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Handmade Eco-Friendly Filter Using Rice Husk for Water Purification

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Abstract: ***Rice husk is a biomass of polymers with abrasive hardness and higher adsorbing capacities. This work investigates the use of rice husks in the purification of Water. A filter is constructed using carbonized rice husk, and Water is filtered. Results show that this method is efficient for removing hardness, turbidity, toxic metals etc. Also, the filter constructed offers an efficiency of 54 mL per second. The efficiency of adsorbing material shows that this method is economically feasible and eco-friendly. Rice husk can replace the synthetic adsorbing materials used in modern filters, which causes many health issues.***
Keywords: Carbonization, Rice husk, Filtration, Purification, water

I. INTRODUCTION

Water, one of the most abundant resources, is one of the necessities to sustain life. Clean, safe and pure drinking water is an absolute necessity for the well-being of human beings. Many countries, including India, are facing a scarcity of pure drinking water. Purification of Water gains much importance in Kerala after the 2018 flood. Even though there are many purification methods, Keralites are looking for low-cost filters. Also, the Periyar river, the second largest river in Kerala, has been polluted due to human activities like the discharge of domestic, natural, industry and agricultural waste, pesticides by farmers, leakage of radioactive materials, etc. Recent reports show that using an eco-friendly and low-cost filter in every house is essential. The project investigates the use of rice husks in the purification of Water. In Kerala, rice husk is considered waste with a high level of silica. It is difficult to reuse due to its negative characteristics like abrasiveness, resistance to degradation etc. [1].

Among the various sources of silica, rice husk is considered valuable agricultural biomass material and a cost-effective resource that can provide biogenic silica for biomedical applications [2]. Rice husk is a biomass of polymers with abrasive hardness and higher adsorbing capacities. They contain a higher quantity of lignin and 95% SiO_2, responsible for their adsorbing capacities. It can be used for water filtration since it has a high external surface area and can trap up to 95% turbidity and bacteria in Water [3]. The significant advantage of this project is that it is a novel water purification method and is simple, efficient and economically viable. This method makes the purification of Water possible by following a green path. Turbidity, chemical contents, chlorine content, presence of metals etc., are analyzed before and after Filtration. Rice husk is a potential source of amorphous silica, which has a variety of applications in material science, production of Portland cement etc. [4] Because of the high specific surface area and presence of activated carbon, they are good in imprisoning other impurities as well as substances such as Chlorine. This method can also be used for the purification and elimination of toxic components in the liquid and gaseous state and reactions of catalysis [5].

The carbonized rice husk's physical and chemical properties vary with the temperature increase. When we increase the temperature, it becomes more friable and less hygroscopic [6]. Carbonization is a thermal decomposition that occurs at a temperature above 500°C and eliminates non-carbon species, creating a fixed and porous mass of carbon in an inert atmosphere. Activated carbons are widely used to adsorb coloured substances in gases or liquids [7]. Here, the principle involved is adsorption, which can be defined as fixing one molecule on the surface of another molecule. Since there is an enormous surface area, carbon gives it various places for bonds. Activated carbon can trap impurities, carbon as a base, and substances like Chlorine.

Another attraction of this work is that we are reducing waste by effectively utilizing it. So, in this way, we can protect our environment. After the 2018 flood in Kerala, the demand for filters has increased. Many filters are causing severe hazards to the environment. In this situation, this eco-friendly filter will make purification possible in a green way. Utilizing waste materials like rice husks will also decrease the negative impacts on the environment. Recent studies have shown that carbonized rice husks are efficient adsorbing material because of their large surface area [8]. This strategy achieves a comprehensive utilization of rice husks, exhibiting tremendous economic and environmental benefits [9].

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II. MATERIALS AND METHODS

Rice husk, collected from a local rice mill in Choornikara panchayath, is used for the work. Collected Rice husk is carbonized in a muffle furnace at 200°C for 45 minutes (Fig 1).



Fig 1. Rice husk Before and After Filtration

Materials required for Handmade filter: PVC pipe, MTA (Male Threaded Adapter), FTA (Female Threaded Adapter), PVC end caps, Carbonized rice husk, activated carbon, pebbles etc., Digital pH meter, Digital TDS meter, Conductivity meter, and Turbidity meter. Materials for the determination of the hardness: ZnSO4. 7H2O, Distilled water, Buffer solution, EDTA (Ethylene diamine tetra acetic acid) solution, EBT indicator, Sample water (water sample is collected from a borewell in Varappuzha). Atomic Absorption Spectrometer (AAS) for determining Copper content [Specification: CHEMITO, Model No. AA203].The spectrophotometer is used for the determination of Fe (Iron) content. [Specification: THERMOSCIENTIFIC, model No. EVOLUTION 201].

In the construction of the filter, a PVC pipe is used. MTA (Male Threaded Adapter) and FTA (Female Threaded Adapter) are connected on both sides. They are plumbing materials used to connect pipes with metals, hoses etc. FTA and MTA are joined with PVC-by-PVC end caps on both sides. In addition to these, hoses are also fitted on both sides. The figure is shown in Fig 2 a &b depict the original and schematic diagram. One hose will allow the passage of untreated Water through it; another one will treat it, and filtered Water can be collected. The PVC pipe is filled with activated carbon, carbonized rice husk and pebbles and constitutes the filtration bed. Rice husk is carbonized at 200°C for 45 minutes. Carbonized rice husk having a large surface area will absorb heavy metals, like calcium, Magnesium, Fe etc., into its surface, and they can be removed. The sample is added to pass through the filtration bed, and filtered Water is collected. The physical parameters of water samples are analyzed before and after Filtration. pH, conductivity, turbidity, TDS, hardness etc., are measured. Cu content is measured by Atomic Absorption Spectroscopy (AAS), and Spectrophotometry determines Fe content. Then compared the quality of Water before and after Filtration and then analyzed the adsorbing capacity of rice husks.



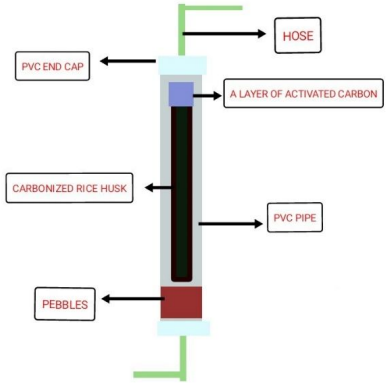


Fig 2a Filter b Schematic diagram

III. RESULTS AND DISCUSSIONS

Physical and chemical parameters of the sample water before and after Filtration are given in Table 1 below. The acceptable pH level in drinking water ranges from 6.5 to 8.5 [10]. The sample under consideration was slightly acidic. After filtration, the pH increased from 6.59 to 7.98.

The slight increase in pH after treatment is due to the removal of fulvic and humic acids, which have an intense colour and can be found in the soil. The table also gives a clear idea about the significant decrease in TDS from 208 ppm to 0.000000277 ppm. It shows that the dissolved content of all inorganic and organic substances present in the water in molecular, ionized or micro-granular form has been reduced. When the concentration of ions increases, conductivity also increases. The acceptable level of conductivity in Water is 200 micro siemens [11].

Table 1.
Physical And Chemical Parameters Of The Sample Water Before And After Filtration

Parameters studied	Water Quality		Acceptable value	Percentage decrease
	Before Filtration	After Filtration		
TDS [ppm]	208	0.277×10^{-6}	300	99.9%
pH	6.59	7.98	6.5-8.5	17.41%
Conductance [Micro siemens]	331	83.43	200	74.8%
Turbidity [NTU]	846	7	1	99.17%
Hardness [mg/L]	48.21	40.21	75	16.6%
Iron [mg/L]	14.53	0.22	0.3	98.48%
Copper [mg/L]	0.01	PDF	0.05	90% and above

PDF- Below Detection Level

Rice husk adsorbed calcium and Magnesium ions into its surface when untreated water is passed through it, and this causes a reduction in the hardness of the sample water [12]. The work was also successful in the removal of heavy metal Cu. It is a metal in the environment as a mineral in rocks and soils. According to IS-10500-2012, the acceptable level of Cu in Water is 0.05 mg/L [13]. The permissible limit of Iron in drinking water is 0.3 mg/L, according to Indian Standard [14]. Filtration through carbonized rice husk caused a remarkable reduction of Iron from 14.53 mg/ L to 0.22 mg/L. Passing through carbonized rice husk, the turbidity of water has reduced from 846 NTU to 7 NTU. Fig 3 depicts the quality of Water before and after Filtration.



Fig 3 Water Quality Before and After Filtration

IV. CONCLUSION

In this work, a new technique for using activated carbon embedded in rice husks was created and used. The filter has shown promising results regarding the water purification process. The Rice husk has many economic and biological applications [15]. Using waste and by-products from rice cultivation and commercial rice processing has increased farmers' income and reduced environmental pollution [16]. Removal of Hardness, Fe content, Copper, and turbidity from Water will prevent many diseases. Carbonized rice husk can be a replacement for activated carbon. This technique can contribute to the current investigations on the mechanisms of carbonaceous materials. The artificially activated carbon synthesized by industries contains various chemical contaminants.

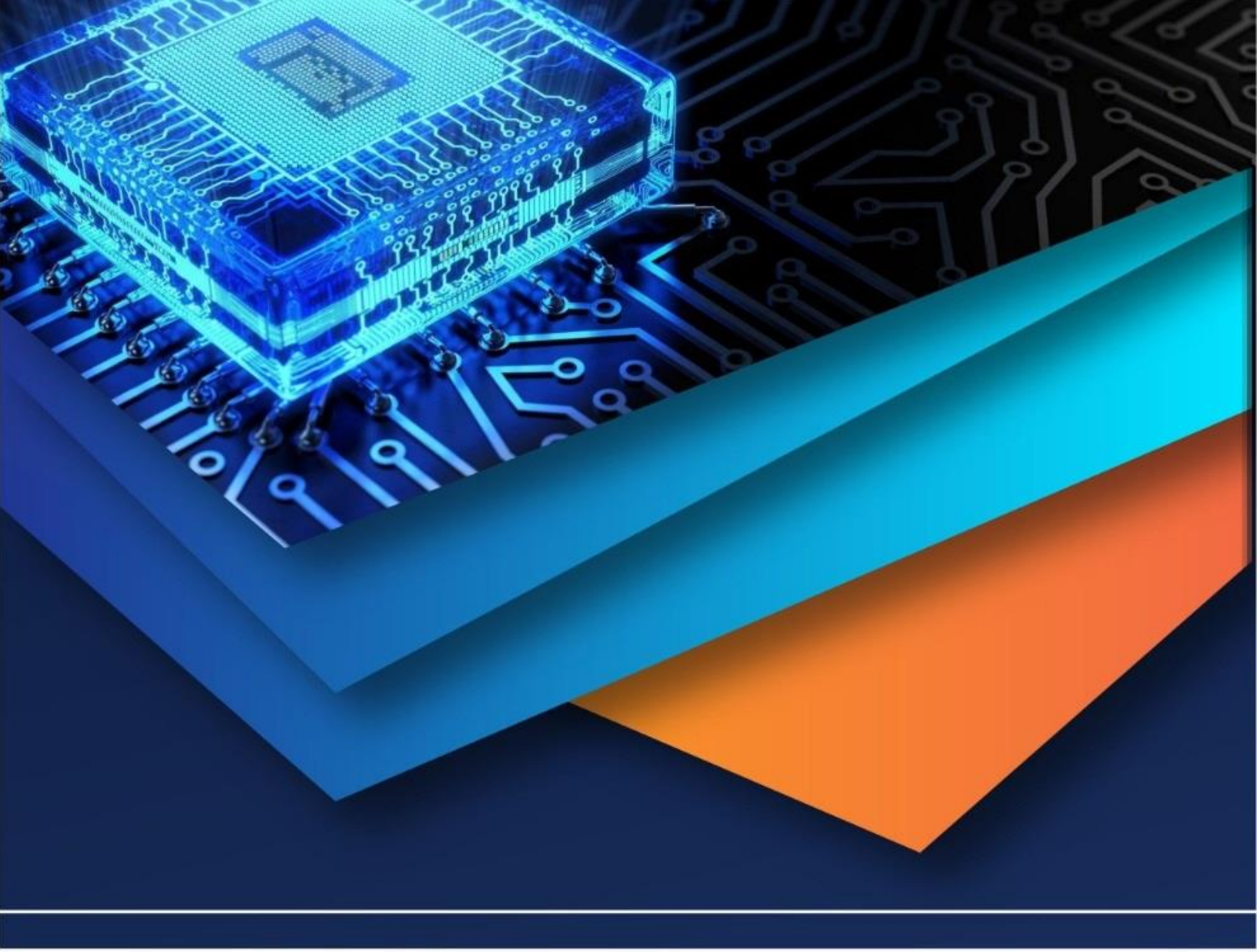
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The Water purified with this activated carbon is not much safe to drink. Multiple pollutants such as textile dyes, organic contaminants, inorganic anions, pesticides and heavy metals can be effectively removed by rice husk-derived activated carbon. The commercial form of activated carbon now available in markets is costly. So, replacing this activated carbon with carbonized rice husk is cost-effective. Moreover, there are no chemical contaminants, so the Water will be safe for drinking.

To conclude, the treated Water is acceptable for drinking purposes according to Indian standards. The efficiency of Water has also been determined. It is done by passing untreated Water into the filter for one minute. The volume of Water coming out of the filter is measured. The value of the filter's efficiency in purifying water in one second is found to be 54 mL per second.

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