- The use of charcoal as a filter media is also observed to be very effective. The turbidity and conductivity seems to be less in the filtered samples.
- The results show a new area of application for coir pith as a filter media which is purely eco friendly and very economical.

REFERENCES

1. Shilpa, S. Ratnoji., and Nimishasingh., "A study of coconut shell - activated carbon for filtration and its comparison with sand filtration", IJREEE, 2014, Vol 2, No 3, pp 201-204.
2. Siong, Y., Idris, J., &MazarAtabaki, M., "Performance of activated carbon in water filters" Reseach Gate, 2013.
3. Azhar Abdul Halim., Noor Nazurah Zainal Abidin., Normah Awang., Anuar Ithnin., Mohd. Sham Othman., & Mohd. Ikram Wahab "ammonia and cod removal from synthetic leachate using rice husk composite adsorbent", JUEE, 2011, Vol 5, No 1, pp 24-31.