

Fabrication of Rice Husks Through Compaction Techniques for Water Filter Application

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Abstract

Rice husk are the outermost protective layer of rice grains. It is a byproduct that usually removed during the rice milling process. Therefore, the compaction method applied to rice husk has revolutionized its utility, transforming this agricultural waste into a valuable resource. This paper discussed fabrication water filtration with rice husk silica through compaction techniques. Since silica is the main material, it must be treated carefully as it might harm the environment. The sample mixture contains 65:17.5:17.5 ratios by weight of rice husk silica, water and polyethylene glycol (PEG). Then, the sample of water filter go through the sintering process at a temperature of 1200°C. Porosity and density testing were performed to see the physical properties of the water filter samples. The results show that 65wt% composition has the highest apparent porosity of 43.74%, indicating a larger volume fraction of open pores within the material, while 85wt% composition has the lowest apparent porosity of 39.77%. For the density, 85wt% composition has the highest density of 1.3714 g/cm³, while 65wt% composition has the lowest density of 1.2841 g/cm³. In conclusion, the objective of analyse the physical properties of the sample silica was accomplished as it showed all the necessary evidence that the sample has the evaluation to be used in apparent porosity and density.

1. Introduction

Rice husks which are separated from rice grains during the milling process, serve as robust protective coverings for the grains. This waste material, known as rice husk, is abundantly available in all rice-producing nations. It contains a significant percentage, ranging from 30% to 50% of organic carbon. According to [1], rice husks are primarily comprised of lignin, cellulose, hemicellulose and minute quantities of metal oxides. The extensive utilization of rice husks can be attributed to the fact that silicon dioxide serves as an inexpensive silicon source, frequently employed in the fabrication of substances like concrete, filter aids, and silicides.

1.1 Rice Hush Ash

Rice husk ash is derived from the combustion process of rice husk. The combustion of rice husk causes the gradual elimination of most of its volatile components, leaving behind primarily silicate residues. The properties of the ash are contingent upon the composition of the rice husks, the temperature at which they are burned, and

the duration of the burning process. When the burning of rice husks is controlled, the volatile organic matter, which consists of cellulose and lignin, is eliminated, leaving behind predominantly amorphous silica ash with a cellular structure that is microporous [2]. The pore characteristics of the rice husk ash acquired by various scholars differed, encompassing minuscule cavities and extensive interlinked openings, reliant upon the origin of rice husks, the temperature of calcination, the duration of combustion, and the duration of storage, among other factors. Additionally, the incineration of rice husks after acid leaching can generate rice husk ash containing a substantial concentration of pure silica [3]

1.2 Silica

Silica is an indigenous mineral found in various substances such as rice husk. Silicon dioxide, known as silica, can be found in two main states: amorphous and crystalline. Crystalline silica refers to a specific form of silicon dioxide that exists in a crystalline or structured form. It is a naturally occurring mineral that can be found in various types of rocks including quartz, cristobalite and tridymite. Crystalline silica is a fundamental component of the Earth's crust [4].

Amorphous silica becomes apparent as a flexible and dominant silica polymorphology found in the extraction of Rice Husk Ash (RHA). This type of silica is common in rice husk ash and does not have the long-range atomic order seen in crystalline structures. It differs from crystalline like quartz and cristobalite due to its non-crystalline, disordered atomic structure, which makes it an important participant in a wide range of industrial and research applications [5].

1.3 Water Filter

Water is an essential necessity that cannot be replaced by any other resource. In certain nations or areas, individuals still utilize tap water in their homes or use soil water from wells to meet their daily needs. In fact, severe outbreaks of diarrheal disorders continue to be caused by tainted drinking water, not just in underdeveloped but also in developed nations [6].

Porous ceramics are effective filtration elements for gathering undesired particulates in hot gas from the exhaust of diesel engines and industrial processes. Drinking water can be purified using porous ceramic filters that eliminate pollutants, viruses and heavy metals. Porous ceramic as catalyst supports the creation of hydrogen, the mineralization of phenol and the degradation of contaminants in the environment. Porous ceramics are used as parts of batteries and concentrated solar power systems for energy storage. Because of their porous structures, porous ceramics are excellent building materials because they can absorb sound and provide heat insulation [7].

2. Material and Method

The material, methods and equation known as methodology, describes all the information that is required to fabricate the water filter sample.

2.1 Materials

The raw materials used in this study are silica rice husk, water, and Polyethylene Glycol (PEG). The composition of the five sample water filters is 65wt%, 70wt%, 75wt%, 80wt%, and 85wt%. The sample shape is a round cylinder. This section described the specifications and properties of the material and equipment.

2.2 Sample Preparation

Rice husk was burned in the furnace at a temperature 500°C until the amorphous silica was produced, estimated 1.5 hours to 2 hours. The amorphous silica size will be separated using a sieving machine using 63µm. Then, the mixture of the sample contains 65:17.5:17.5 ratios by weight of rice husk silica, water and polyethylene glycol (PEG) and goes through compaction process (dry pressing). After that, the sample of water filter was produced and went through the sintering process at a temperature of 1200°C. Lastly, the sample is tested for porosity and density, and the result is obtained by getting the average value for porosity and density testing. Sample after sintered is also analyzed with microstructure analysis.

3. Result and Discussions

The result will consist of the colour change of the water filter samples after sintering process, average value of all tests (porosity and density). It also shows the result of microstructure analysis.

3.1 Physical Observation

After the sintering process, the sample is observed based on their physical difference at the same sintering temperature. Table 1 shows the physical observation before and after sintering process. Based on the Table 1, the sample at 1200°C sintering temperature shows the colour obviously different after sintering process the changes colour from dark to light and little bit crack.

Table 1 Samples before and after sintered at 1200°C

Composition	Before Sintering Process	After Sintering Process
Composition 1 65% Silica 17.5% Water 17.5% PEG		
Composition 2 70% Silica 15% Water 15% PEG		
Composition 3 75% Silica 12.5% Water 12.5% PEG		
Composition 4 80% Silica 10% Water 10% PEG		
Composition 5 85% Silica 7.5% Water 7.5% PEG		

3.2 Shrinkage, Apparent Porosity and Density

All tests were conducted three times, and the average value was taken. Table 2 shows the average value of all tests.

Table 2 The average value of porosity and density

<i>Silica Composition (wt%)</i>	<i>Apparent Porosity (%)</i>	<i>Density(g/cm³)</i>
65wt%	43.74	1.2841
70wt%	40.28	1.3594
75wt%	41.37	1.3384
80wt%	40.32	1.3553
85wt%	39.77	1.3714

From Table 2, 65wt% composition has the lowest density value of 1.2841 g/cm³ and 85wt% composition has the highest density value of 1.3714 g/cm³. Then, the highest percentage of apparent porosity was in 65wt% composition which is 43.74% and the lowest percentage of apparent porosity was in 85wt% composition which is 39.77%. Results from the table show that the 65wt% composition has the highest apparent porosity and the lowest density value, while the 85wt% composition has the highest value density and the lowest apparent porosity.

3.3 Apparent Porosity and Density Analysis

Figure 1 and Figure 2 show the graph of apparent porosity and density against different compositions. We can see that 65wt% composition has the highest apparent porosity of 43.74%, indicating a larger volume fraction of open pores within the material, while 85wt% composition has the lowest apparent porosity of 39.77%. Lastly, for the density, 85wt% composition has the highest density of 1.3714 g/cm³, while 65wt% composition has the lowest density of 1.2841 g/cm³.

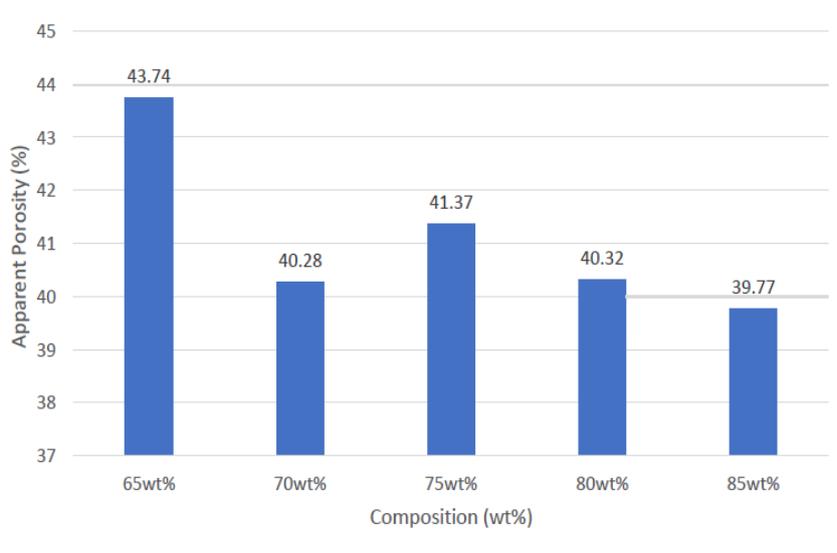


Fig. 1 Graph for different silica composition against apparent porosity

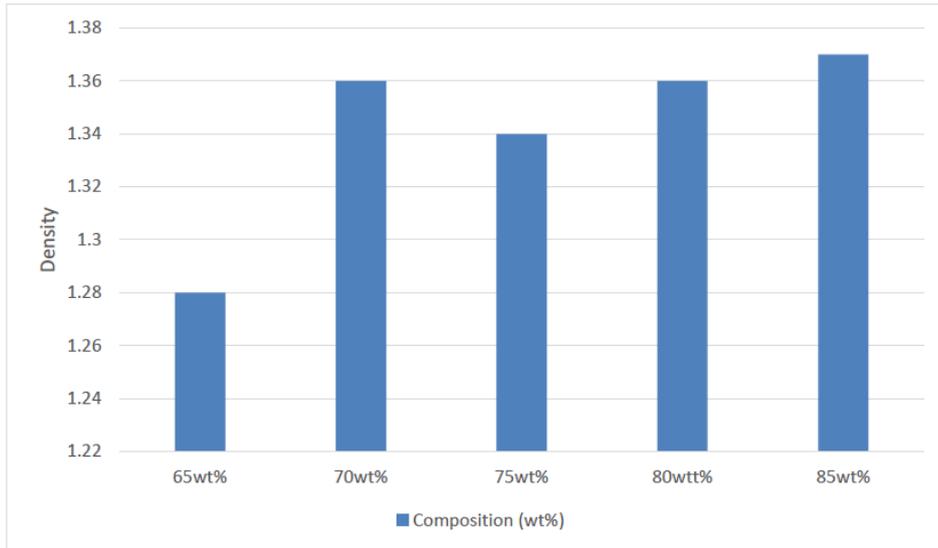
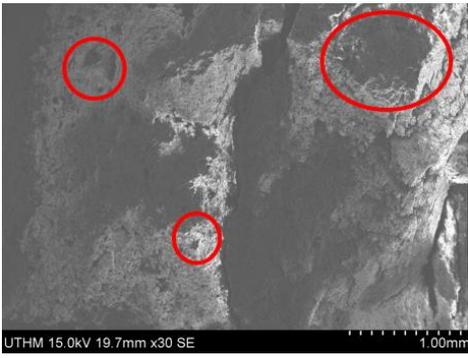
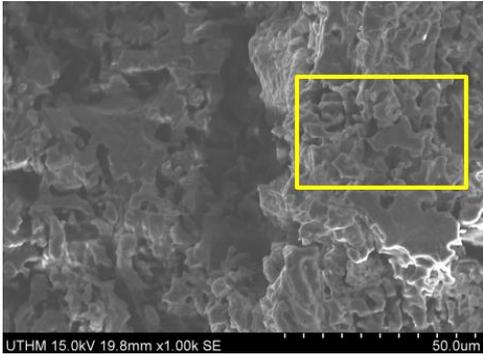
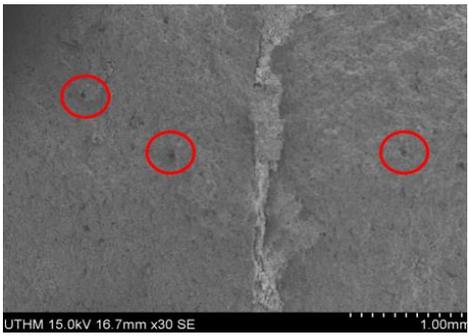
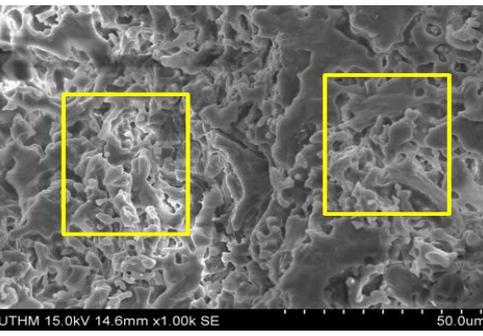


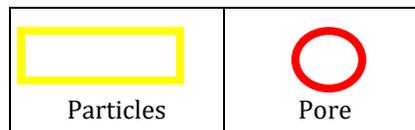
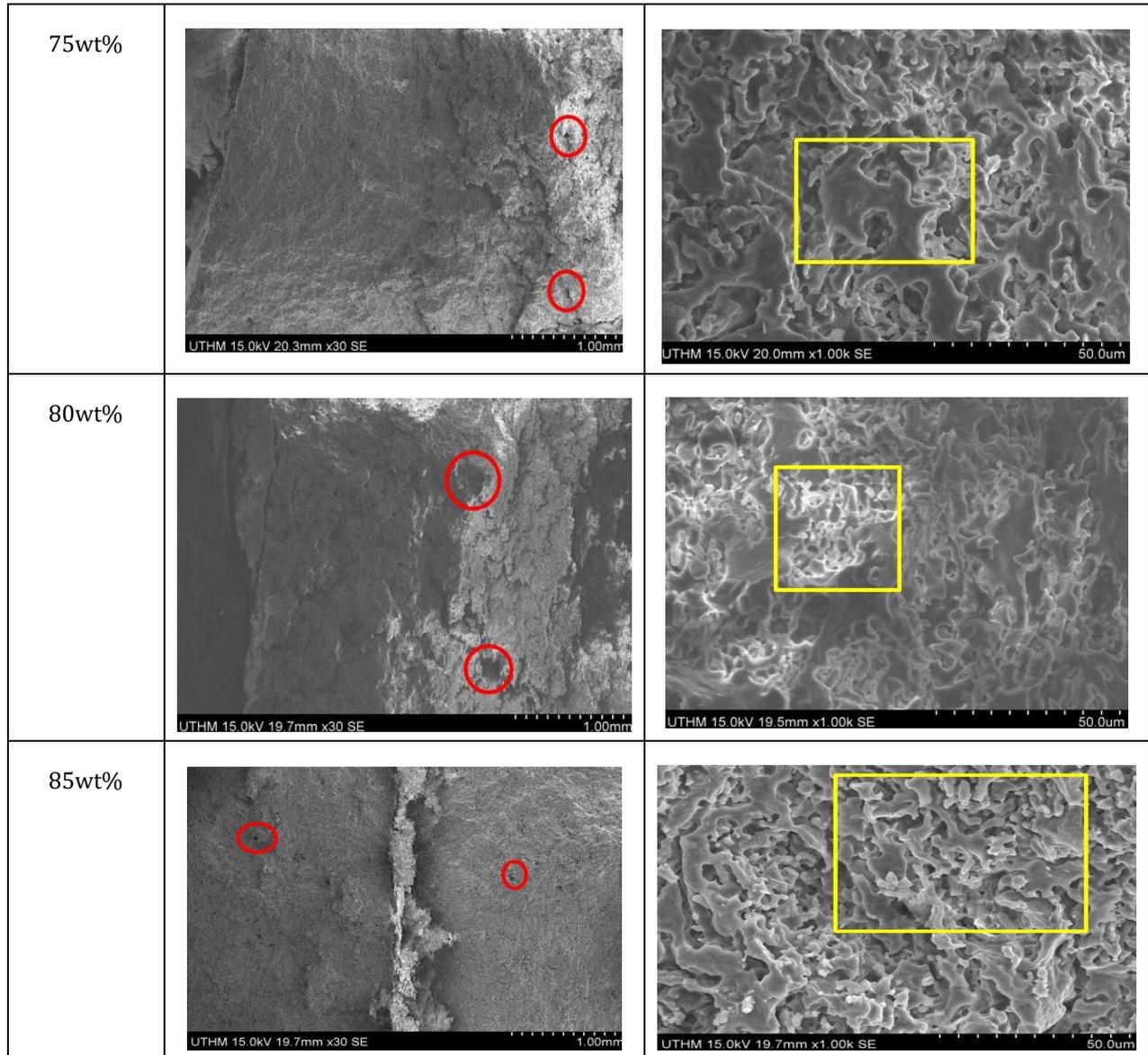
Fig. 2 Graph for different silica composition against density

3.4 Microstructure Analysis

Scanning electron microscope is used to determine the particle size and structure image of silica. The microstructure test is very important to determine the pore size and to observe the bond particle from five different compositions that have been sintered. Figure 3 shows the morphology of composition 65wt%, 70wt%, 75wt%, 80wt% and 85wt% with 30x and 1000x magnification. It shows that 65wt% composition has the highest porosity, and the particle is combined while the 85wt% composition has the lowest porosity, and the particles become larger due to the fusion between the particles.

Fig. 3 The morphology of silica composition 65wt%, 70wt%, 75wt%, 80wt% and 85wt% with 30x and 1000x magnification.

Composition	30x magnification	1000x magnification
65wt%		
70wt%		



4. Conclusion

In this study, water filtration with rice husk silica through compaction techniques was fabricated using several materials. Rice husk ash has been used as a primary material, and the type of rice husk ash is a chemical RHA that is burned at 500°C. The composition of the silica rice husk, water, and polyethylene glycol (PEG) is stated at a ratio of 65:17.5:17.5. The process of producing the water filter uses a dry pressing method. During the pressing process, compaction pressure is 3 tons within 5 minutes. After that, the sample is inserted into the furnace and sintered at 1200°C. Furthermore, we can see that 65wt% composition has the highest apparent porosity of 43.74%, indicating a larger volume fraction of open pores within the material, while 85wt% composition has the lowest apparent porosity of 39.77%. Then for the density, 85wt% composition has the highest density of 1.3714 g/cm³ while 65wt% composition has the lowest density of 1.2841 g/cm³. In conclusion, the objective of analysing the physical properties of the sample silica was accomplished as it showed all the necessary evidence that the sample has the evaluation to be used in apparent porosity and density.

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