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A Case Study on Efficient Filter Media Adding Rice Husk

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Abstract— World has 70 % of its area covered with water and out of this India has only 4% on its land [1]. The demand for water has increased and is constantly increasing as only 3% of world's water is fresh. Inspite of the vigorous actions being taken by the government of India to provide fresh water to every house, the challenge of providing its citizens with clean potable water free from pathogenic bacteria and viruses could not be met. It is estimated that Diarrhea causes about 10 Million illness and 7,00,000 deaths in India out of which 4,00,000 are of the children under the age of five [2]. This scenario of deaths is more frequent in rural areas. This case study presents the usage of agricultural waste materials to treat the water for safe drinking. The physical and chemical properties of the water sample were tested such as turbidity, TDS and E.Coli. Suitable quantity of rice husk was collected and was converted to ash using Muffle Furnace at a temperature of 500°C. Later the filtered water was tested for the physical and chemical properties and the variations in the properties are noted.

Keywords— Rice Husk Ash, Activated Rice Husk Ash, Ground Water, Agricultural waste materials.

I. Introduction

The scarce water availability in India and lack of proper treatment methods has resulted into about 2 million deaths (WHO). All surface water varies in quality and quantity throughout time and geography. Thus this water must be optimized and treated to a drinkable quality to prevent the casualties and to increase the accessibility to everyone. The treatment of water involves various steps and use of activated carbon as adsorbent is one of the steps of the treatment process but the cost is very high. This activated carbon can also be made at a very less cost by burning the husks of rice at high temperatures. Rice is one of the chief grains of India. Moreover, India has the largest area under rice cultivation as it is one of principal food crops. India is the 2nd largest producer of rice after China. For every ton of paddy processed, an average mill produces 200 kg of Rice Husk and 40 kg of RHA (Rice Husk Ash). the total amount of rice husk produced in India is estimated to be about 24 Million tons, while the RHA production is estimated to be about 4.4 Million tons per year. Some of this RHA is utilized in industries such as steel, cement, bricks, etc. while the remaining is usually dumped in open land. Compositionally depending upon the conditions at which the hulls are burnt RHA is approximately 63-98% silica and 3-6.5% carbon. The silica in RHA carries a negative surface charge thus making it an ideal absorbent for positively charged species like Cd, Ni, Zn. At the same time carbon in the RHA is an ideal absorbent of negatively charged species, such as fluorides and organic compounds such as phenols. Due to these unique properties and its abundant availability at nominal cost RHA has been used for a variety of applications. Physical and Chemical properties of carbonized RH vary with increase in temperature. Carbonization is a thermal decomposition which occurs at a temperature above 500^0C [3] and which eliminates non-carbon species, producing a fixed and porous mass of carbon generally in an inert atmosphere. Activated carbon is that which is treated with oxygen to open thousands of tiny pores between the carbon atoms. "The use of special techniques of fabrication results in highly porous carbons. In absorption the molecules of one substance are fixed to the surface of another substance. The enormous surface area of activated carbon gives it various places for bonds. When certain chemical substances pass near to the carbon surface, they are united to this surface. Many other chemical substances are not attracted by carbon (Sodium, Nitrates, etc) passing directly by it. This means that a filter of activated carbon will remove certain impurities but ignore others [4]. This type of material possesses attractive adsorbent qualities which have been utilized for the purification and elimination of toxic components in the liquid and gaseous states. Observing the progressive degradation of the environment, it is hoped that this low cost activated carbon may play an important role in the reduction of pollutants from the water.

II. Material and Method

Rice Husk is the hard protective covering of grains of rice. Combustion of the rice husk affords Rice Husk Ash. The microscopic examination of rice husk ash shows that it is a source of amorphous reactive silica. This ash can be used as a suitable media for water treatment in water filtration units. Silica is the basic component of sand, which is used in filter media in addition to other sand and gravels. The Rice husk ash was used in the experiments. It is prepared from the rice hulls by heating it upto a temperature range of 500-550ºC in a muffle furnace. The operating pressure for its preparation ranges from 12 bar to 42 bar with residence holding reaction time 1 hour [5]. This results in the increase of the percentage of mass of carbon 2-3 times and forms Carbonized Rice Husk Ash.

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2.1 TEST FOR IRON CONTENT

In the proposed work, the initial iron concentration is determined by conducting test using Spectrophotometer. Deepika and Pradeep Kumar did a comparative study regarding Iron Removal from drinking Water Using Low Cost Adsorbents submitted at International Journal of Innovative Research in Science, Engineering and Technology [6]. It was passed through the open end of unit. Inside the glass filter, different adsorption media of specified thickness (5cm, 15cm and 30cm) were placed one by one with proper support. Sample water was made to pass through the top end of the unit. After adsorption, the clear water was collected through the outlet of the unit in a beaker and the final concentration of iron was measured using spectrophotometer. The rate of adsorption was noted and for each adsorption media, for analyzing effectiveness of technique.

2.2 TEST FOR TURBIDITY

The test for Removal of Turbidity from Water using Low Cost adsorbents were conducted by Gurpreet Singh Kainth student of NIT Rourkela under the guidance of Prof. Somesh Jena [7]. At first, we take three test samples of turbid water one by one. In the first test sample of Gravity sand filter, the gravels and sand removed organic matter and dirt which was already present in water. The coagulation of dirt present in the water is easily removed by Sand at the 1st attempt. In the next test sample step we use the Activated rice husk which has the ability to stop the coagulants effectively. The same sample is poured in it and the result is calculated.

2.3 TEST FOR TOTAL DISSOLVED SOLIDS (TDS)

The test for Removal of TDS from Water using Low Cost adsorbents were conducted by S.K. Singh, Neha Narwal of Delhi Technical University and published a journal on “Assessment of Fixed Bed Column Reactor using Low Cost Adsorbent (Rice Husk) for Removal of Total Dissolved Solids” [8]. A PVC column with an inner diameter of 10.15 cm and a length 70 cm was used. The bottom of the sample column was sealed off so that there is no adsorbent loss during the process. Four different outlets are provided at different heights with 10 cm in the column. The water reservoir is kept at a particular height above the column so that water flows under the action of gravity into the column. A constant flow valve was attached from the water reservoir to the column so as to maintain a constant flow rate of water. Rice husk ash is compacted tightly in the column from which the sample water flows downward. Head loss maintained for the proper functioning of the apparatus and continuously maintained. At last the water passing through the filtration media is collected from one of the outlets into a collecting beaker.

2.4 TEST FOR E.COLI

Carmalin [9] performed test on bacterial inactivation in CSIR National Environmental Engineering research institute, Chennai. The test is as follows:

The filter column (dia 2cm) was loaded with adsorbent (5 cm thick RHC). 50 mL of contaminated sample is passed through column. The raw influential and effluent was estimated for E. Coli count.

III. RESULT AND DISCUSSION

3.1 IRON REMOVAL

The test shows that by using Rice Husk, the desired results are obtained with a very good efficiency rate.

Adsorbent RHA	Depth (cm)	Initial conc. of sample (mg/Lt)	Final Conc. Of Sample (mg/Lt)	Efficiency (%)
RHA	05	1.8	0.34	81.11
	15	1.8	0.04	97.78
	30	1.8	0.02	98.89

Table.2.1 Showing iron content after adsorption with RHA

3.2 REMOVAL OF TURBIDITY

The tests results for the removal of Turbidity from the water by using low cost adsorbent rice husk ash are as follows:

Turbid Pond Water Sample	Original Turbidity Concentration	After passing through gravity filter	After passing through Activated Rice husk
Passing the water individually	73.8	13.4	3.4
Passing turbid water one after another	73.8	13.4	0.9

Table 2.2 Observation Table

3.3 REMOVAL OF TOTAL DISSOLVED SOLIDS (TDS)

From the tests which were conducted to remove TDS from the sample water, we observed that the removal efficiency decreases as the flow rate of the influent is increased, this is because the contact period for the adsorption media of dissolved solids is decreased if the flow rate is increased. Here we observed a maximum removal efficiency of 21% of TDS removal for flow rate of 40 mL/min and minimum for flow rate of 120 mL/min which was around 10% of TDS removal. Also, it can be observed that removal efficiency of TDS is maximum when the depth of outlet is the maximum, thus providing maximum contact area for the sample before the effluent is

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taken out. Considering a particular flow rate (40 mL/min), we note that removal efficiency of TDS is 20.79% at a height of 10cm from the base of column and 13.81% and 10.10% for the heights 20cm and 30cm respectively. Therefore, we come to the conclusion that removal efficiency increases when the depth of the adsorption media is increased.

3.4 REMOVAL OF E.COLI

The initial count of the spiked water used was found to be 300 x10^7 cfu/mL. After performing the tests the final E.Coli reading was 17x10^7 cfu/mL hence, giving a filtration efficiency of more than 99%.

IV. CONCLUSION

On the basis of foregoing studies available we came to the conclusion that rice husk is viable to be used in a filter plant. The abundant availability of Rice Husk at low cost in our state (J&K) makes it more feasible than other materials like coconut husk, crushed glass which can also be used as adsorbents. From the previously conducted tests we found that, turbidity removal on an average using rice husk was around 95% and the removal of iron concentration from the given sample was varying from 81%- 98%. Owing to its great adsorption properties it can remove the smallest of the impurities and microorganisms. Rice husk has proved to be very efficient in bacterial inactivation (Escherichia Coli) with an efficiency of 99 %. It is much more safe to use RHA for bacterial inactivation as it does not react with naturally occurring organic compounds found in water to form carcinogenic compounds. All the tests using rice husk ash showed results which were in compliance with permissible limits of B.I.S. Moreover, it can be concluded that replacement of sand with rice husk ash from filter bed is not possible but it can be used as an additional filtration unit or can be used in rural areas with low cost. The possible suitability of such a material which is considered as agricultural waste can prove its ability for environmental conservation and has the potential to benefit millions of people who suffer from water borne diseases such as cholera and typhoid.

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