

Rice Husk Silica Ceramic Water Filter System

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DOI: <https://doi.org/10.30880/rpmme.2024.05.01.027>

Article Info

Received: 30 June 2024

Accepted: 15 August 2024

Available online: 15 September 2024

Keywords

Ceramic filter; Prototype; Rice-husk Silica; SolidWorks; Water filter system

Abstract

Rice-husk Silica, an accommodating, sustainable substance with many uses, is concealed in rice grain husks. It's about recycling waste and turning a readily available resource into a beneficial asset that can be used in many areas. The hard outer layer of rice husks contains silicon dioxide (SiO₂), called silica. About 20% of the husk's weight is this layer, which can be used to extract silica. Silica can be removed and processed chemically or thermally to make a high-quality, flexible product. Rice husk silica, once considered a rice cultivation waste, is now being recycled into a fascinating substance with several ecological uses. Its use in filtering systems is promising. Rice husk silica filters are a novel and effective filtration option. It is filter well and can treat industrial effluent and domestic water due to their huge surface area and porous nature. Since rice husks are abundant, they are lightweight, inexpensive, and scalable. Rice husk silica, which can be easily and sustainably sintered at 1200°C, would be used to build a water filtration system in this research. SolidWork simulates the water filter system's careful design and construction. A prototype water filter system would test filters made from prior research. Based on water filter system flow, this study evaluates and records the time taken of water flow.

1. Introduction

Filtration is a process of passing a solution through a porous medium or membrane to remove suspended particles from a fluid medium. The solid particles are held on the surface of the medium or, in certain situations, on the walls of the pores while the fluid, known as the filtrate, is driven through the gaps or holes of the filter medium[1]. To reduce the number of contaminants that are present in water, a device known as a water filter applies a physical barrier to collect impurities. Ceramic is a material that is frequently used to construct internal elements. To remove contaminants from water, water filters utilize chemical and physical filtration as their two disposal methods. The removal of small particles from water is part of the process known as physical filtering. Both carbon and ceramic are utilized in the process of physical filtering. This is because these materials possess microscopic holes that allow them to mechanically strain out impurities, microscopic components, and small particles. All the chemicals and contaminants come into direct contact with the filter medium, but it takes some time for the carbon to bind them together. To eliminate impurities using chemical means, the process of chemical filtering involves passing water through an active charged substance. Considering this, most water filter systems depend on physical filtration systems. For this study. The filter is made from rice husk silica.

Rice husk is a product of the rice milling process that has a wide range of applications. The skin or grain of several grain plants, including rice, is said to generate easily identifiable husks. Seeds of primitive cereal crops

such as rice, wheat, and certain other grains are firmly coated in husk[2]. The husk contains the outer layer but has a high silica content. Silica (SiO_2) occurs naturally as sand and quartzite. Sand is ceramics preferred raw material since it doesn't require costly crushing. Quartzite dissolves faster than sand in the molten phase because it converts into cristobalite when heated. Filler quartz is added to ceramics. Fillers are chemically resistant minerals having a high melting point at commercial fire temperatures ($<1300\text{ }^\circ\text{C}$). They inhibit body twisting, distorting, and shrinking when burned at temperatures that form viscous glass. The most prevalent material in the earth's crust is silica (SiO_2), which can be crystalline or amorphous [3].

2. Methodology

The overall for ceramic water filter is necessary to show the flow in designing and testing the ceramic water filter. Solidworks 2023 software is used to create and simulate the water filter system for software development. Hardware development will be focused on fabricating and testing the design system on a real water ceramic filter system. For material testing, filter ceramics will be tested with density and porosity. Figure 1 shows the overall flow of ceramic water filter system.

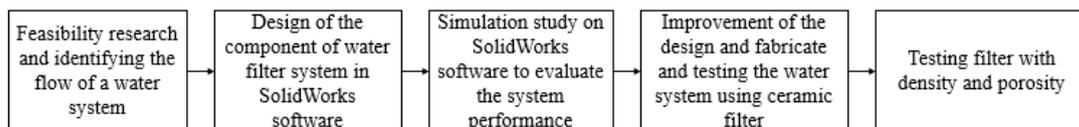


Fig. 1 Overall flow of ceramic water filter system

2.1 Design of Ceramic Water Filter System

The system is used to remove impurities from contaminated water in a simple way. The system water uses a water pump and two ceramic filters to remove impurities from contaminated water. The water filter involves a series of steps designed to effectively filter and treat water, remove impurities and get clean water. By using appropriate filtration techniques and additional treatment, water filters ensure its safety, quality and usability for different purposes, from food and beverage production to industrial.

A ceramic filter for a water system is designed with SolidWorks software version 2023. SolidWorks is mechanical design automation software that may be used to create components and drawings. It includes three types of assembly modelling technologies: bottom up, top down, and middle out. The bottom-up approach is utilized to construct the water filter system for ceramic filters. This strategy involves manufacturing discrete elements before integrating them into an assembly. This filter design consists of several individual parts. Table 1 shows the component of the water filter system.

Table 1 Component of water filter system

No.	Component	Description
1	Ceramic filter	To remove suspended particles from a fluid medium
2	Housing filter	A container that filters to remove pollutants
3	5-micron filter	Additional filter to filter small things of particle.
4	Tank	This container is filled with sediment water of clean water.
5	Pipe	To connect water supply
6	Pressure Switch	To control the water pressure in maintain and to protect housing filter and filter from being damage
7	Pump Pressure	To compress water from lower level to high level
8	Valve	To controlling piping direction of flow
9	Switch on off	To opening or closing an electrical circuit in a manner that is consistent and reliable.
10	Battery	To supply power to pressure switch

2.2 Simulation of Design Ceramic Water Filter

The use of SolidWorks motion studies in the field of three-dimensional design allows the models to move beyond static visuals and into the realm of dynamic analysis. It is a useful tool to simulate and analyse how the assemblies move and interact in situations based on the actual world. Motion studies provide vital insights into the performance, functionality, and potential challenges that the design might experience. This goes well beyond merely making cool animations or rendering them[4]. SolidWorks Motion would test product performance and quality during the development process. For this project, the simulation would be run with water flow on the water filter system.

2.3 Water Filter System Process

Pollutants and contaminants must be removed from water before it is considered safe for usage such as drinking, cooking, and industrial applications [5]. The purification process frequently needs multiple stages to ensure the removal of biological, chemical, and physical contaminants. The drainage water flows into the pump to operate the system. After that, the water filter is forced through by the pump. After impurities are eliminated from the water by the water filter, the system releases the pure water. The method is a practical and efficient approach to rid drainage water of impurities. It is a fantastic choice for a range of applications because it is portable and simple to use.

During the experiment, there were several experiments to develop a water filter system followed by design and simulated using Solidworks. To evaluate the water filter capabilities, the water undergoes an appropriate water filter process. The results of the test depend on the strength of the filter

3. Result and Discussion

A water filtration system would develop and filter using ceramic water filter. In addition to this, this considers the flow of water throughout the system and any errors that may have occurred throughout the experiment. The findings of many different experiments, including design, simulation, and prototype system. Because of this, it is necessary to examine the irrigation system of the water filter as well as the condition of the filter once the system has been completed.

3.1 Design Water Filter System

The flow diagram of the water filter system is shown in Figure 2. To get clean water, this system is easy with a 5-micron filter to help the system filter water that contains small particles to prevent damage to the ceramic water filter and housing to obtain clean water from water that has been contaminated [6], a water pump is used for pushing the water through the water filter system. Meanwhile, the filter system has a pressure switch that is used to control pressure water. After that, the water will be filtered through a ceramic water filter, eliminating any impurities present, and resulting in the water being clean. Figure 3 shows the design of a water filter system using SolidWorks 2023.

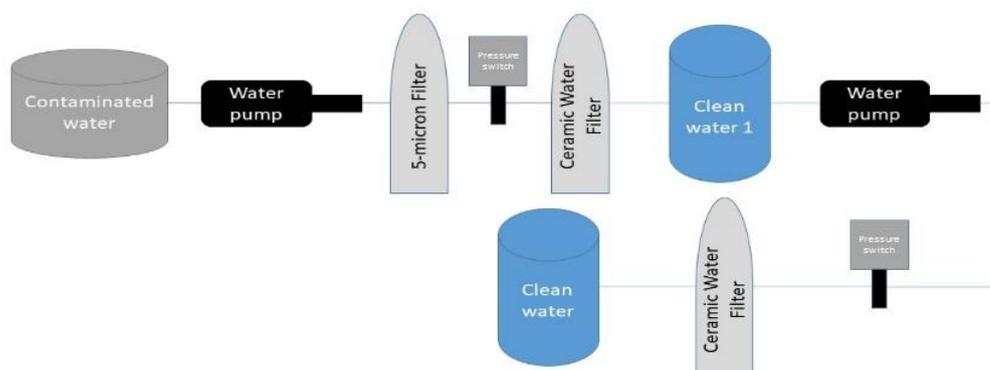


Fig. 2 Flow of water filter system

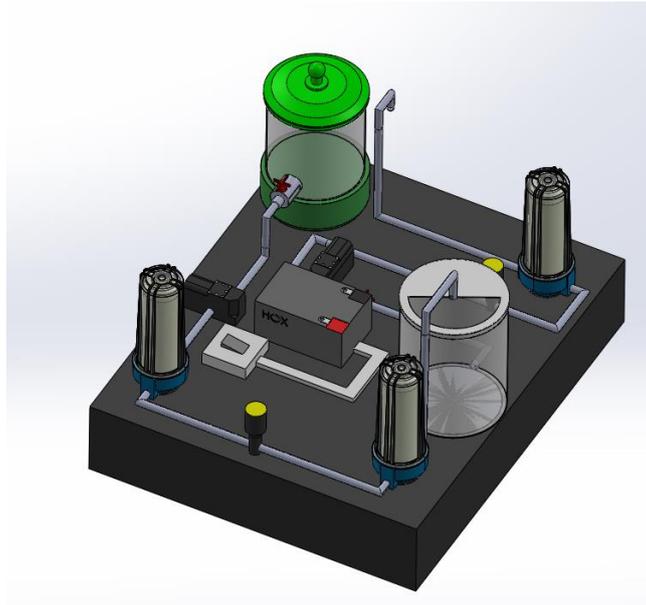


Fig. 3 Design water filter system using SolidWorks

3.2 Simulation Study

Simulation study is done on the first testing water filter system to analyse the motion study on the system. Figure 4 shows the graphical simulation of motion for water flow without changing its assembly feature. It simulates and animates the motion of the water flow as desired.

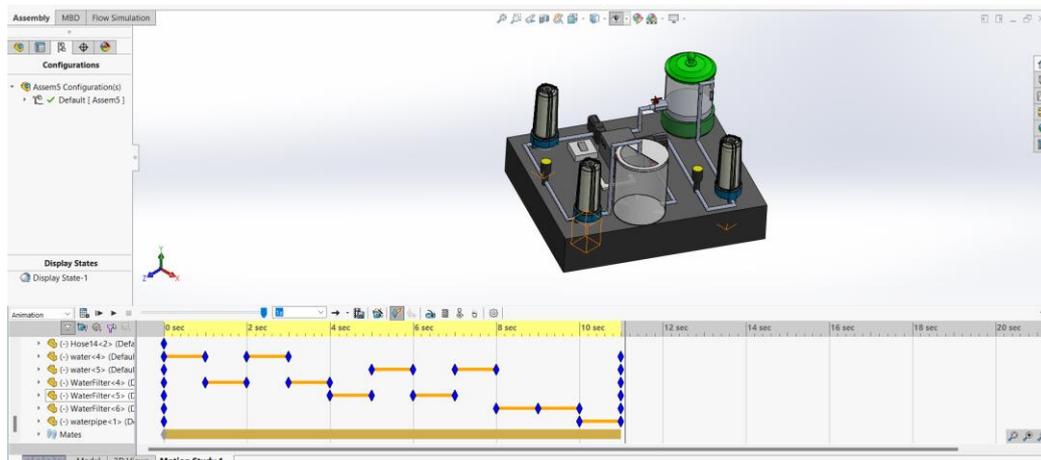


Fig. 4 Motion study of water filter system

3.3 The Real Water Filter System

As Figure 5, the system has a pressure switch and a 5-micron filter in order to remove contaminants from water that contains contaminants. A filter with a 5-micron pore size can filter a significant quantity of containment water. One factor contributing to the formation of cracks in the filter or the filter housing itself is the presence of high pressure. Consequently, the pressure switch can avoid the damage from occurring. The pressure of the water pump can be controlled via a pressure switch. A favourable outcome is being considered for this water filter. A ceramic water filter is capable of filtering silt particles and other impurities in a very smooth manner through the filter. Figure 6 shows ceramic filters that had been filtered with soil water during the water system.

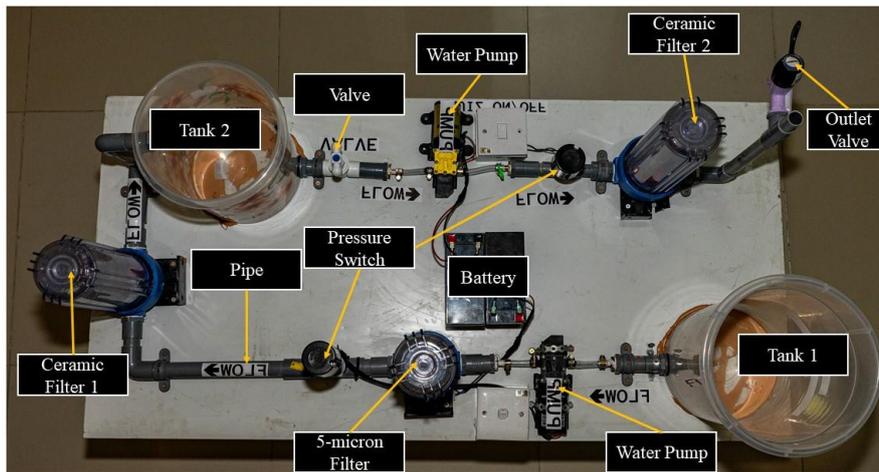


Fig. 5 Prototype ceramic water filter system

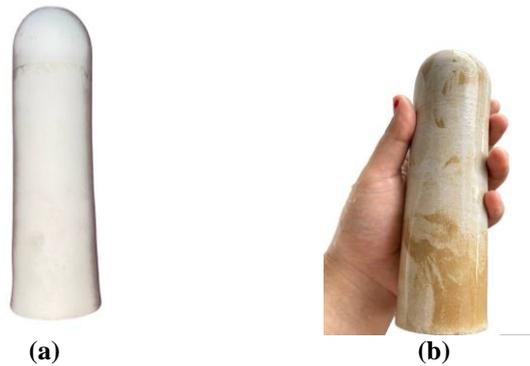


Fig. 6 Condition of ceramic filter (a) Ceramic filter before water testing; (b) Ceramic filter after water testing

4. Conclusion

In conclusion, the purpose of this study project was to carefully construct a ceramic water filter using a filter developed from rice husk silica. The system is functioning well during the process of testing the water filter system. A smooth water flow is present throughout the system, and the filter has not been damaged. Within the constraints of this water filter system, the use of various types of ceramic filter compositions is possible. Ceramic filters are made from Silica Rice husk because it is a low-cost and renewable resource. A successful test of the ceramic filter was carried out by the developed water system. While the water system was running, the ceramic filters were in good condition, although it required high water pressure to pass through the small pores on the ceramic filter. Using this filter system, it is also possible to alter the colour of the water from dirty water to clear water while maintaining the same level of cleanliness.

Acknowledgement

The authors would like to thank the Faculty of Mechanical and Manufacturing Engineering, Universiti Tun Hussien Onn Malaysia for give a support to conducting the research.

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