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Fabrication of Water Filter Using Silica Powder from Rice Husk Waste Product Under Compaction Method

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Abstract. Ceramic water filtration is the method of filtering water using a porous ceramic medium to remove contaminants or germs and also the pore size of the ceramic water filter is small enough to catch anything larger than a water molecule, including bacteria. By producing silica water filter from rice husk for the use in water filter can help to purify the water and remove unwanted substance from the water. This study, the type of silica which is amorphous is used with very low residual carbon content was successfully achieved through combustion with a temperature of 500 °C. The sample of product was prepared and each of the sample product were mixture with Polyethylene Glycol by 1 wt%. The sample product was compacted by hydraulic press machine with the pressure used is 7 tones. The sintering process has been conducted in temperature of 900°C,950°C,1000°C,1050°C and 1100°C with two different composition of silica which is 60 wt% and 65 wt%. The result of bulk density, apparent porosity and water absorption were recorded for each sample. Based on the result, the favorable properties of sample sintering were obtained at sintering temperature of 1100°C Thus, the appropriate values of apparent porosity, water absorption, and bulk density for silica 60 wt% were 59.8499%, 71.2486%, and 0.84 g/cm^3, respectively, while for silica 65 wt% were 65.5086%, 82.9045%, and 0.7902 g/cm^3. In conclusion, the objective of this study was achieved to filter the waste water using silica water filter.

INTRODUCTION

Ceramic water filtration is the method of purifying water from contaminants or germs using a porous ceramic material. [1]. Water filters have grown from a desire to improve poor tastes, then to successfully remove materials that may cause diseases, and ultimately to eliminate elements that influence appearance. The objective of this study is to create a silica filter using the compaction process and analyse the physical properties of silica once the water filter is created.

The abundant of rice husk today is the reason why many researchers want to study the benefits and appropriate ways to increase the use of rice husk as well as reduce the waste produced by paddy agriculture. Many advantages

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that can be produced by rice husk which is into fuel and fertilizer. Rice husk is not popular with farmers because it is so cheap to sell. Therefore, the waste produced by paddy crops is a contributor to abundant and causes this waste not to be used. Rice husk recycling aims to conserve limited resources by reusing materials or finding sustainable substitutes to study the fundamental of water filter.

The relative amount of silica was increased after burning out the rice husk at different times and temperatures. A 95% silica powder could be produced after heat-treating at 700ºC for 6 hours [2]. Silica in rice husk ash contain of amorphous and crystalline. According to S. K. Hubadillah (2018) amorphous and crystalline silica of rice husk ash can be produced when burned at 550ºC to 800ºC and 900ºC to 1300ºC, respectively [3]. However, rice husk ash can cause environmental and health problems if it ends up being dumped in open spaces, therefore, it is very important to find pathways to fully utilize the rice husk ash. This generates rice husk ash, which contains a huge quantity (85-95%) of amorphous silica [4]. Then, it is a low-cost and renewable resource, rice husk is a promising adsorbent material for eliminating various pollutants. So, in this research the amorphous silica has been chosen to product water filter because of the low consumption of energy to produce the silica form rice husk.

METHODOLOGY

For this study, the preparation of raw materials required is Rice husk from Pasir Puteh, Kelantan. To produce 100g of silica rice husk, it needs to burn 1 kg of raw rice husk at a ratio of 1:10. In additional, the rice husk was converted into powder after burning process with temperature of 500 ºC in the furnace. Uniaxial pressing technique were applied for sample fabrication because it can be produced large quantity. The composition of silica that have been used are 60wt% and 65wt%. The sintering process has been conducted in temperature of 900ºC,950ºC,1000ºC,1050ºC and 1100ºC. The sintering temperature and soaking time are two important sintering parameters that can impact the value of result. Table 1 shows the samples were sintered at temperature ranging from 900ºC to 1100ºC with soaking times ranging from 1 to 2 hours. Due to its high silicon content, rice husk has become a source for preparation of elementary silicon and a number of silicon compounds, especially silica, silicon carbide and silicon nitride. In the other hand, physical testing was performed to determine the physical properties of ceramic material, the condition of microstructure aspect of the ceramic sample. Physical properties obtain from the testing provide evidence of localized density variation, type of porosity and volume drop off from the composition of the ceramic. The test is conduct using measuring instrument to obtain important value to analyze the finding.

TABLE 1. Sintering parameters and their intervals

Sintering Temperature	900ºC	950ºC	1000ºC	1050ºC	1100ºC
Soaking time	2 hours	2 hours	2 hours	2 hours	2 hours

RESULT AND DISCUSSION

This chapter is then continuing by proper discussion on the result which is water absorption, bulk density and apparent porosity were recorded for each sample.

Water Absorption Analysis

The percentage of water absorption for each sintered sample from 900°C, 950°C, 1000°C, 1050°C and 1100°C. Figure 1 shows the graph for water absorption and results against the sintering temperature of the composition 60wt% and 65wt% of silica.

Referring to the Fig. 1, it can be noted that the result produces decreasing value of water absorption when the sintering temperature increase. Sintering temperature at 1100 ºC shows the lowest value obtained is 71.2486% and 82.904 % and the highest value obtained at sintering 900ºC which is 97.2823% and 99.6468% for the composition of silica 60 wt% and 65 wt% respectively. Figure 1 shows that the sintering temperature between 900 ºC,950 ºC and 1000 ºC obtained high ranges value of water absorption compared to the sintering temperature of 1050 ºC and 1100 ºC.

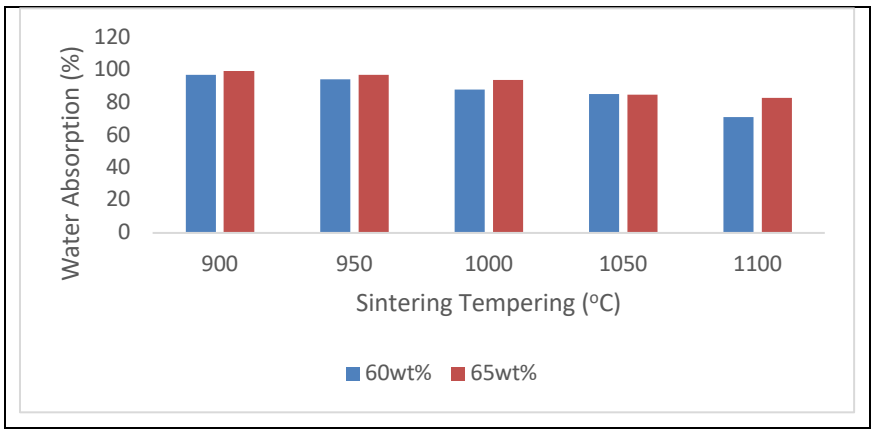

FIGURE 1. Results of water absorption for silica water filter at different sintering temperature

The graph trend produces decreasing for different of composition. The value obtained for the 65 wt% is higher than 60 wt% for the increasing of sintering temperature by 0.1% at the 1100 °C. According to Sutas, J. Mana, A. and Pitak, L. (2012) the water absorption increases with the increasing of composition silica rice husk because of the high porosity spacemen with evaporate of rice husk when burn [11].

The composition of 65 wt% shows the higher value obtained of percentage of water absorption than 60 wt% of silica. The result of water absorption normally associated with density. The previous research established that the amount of water absorption is depend on the arrangement of the pores and the way they are link together [7].

Bulk Density Analysis

For determining the physical of ceramic material, the value of density is an important factor. Figure 2 shows the graph of bulk density against the sintering temperature. Density was measured by Archimedes principle and the result provide were based on sintering temperature.

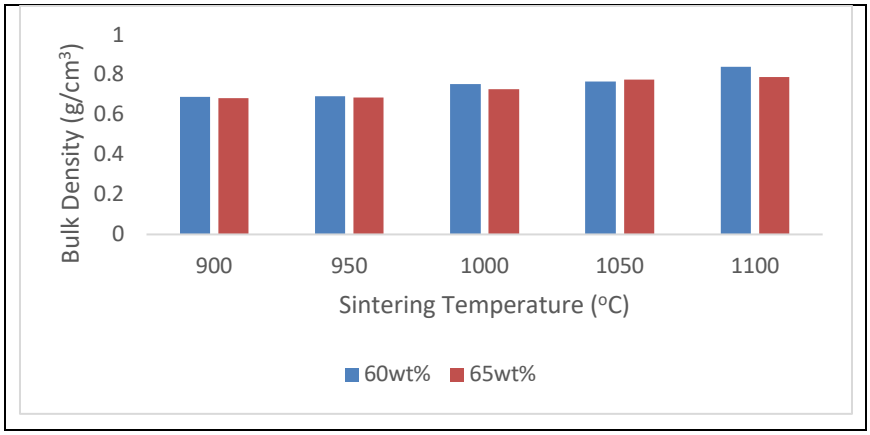

FIGURE 2. Results of bulk density for silica water filter at different sintering temperature

Figure 2 reveals that the result produces for different composition of silica which is 60wt% and 65wt%. The graph shows value obtained for density is increasing when the sintering temperature increase. The sintering temperature for 900°C shows the lowest density value for different composition. The value obtained for 900 °C is 0.6911g/cm^3 and 0.6834g/cm^3 for the 60wt% and 65wt%. The increasing value of density is at 1050 °C and 1100 °C for different composition silica. The increment value for 60wt% and 65wt% of silica are 0.0014% and 0.001%.

Accordingly, there is a clear trend of increasing density value obtained within increasing of sintering temperature showed in Fig. 2. Bulk density increases slowly up to 950 ºC by a rapid increase up to 1100 ºC. From previous research the porosity affected the bulk density value, because of the increase in strength with sintering temperature is due to the sintering phenomena, where particle rearrangement, mass diffusion to pores and grain growth take place [10]. As the result, the bulk density increase, the porosity decreases.

However, J.P. Nayak and J. Bera (2009) endorsed the usage of rice husk ash as a source of silica in their research by employing it in Fig. 1 and 2 [5]. According to their findings, as the sintering temperature rises, the percentage of water absorption decreases and the bulk density rises.

Apparent Porosity Analysis

Apparent porosity analysis was carried out for this study because the porosity would five a significant influence on the mechanical properties of ceramic material. The structure of the ceramic body would become more fragile if the value of the resulting porosity is large. The Fig. 3 show the graph of apparent porosity against sintering temperature.

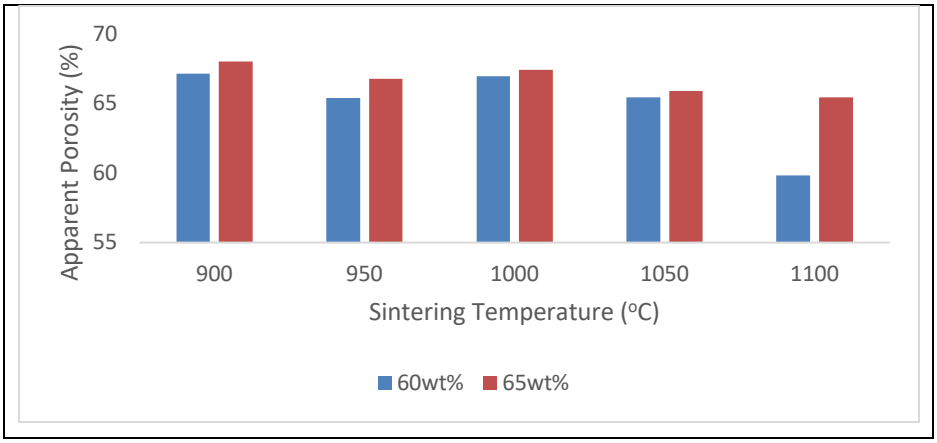

FIGURE 3. Results of apparent porosity for silica water filter at different sintering temperature

By reffering to the Fig. 3, it can be seen that the temperature of 900 ºC produce high apparent porosity value which is 67.2323% and 68.0953% for 60wt% and 65wt% composition of silica. The small decrement value of percentage between 900 ºC and 1000 ºC can be seen which range 0.002% and 0.005%. Meanwhile, for sintering temperature at 1100 ºC show lowest percentage value of apparent porosity which is 59.8499% and 65.5086%. High porosity indicates that there are more blank spaces in the ceramic filters, allowing water to travel through the filter components [10]. According to Bulta and Micheal (2019) the high flow rate with 63.91% value of apparent porosity is good for reduce clogged of water filter with high turbidity which is easiest way to allow the water to flow through the element.

The graph trend produced was nearly similar with water absorption. Sintering temperature elevation would give lower apparent porosity value at 1100 ºC and increasing sintering temperature deacrease apparent porosity. Also, the examination of obtained findings revealed that the apparent porosity samples tend to decrease with increasing sintering temperature. Following to Görhan, G. and Şimşek, O. (2013) an increase of rice husk leads to an increase in the apparent porosity and this effect decrease the unit weight and improved the thermal insulating properties [9].

CONCLUSION

This experiment shows sintering temperature influences water filter sample qualities. The suitable properties of sample sintering were obtained at sintering temperature of 1100^{o}C. When the sintering temperature increases, the water filter sample will turn bright. As sintering temperature increases, apparent porosity decreases as well, water absorption decreases, and bulk density increases. In addition, the physical properties of silica rice husk are investigated. The value of results show that the silica rice husk provides results which can be potentially used in production water filter.

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