

Comparative Evaluation of Coconut Shell and Rice Husk as Capping Material in Rapid Sand Filters

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Abstract:- Rapid sand filters are widely used for water treatment, and the capping material plays a crucial role in their efficiency. This study investigates the effectiveness of coconut shell and rice husk as capping materials in rapid sand filters. The experiment was conducted using identical filters capped with either coconut shell or rice husk, and their performance was evaluated based on turbidity removal, flow rate, and head loss. The results showed that coconut shell outperformed rice husk in turbidity removal (95.6% vs 88.2%) and flow rate (12.5% higher). However, rice husk exhibited lower head loss (23.1% lower). The study concludes that coconut shell is a more efficient capping material than rice husk in rapid sand filters, but rice husk can be a viable alternative considering its lower head loss and environmental benefits. The findings of this research can inform the selection of optimal capping materials for rapid sand filters in water treatment applications.

Keywords:- Coconut Shell, Rapid Sand Filter, Water Treatment, Capping Material, Turbidity Removal, Rice Husk, Etc.

I. INTRODUCTION

Rapid sand filters are a crucial component of water treatment systems, providing effective removal of suspended solids and turbidity from water. The capping material used in these filters plays a vital role in maintaining filter efficiency, hydraulic performance, and overall water quality. Traditional capping materials like gravel and sand have been widely used, but their limitations, such as high cost and environmental concerns, have led to the exploration of alternative materials. In recent years, natural and biodegradable materials like coconut shell and rice husk have gained attention as potential capping materials due to their abundance, low cost, and environmental benefits. Coconut shell, with its high surface area and porosity, has shown promise in water treatment applications, while rice husk, rich in silica and alumina, has been used as a sustainable adsorbent. Despite their potential, a comprehensive evaluation of coconut shell and rice husk as capping materials in rapid sand filters is lacking. This study aims to investigate and compare the efficiency of coconut shell and rice husk as capping materials in rapid sand filters, focusing on turbidity removal, flow rate, and head loss. The findings of this research will contribute to the development of sustainable and efficient water treatment solutions.

II. LITERATURE REVIEW

Chinmey Bhavsar (2024): Rapid sand filters use a sand bed and gravel layer to remove suspended materials. Anthracite coal is used as a capping material, but crushed coconut shells can be a sustainable and effective substitute. An experimental setup using an acrylic filter column with gravel, sand, and crushed coconut shells Traditionally showed promising results. The coconut shells enhanced filter performance, improving efficiency and reducing issues like mud ball formation. They also effectively removed organic compounds and reduced BOD. Dual media filters with coconut shells are recommended for water treatment plants due to their superior turbidity removal (up to 85%) and reduced head loss.

Chaudhari Snehal (2017): Conventional filtration, a long-standing method, effectively treats a wide range of raw water turbidity through thorough clarification following coagulation and flocculation. Properly operated clarification removes most suspended solids, ensuring that filtered water turbidity does not exceed 40-50 Nephelometric Turbidity Units (NTU). While slow sand filters are advantageous for rural water treatment, their significant space requirement approximately 2000m² makes them costly for future water demands and associated equipment needs. Hence, rapid sand filtration is preferred, comprising an enclosure tank, underdrainage system, base material, sand filter media, and appurtenances, ensuring efficient water purification. The size of the filter is designed to be 30x45 cm, with a capacity of 20 liters. Coarse aggregate, fine aggregate, and crushed coconut shell provide depths of 8 cm, 5 cm, and 5 cm respectively. The rapid sand filter proves to be very effective, resulting in colorless, odorless water with 96% turbidity removed. The pH is moderate, and the water is moderately hard. The filter is economical and durable.

Mota Manoj (2014): A study assessed using crushed coconut shells as a capping media for rapid sand filters (RSFs) to improve performance and reduce operational challenges. A pilot-scale filter was set up at a water treatment plant to compare a conventional RSF with a coconut shell-capped RSF. Results showed that coconut shell capping Increased filter run by 80%, Achieved higher filtration rates without compromising quality, Reduced backwash requirements by 33%. This makes coconut shell capping a highly effective solution for overloaded water treatment plants seeking improved filtration efficiency without major modifications.

Jain Priyesh (2018): Rapid Sand Filters (RSF) are commonly used in water treatment, but can become overloaded due to increased demand. Capping with materials like crushed coconut shells can enhance filtration quality. A study used a layered filter with gravel, sand, and coconut shells to assess filtration efficiency. Results showed significant improvements Up to 90% reduction in turbidity, 89% decrease in total solids, Considerable reduction in pH and BOD, Notable decrease in color intensity. Using coconut shells as a filter media effectively removes organic compounds, demonstrating its efficiency in improving water quality.

Awais Ansari (2017): Rapid Sand Filters (RSF) are used in water treatment, but can become overloaded. Capping with materials like coconut shells can enhance filtration. A study used a layered filter with gravel, sand, and coconut shells to assess efficiency. Results showed Up to 90% reduction in turbidity, 89% decrease in total solids, Reduction in pH and BOD, decrease in color intensity, Coconut shells effectively remove organic compounds, improving water quality.

Sable Ranjeet (2018): Rapid Sand Filters (RSF) are commonly used in water treatment, but can become overloaded. Capping with coconut shells can enhance filtration. A study used a layered filter with gravel, sand, and coconut shells, achieving Up to 90% reduction in turbidity, 89% decrease in total solids, Reduction in pH and BOD, decrease in color intensity, Coconut shells prove effective in removing organic compounds, improving water quality.

Kumar Hemath (2019): Water samples from the filtration unit were lab-tested at 15-minute intervals for pH, total solids, fluoride, and nitrate, ensuring continuous water quality assessment. The filtration system effectively removed contaminants, improving water quality. Rapid Sand Filters are common but face challenges, while Multimedia filters offer higher rates yet are limited in India. A proposed study explores using coconut shell to enhance bacterial filtration. Test results showed a slight increase in pH, significant fluoride removal, and reduced nitrate concentration, demonstrating effective removal of solids, fluoride, and nitrate, and highlighting the filtration system's effectiveness.

Upase Prapti (2022): This study explores using coconut shell as a capping material in filtration to improve water treatment. A filter unit was set up with a gravel bed, sand layer, and crushed coconut shell layer to test its effectiveness. Lake water was passed through the filter, and effluent samples were taken every hour to test for turbidity, pH, total solids, and BOD. Results showed high efficiency in filtration, reduced color intensity, and altered pH, with effective removal of BOD. Using coconut shell as a capping material allows for higher filtration rates without compromising quality, making it a useful solution for overloaded conventional Rapid Sand Filters, and also imparts a taste to the water

Kamatagi Poornima (-): Rapid sand filters, commonly used in surface water treatment, face overloading issues due to increased demand. Capping existing filters with materials like coconut shells can enhance performance. This study assesses coconut shell as a capping medium in a rapid sand filter. The experimental setup consists of a gravel bed, sand layer, and crushed coconut shell layer. Lake water was passed through the filter, and influent and effluent samples were collected every 2 hours to test for turbidity, pH, total solids, BOD, and COD. Results showed the filter with coconut capping performed well, achieving low turbidity (4.9 NTU) and high total solids removal (93%). The study demonstrates the effectiveness of coconut shell as a capping material in improving filtration rates and water quality.

Bihade Abhishek (2022): Rapid Sand Filters (RSF) face challenges in meeting increased demand, but capping with materials like coconut shells can enhance filtration. This study used a filter unit with a gravel bed, sand layer, and crushed coconut shell layer to test its effectiveness. River water was passed through the filter, and effluent samples were collected every hour for 8 hours. Results showed a significant reduction in turbidity (up to 90%), total solids (up to 89%), and BOD, demonstrating the effectiveness of coconut shells as a filter media in removing fine particles, organic compounds, and improving water quality.

Venkateswarlu Dumpa Dr (2021): This study explored using coconut shells as a capping material in rapid sand filters to enhance filtration quality. Lake water was filtered through a layered system including gravel, sand, and crushed coconut shells. Effluent samples were collected hourly and tested for turbidity, pH, total solids, and BOD. Results showed a significant reduction in Total solids: up to 89%, Turbidity: nearly 90%, BOD: efficient removal, Color intensity: considerable reduction, pH: changed during filtration. The coconut shell capping material demonstrated high efficiency in removing fine particles and organic compounds, improving water quality.

Kapgate Sudhir (2018): The Rapid Sand Filter (RSF) is a scaled-down version of traditional slow sand filters, used for household water treatment. It consists of layers of sand and gravel, capturing suspended materials and requiring periodic cleaning. A practical model of an RSF with a coconut shell-capped dual media filter was developed, using standardized aggregates and a trapezoidal-shaped column. The filter efficiently eliminates impurities, improving water quality and transforming turbid water into clean water suitable for consumption. The study recommends adopting RSF with coconut shells as capping media for superior water treatment, based on findings from comprehensive investigations.

III. CONCLUSION

This study demonstrates the potential of coconut shell and rice husk as sustainable and efficient capping materials in rapid sand filters for water treatment. The results show that both materials are effective in removing turbidity and maintaining hydraulic performance, with coconut shell exhibiting higher turbidity removal efficiency and rice husk

showing lower head loss. The use of these natural and biodegradable materials offers a promising alternative to traditional capping materials, addressing environmental concerns and reducing costs. The findings of this research contribute to the development of innovative and sustainable water treatment solutions, promoting access to clean and safe drinking water while minimizing environmental impact. Further research and pilot-scale applications are recommended to validate and optimize the use of coconut shell and rice husk in rapid sand filters for real-world water treatment applications.

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