

# Iron Removal from Drinking Water Using Low Cost Adsorbents – A Comparative Study

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**ABSTRACT:** Clean water is being a primary importance in developing countries. Contaminated water will affect the life of people to the greater extent. Efficient and low cost water purification systems are being utilized and being tried to be accessed worldwide for purification of water. About one-fifth of the population on earth lack the access to safe drinking water, a condition that resulted in the death of 2 million people in 2004, as per the records of United Nations. In this work an attempt was made to develop a “Low Cost Water Purification Technique” to remove iron from drinking water using the basic ideas of glass filter, some locally available filter material like Rice Husk and Sugarcane bagasse. Adsorption technique was used for removal of iron from ground water. Among all the low cost materials used, the ash produced from rice husk was proved to give the best result in removal of iron and also available in local area having the cheapest material cost. Locally collected Sugarcane bagasse and Rice husk were combined which also proved to be effective for removal of iron.

**KEYWORDS:** Drinking water, Iron, Bagasse ash, Rice husk ash, Low cost materials, Adsorption technique.

## I. INTRODUCTION

Purified water is essential for living a healthy life and hence everyone should have access to it. Drinking water conditions have great impacts on everyday life of human, especially in the rural and remote regions where access to safe drinking water is very crucial. Ground water often is the only source in such areas, thus water contaminations are difficult to avoid due to rigorous and over exploitation of ground water. Unsafe drinking water may result in chronic diseases.

Treatment options recently considered for the removal of emerging contaminants from drinking water as well as wastewater are adsorption, Advanced Oxidation Processes (AOPs), Nano-filtration (NF), and Reverse Osmosis (RO) membranes. Although adsorption can be effective for the removal of emerging compounds, these processes can lead to the formation of oxidation intermediates that are mostly not known at this point. Conversely adsorption processes do not add undesirable by-products and have been found to be superior to other techniques used for water treatment in terms of simplicity of design and operation, and insensitivity of toxic substances.

This work presents best drinking water purification by adsorption, focusing in better way on removal of iron using economic adsorbents. The two low cost adsorbents taken into consideration are rice husk ash and bagasse ash.

## II. RELATED WORK

Takerlekkopoulou, studied in 2006 the physio- chemical and biological iron removal from portable water. He used the technique of trickling filter and constructed a model for it including the pilot- testing. The detailed chemical reaction and extent of each oxidation was studied. Experimentation was done with specified temperature, optimum feed iron concentration and volumetric flow rate.

William, et al, in 1992 studied the impact of dissolved organic carbon on the removal of iron during water treatment. He used the iron removal process by oxidation and coagulation method.

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(An ISO 3297: 2007 Certified Organization)

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### III. MATERIALS AND METHODOLOGY

Rice husk are the hard protecting covering of grains of rice. The chemical composition of Rice husk is similar to that of many common organic fibres and it contains cellulose 40-50%, lignin 25-30%, ash 15-20% and moisture 8-15 % (by Hwang and Chandra 1997). After burning, most evaporable components are slowly lost and the silicates are left.

Rice husk ash was collected from a local mill in Hiriyadka, Udupi. It was washed with tap water to remove impurities and then with distilled water. The rice husk was then sieved using 600 micron mesh and ash retained in the 600 micron sieve was used in order to increase its surface area.

Bagasse is sugarcane fibre waste left after juice extraction. Bagasse contains mainly cellulose, hemi cellulose, pentosans, lignin, sugars, wax and minerals. Sugarcane bagasse was collected from Hiriyadka, Udupi. It was first washed thoroughly with tap water and then with distilled water to remove dirt and metallic impurities and after which it was dried in the oven at about 105 degree Celsius for 3 hours and 24 hours dried in sun light. The dried bagasse was grounded and made like fine particles to increase its surface area. It was sieved using 300 micron sieve and the ash retained on it should be taken for the test.

In the proposed work, the initial iron concentration is determined by conducting test using Spectrophotometer. 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.

#### Methods:

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#### Analysis of factors affecting adsorption:

Jar test was conducted to analyze the factors affecting adsorption technique. The factors taken into consideration are dosage of adsorbent, optimum  $p^H$  range of adsorbent and contact time of the adsorbent and sample water.



Plate 1: Jar test

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## IV. RESULTS AND DISCUSSIONS

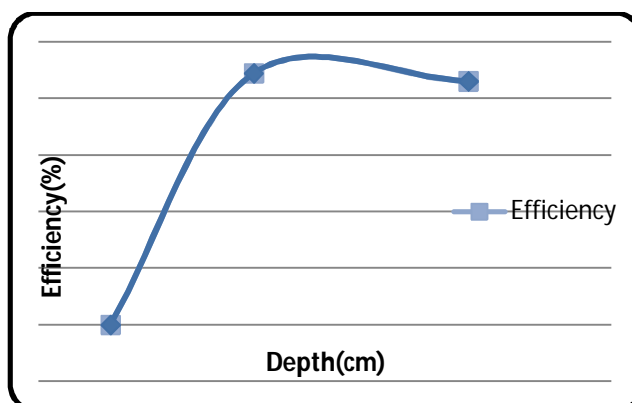
The results of the preliminary tests as well as the final tests are discussed below:

| SL. NO. | PARAMETERS CONSIDERED         | INITIAL CONCENTRATION OF SAMPLE | BIS STANDARDS |
|---------|-------------------------------|---------------------------------|---------------|
| 1       | Chloride, mg/l                | 51.6                            | 250           |
| 2       | Hardness, mg/l                | 144.96                          | 300           |
| 3       | Sulphates, mg/l               | 223.85                          | 200           |
| 4       | Turbidity, NTU                | 50.3                            | 5             |
| 5       | PH value                      | 5.2                             | 6.5-8.5       |
| 6       | Electrical conductivity, mg/l | 274                             |               |
| 7       | Iron, mg/l                    | 1.8                             | 0.3           |
| 8       | Nitrate, mg/l                 | 1.12                            | 45            |
| 9       | Fluoride, mg/l                | 0.65                            | 0.6-1.5       |
| 10      | Solids in water, mg/l         | 819.6                           | 500           |

Table1: Initial concentration of water sample

| ADSORBENT | DEPTH (cm) | INITIAL CONCENTRATION OF SAMPLE (mg/l) | FINAL CONCENTRATION OF SAMPLE (mg/l) | EFFICIENCY (%) |
|-----------|------------|--|--------------------------------------|----------------|
| B.A       | 5          | 1.8                                    | 0.18                                 | 90             |
|           | 15         | 1.8                                    | 0.02                                 | 98.89          |
|           | 30         | 1.8                                    | 0.025                                | 98.61          |
| R.H.A     | 5          | 1.8                                    | 0.34                                 | 81.11          |
|           | 15         | 1.8                                    | 0.04                                 | 97.78          |
|           | 30         | 1.8                                    | 0.02                                 | 98.89          |

Table 2: Showing iron content after adsorption with different adsorbents



Graph 1: showing efficiency with increase in depth of bagasse ash

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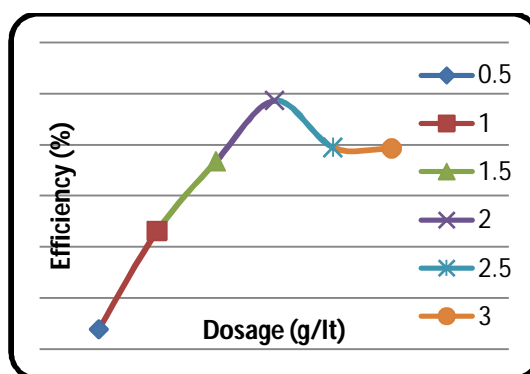
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The test results shown in Graph 1 indicate that increasing the depth of bagasse ash for the test increases the efficiency up to a particular depth. The iron content slightly increases with increase in depth, but remains within permissible limits.

### Jar test results:

| Adsorbent | Dosage (Mg) | Initial Concentration Of Sample(Mg/Lt) | Final Concentration Of Sample(Mg/Lt) | Efficiency (%) |
|-----------|-------------|--|--------------------------------------|----------------|
| B.A       | 50          | 2.6                                    | 2.4                                  | 7.69           |
|           | 100         | 2.6                                    | 1.4                                  | 46.15          |
|           | 150         | 2.6                                    | 0.69                                 | 73.46          |
|           | 200         | 2.6                                    | 0.07                                 | 97.31          |
|           | 250         | 2.6                                    | 0.55                                 | 78.85          |
|           | 300         | 2.6                                    | 0.56                                 | 78.46          |
| R.H.A     | 50          | 2.6                                    | 1.88                                 | 27.69          |
|           | 100         | 2.6                                    | 0.7                                  | 73.08          |
|           | 150         | 2.6                                    | 0.7                                  | 73.08          |
|           | 200         | 2.6                                    | 0.34                                 | 86.92          |
|           | 250         | 2.6                                    | 0.31                                 | 88.08          |
|           | 300         | 2.6                                    | 0.33                                 | 87.31          |

Table 3: Test results for dosage of different adsorbents



Graph 3: Comparisons of efficiency of bagasse ash with varying dosage

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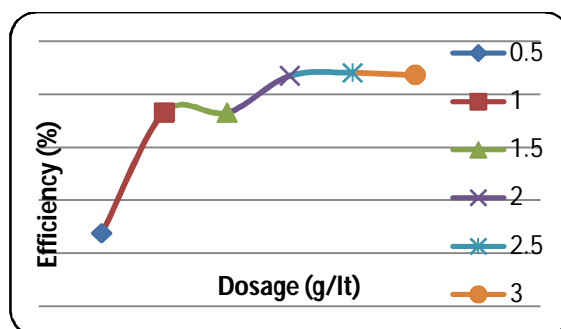
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|       |    |     |       |       |
|-------|----|-----|-------|-------|
| B.A   | 5  | 2.6 | 0.06  | 97.69 |
|       | 6  | 2.6 | 0.065 | 97.5  |
|       | 7  | 2.6 | 0.52  | 80    |
|       | 8  | 2.6 | 0.48  | 81.54 |
|       | 9  | 2.6 | 0.99  | 61.92 |
|       | 10 | 2.6 | 1.01  | 61.15 |
| R.H.A | 5  | 2.6 | 0.32  | 87.69 |
|       | 6  | 2.6 | 0.06  | 97.69 |
|       | 7  | 2.6 | 0.4   | 84.62 |
|       | 8  | 2.6 | 0.66  | 74.62 |
|       | 9  | 2.6 | 1.15  | 55.77 |
|       | 10 | 2.6 | 2.50  | 3.85  |

Table 4 Test results for pH of different adsorbents

The above graph shows that increase in dosage of bagasse ash up to 2g/lit in synthetic sample decreases the iron content, thus increasing the efficiency. But when the dosage exceeds 2g/lit, the efficiency tends to decrease.



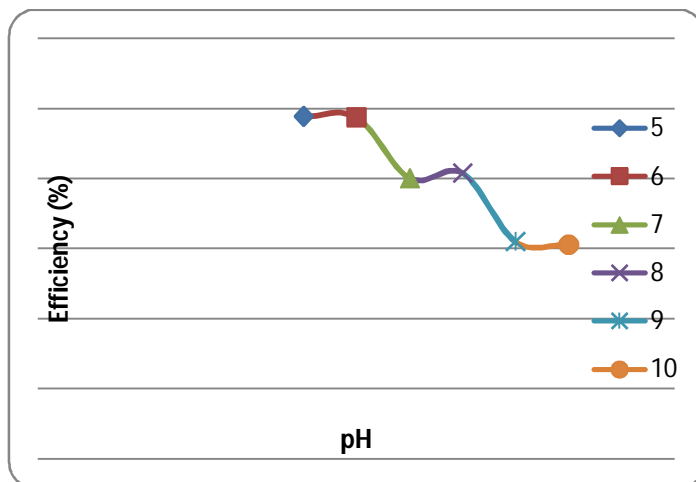
Graph 4: Showing comparisons of efficiency of rice husk ash with varying dosage

The above graph shows that increase in dosage of rice husk ash up to 2.5g/lit in synthetic sample decreases the iron content, thus increasing the efficiency. But when the dosage exceeds 2.5g/lit, the efficiency tends to decrease slightly.

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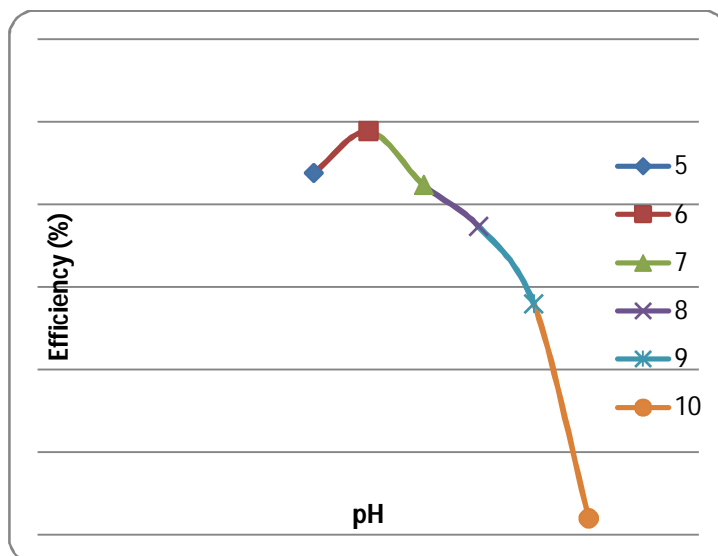
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Graph 5 showing comparisons of efficiency of bagasse ash with varying pH

The above graph shows that increase in pH of synthetic sample along with bagasse ash above 5 decreases efficiency considerably.



Graph 6 showing comparisons of efficiency of rice husk ash with varying pH

The above graph shows that increase in pH of synthetic sample along with rice husk ash above 6 decreases efficiency considerably and pH less than 6 shows lesser efficiency. pH 6 shows optimum efficiency

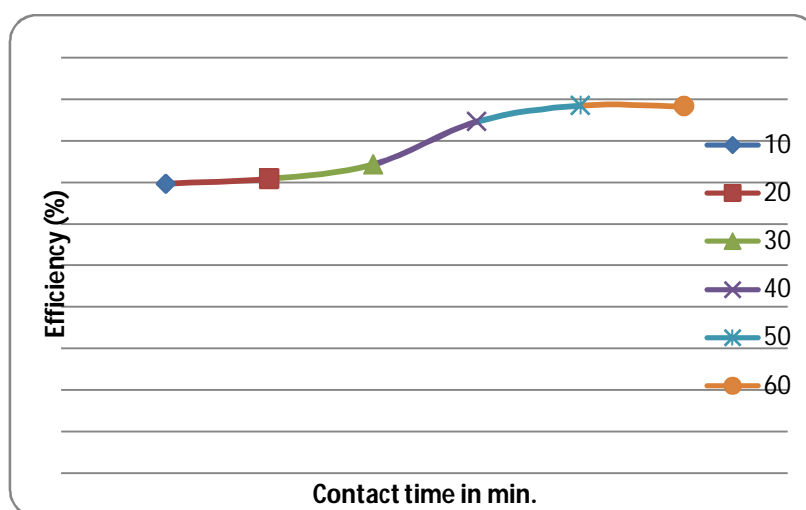
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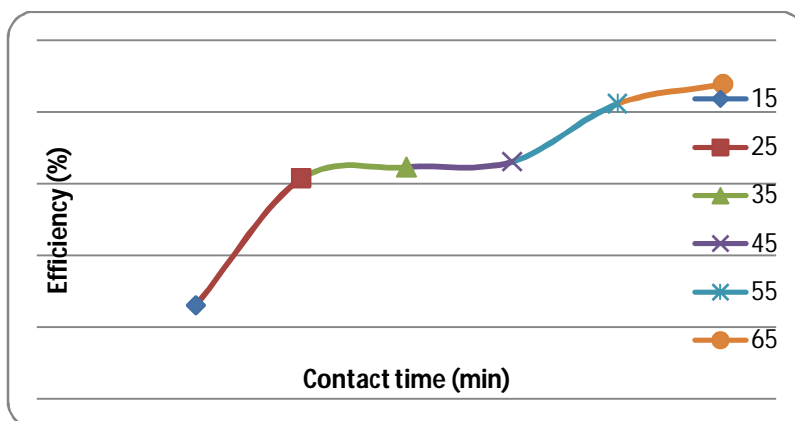
| ADSORBENTS | CONTACT TIME (mins) | INITIAL CONCENTRATION OF SAMPLE(mg/l) | FINAL CONCENTRATION OF SAMPLE(mg/l) | EFFICIENCY (%) |
|------------|---------------------|---------------------------------------|-------------------------------------|----------------|
| B.A        | 10                  | 2.6                                   | 0.79                                | 69.62          |
|            | 20                  | 2.6                                   | 0.76                                | 70.77          |
|            | 30                  | 2.6                                   | 0.67                                | 74.23          |
|            | 40                  | 2.6                                   | 0.4                                 | 84.61          |
|            | 50                  | 2.6                                   | 0.30                                | 88.46          |
|            | 60                  | 2.6                                   | 0.305                               | 88.27          |
| R.H.A      | 15                  | 2.6                                   | 1.92                                | 26.15          |
|            | 25                  | 2.6                                   | 1                                   | 61.54          |
|            | 35                  | 2.6                                   | 0.92                                | 64.62          |
|            | 45                  | 2.6                                   | 0.88                                | 66.15          |
|            | 55                  | 2.6                                   | 0.46                                | 82.31          |
|            | 65                  | 2.6                                   | 0.32                                | 87.69          |

Table 5: Test results for contact time of different adsorbents



Graph 7 showing comparisons of efficiency of bagasse ash with varying contact time

The above graph shows that increase in contact time of bagasse ash and the synthetic sample decreases the iron content, thus increasing the efficiency.



Graph 8 showing comparisons of efficiency of rice husk ash with varying contact time

The above graph shows that increase in contact time of rice husk ash and the synthetic sample decreases the iron content, thus increasing the efficiency.

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