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Effect of Burning Temperature on Rice Husk from Pasir Puteh and Pasir Tumboh Areas, Kelantan

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Abstract: In this study, among the locations taken to see in terms of differences in element composition are in Pasir Puteh and Pasir Tumboh, Kelantan. The samples were divided into five samples according to location with temperatures of 550°C, 650°C, 750°C, 850°C and 950°C. Sintering method by using sintering profile according to the respective temperature in the furnace machine. The analysis performed is the analysis of microstructure, element composition, thermogravimetric and molecular. Ten burnt samples and two raw samples will be involved in this analysis. In conclusion, samples from Pasir Puteh and Pasir Tumboh can be compared in terms of microstructure, element composition, weight reduction and molecular content.

Keywords: Element Composition, Pasir Puteh, Pasir Tumboh, Rice Husk, Silica

1. Introduction

The outer layer of the rice grain, or rice husk, is a by-product of the milling of rice. In all countries that produce rice, it is an agricultural waste product. As in Malaysia, the demand for rice is one of the biggest commodities and it is increasing all the time. The feasibility of this product as a raw material to be further processed in order to have a higher economic worth will unquestionably be ensured by low pricing and vast volumes [1]. There are several applications for use by rice husks that have been identified such as adsorbents for wastewater treatment, raw materials for bioethanol and even biogas or used as composite materials for polymers and building materials [2].

This study focuses mainly on the process of producing crystalline silica from rice husk at different temperatures and times 550 - 950℃ [1] and also analyzes the data obtained. Crystalline silica from rice husk for the combustion process was chosen because of its reliability and advantages such as the availability of raw materials such as rice husk is easy to find and readily available [3], can save

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agricultural waste and can minimize the environmental impact when using rice husk, the high silica content makes it useful for reinforcing in building materials and the nature of silica is known as a porous material [4].

The main objective of this study is to produce crystalline silica powder from rice husk Pasir Puteh and Pasir Tumboh, Kelantan through the method of combustion in a furnace machine. Next, to identify the differences of factor and mineral composition of silica powder at 550°C, 650°C, 750°C, 850°C and 950°C based on sintering profile. Finally, to determining the burning temperature against morphological, elemental, thermogravimetric and molecular analysis of silica powder after the sintering process.

2. Materials and Methods

2.1 Production of silica from rice husk

Rice husk was obtained from Pasir Puteh and Pasir Tumboh, Kelantan, Malaysia. First, silica must first be obtained from rice husk. Then, the rice husk is washed twice using water in a tank and after completion, placed on a canvas and left to dry in the sun for 2 days. Dried rice husk was then baked at 550, 650, 750, 850 and 950°C based on sintering profile. Thereafter, crystalline silica powder was collected and obtained.

The burning process (sintering profile) is important in producing crystalline silica from rice husk. In this study, 550, 650, 750, 850 and 950°C heating temperature were used as parameters. The combustion rate occurs and is maintained at the same temperature based on the parameters. When the temperature reaches the parameter temperature, it is constant in 2 or 3 hours. Thereafter, the furnace temperature decreases horizontally to room temperature.

2.2 Characterization of rice husk

The Scanning Electron Microscopy (SEM) analyses of the morphology of a solid object. It is also using a very fine beam of detector electrons through the entire surface of a material to emit a wide variety of signals that are directly proportional to the amount of radiation. The sample was placed onto the sample holder before being brought to the gold coating process under high vacuum. It was operated at 10kV with 15mm working distance.

Using a thermogravimetric (TG) analyzer, the basis for rice husk was carried out using pyrolysis experimental method. LINSEIS STA PT 1600 (TGA-DSC) was used to conduct the study. Sample of 7 – 9 mg was heated at rating 10℃/min from room temperature to 950℃ under nitrogen atmosphere with a flowrate of 150 ml/min.

2.3 Characterization of silica

X-ray diffraction energy (EDX) is performed to find out the elements present in the sample performed after combustion. These elements occur during the combustion process where high temperatures are applied to the rice husk samples. The main purpose of this x-energy diffraction test is to provide guidance on the presence of elements in the rice husk samples rather in chart or mapping after the combustion process is performed. This X-energy diffraction analysis was performed using a scanning electron microscope (SEM).

The functional groups in the sample were determined using a Spectrum 100, PerkinElmer, Inc., USA, FTIR equipped with attenuated total reflectance (ATR) accessory. The spectra were recorded with 12 scans at a resolution of 4 cm-1 in the range of 4000 - 400 cm-1.

3. Results and Discussion

3.1 SEM analysis of rice husks

Through this microstructural analysis conducted, it is clearly shown that the combustion temperature affects the microstructure of rice husk samples. The higher the combustion temperature, the smaller the pore size and the particles become larger due to the fusion between the particles and the higher their compaction. Meanwhile, for the outer surface of Pasir Puteh and Pasir Tumboh raw rice husk, it was not treated showing uneven and very rough condition.

From figure 1, based on this morphological analysis of these two types of rice husk by looking at the structural distribution of rice husk during the combustion process without destroying the brittle silica network, produces a three-dimensional porous structure. Pasir Tumboh crystalline silica powder shows the strength of the rice husk structure. This is clear as this subsequent analysis explains that the uniformity of its elements does not change at a considerable rate with different temperatures. Pores and structural fragility will still occur, but to compare the studied image clearly Pasir Tumboh crystalline silica powder compared to Pasir Puteh silica is stronger in terms of structure.

Figure 2 shows a water filter sample with 60% silica content has been sintered at a temperature of 1000°C while magnified by a factor of 500. In addition to the uneven morphological condition of this sample structure, there are more tiny pores produced on the sample surface compared to 50wt% sample. The presence of this small pore size does not allow this water flow rate to flow easily through this sample.

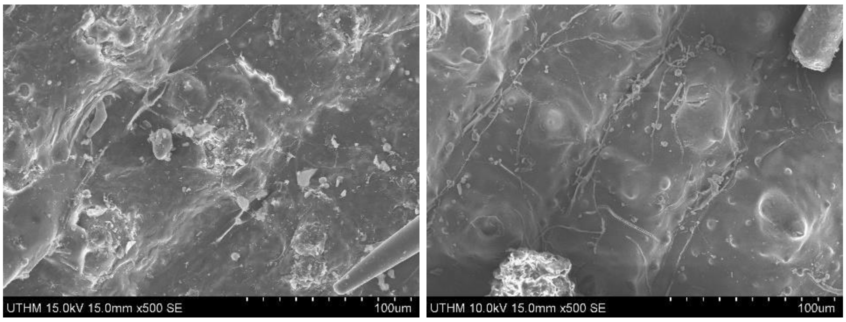

Figure 1: Morphology of a) Pasir Puteh and b) Pasir Tumboh raw sample compare due to it roughness.

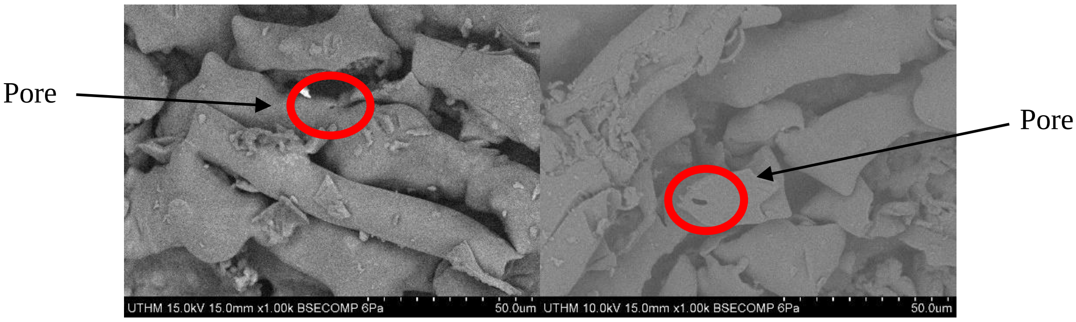

Figure 2: Morphology of a) Pasir Puteh and b) Pasir Tumboh magnification of x1000 of 950°C sample compare due to the size of the pore (circle).

3.2 Thermogravimetric Analysis (TGA) of rice husks

The presence of organic materials in the rice husk was discovered via TGA. Figure 3 shows the TGA curves of Pasir Puteh and Pasir Tumboh rice husks. Without regard to acid leaching, it can be shown that initial weight loss occurs between 50 - 150°C, with a weight loss of 1 to 2% corresponding to the loss of water and other volatile substances.

In the second stage, weight loss occurs quickly and significantly at temperatures between 250 - 360°C. This is because cellulose and hemicellulose, two important organic components of rice husk, thermally decompose. The least stable component of rice husk, hemicellulose, decomposes mostly between 200 - 350°C, while cellulose decomposes between 300 - 350°C. Due to the acid hydrolysis of hemicellulose and cellulose into lower molecular weight molecules that are more easily thermo regulated, the Pasir Tumboh rice husk demonstrated better thermal stability than the Pasir Puteh rice husk.

The third stage displays a weight loss of between 30 - 50%, which may be caused by lignin, an aromatic polymer that decomposes gradually between 370 and 500°C and is thermally more stable. The non-combustible silica makes up most of the ash residue.

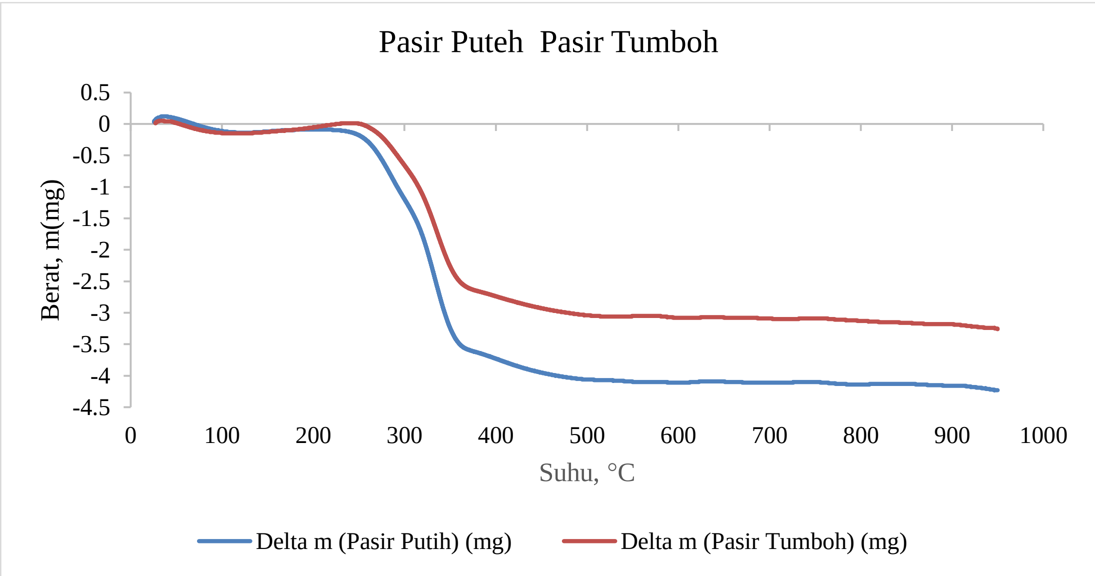

Figure 3: Weight reduction for both Pasir Puteh vs Pasir Tumboh rice husks in TGA analysis

3.2 EDX analysis of silica

Si, O, and C were the most prevalent elements in the EDX profile of Pasir Puteh and Pasir Tumboh of 950°C mentioned in Figure 4 & 5. The silica is represented by the Si and Oxygen peaks. The unburned carbon can be the cause of the minor peak that corresponds to C. The images from Figure 4 & 5 of rice husk crystalline silica that were roughly taken along the zone axis are displayed in EDX analysis mapping. There are maps of O (yellow), Si (red), and some C (blue). Given that the powder is dispersed across the surface of the carbon tape, it virtually mimics the situation where each column of atoms is not entirely resolved in comparison to O and Si. The blue boat image demonstrates that the samples are mostly isolated along the visible tape surface contact, where the C atoms not only precipitate randomly but also predominately isolate. Table 1 shows the percentage of weight of oxygen and silica element from this analysis.

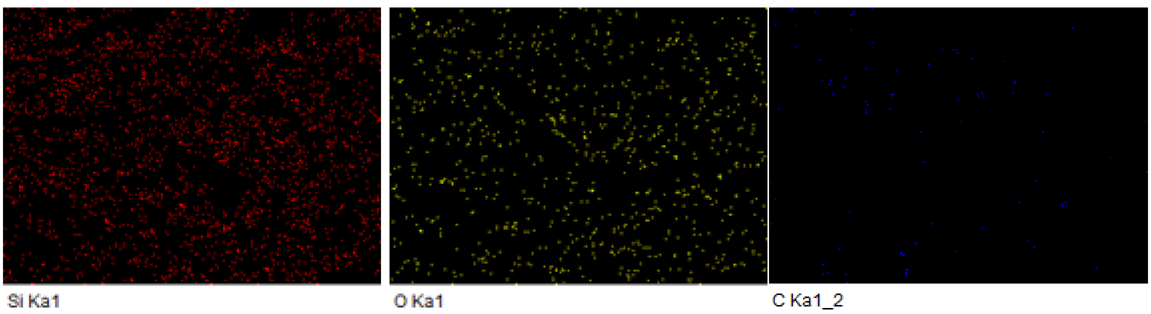

Figure 4: EDX and mapping of the EDX of Pasir Puteh of 950 ℃ at x50 magnification

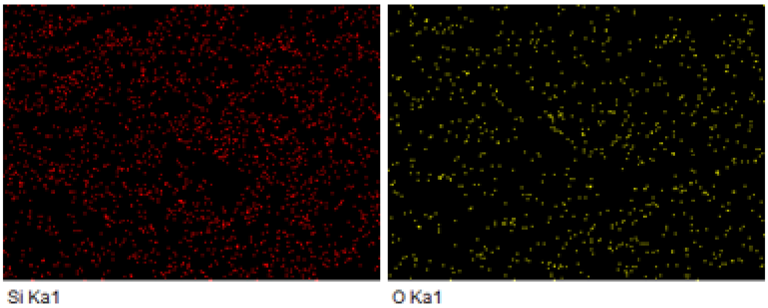

Figure 5: EDX and mapping of the EDX of Pasir Tumboh of 950 °C at x50 magnification

Table 1 Mapping data based on weight percentages of oxygen and silica from EDX

Rice Husk	Temperature	Element weight (%)		
		Oxygen (O)	Silica (Si)	Carbon (C)
Pasir Puteh	550°C	61.06	38.94	10.83
Pasir Tumboh	650°C	56.27	43.73	-

3.2 Fourier transforms infrared (FTIR) analysis of silica

Figure 6 depicts the FTIR spectra of crystalline silica from Pasir Puteh and Pasir Tumboh at 950°C (combustion at 950°C is used as an example; silica spectra at other combustion temperatures were comparable). O-Si-O stretching, and bending vibrations are responsible for the prominent absorption peaks at 1059 cm^{-1}, 790 cm^{-1}, and 620 cm^{-1}. The higher the peak of the transmitter, the lower the presence of silica.

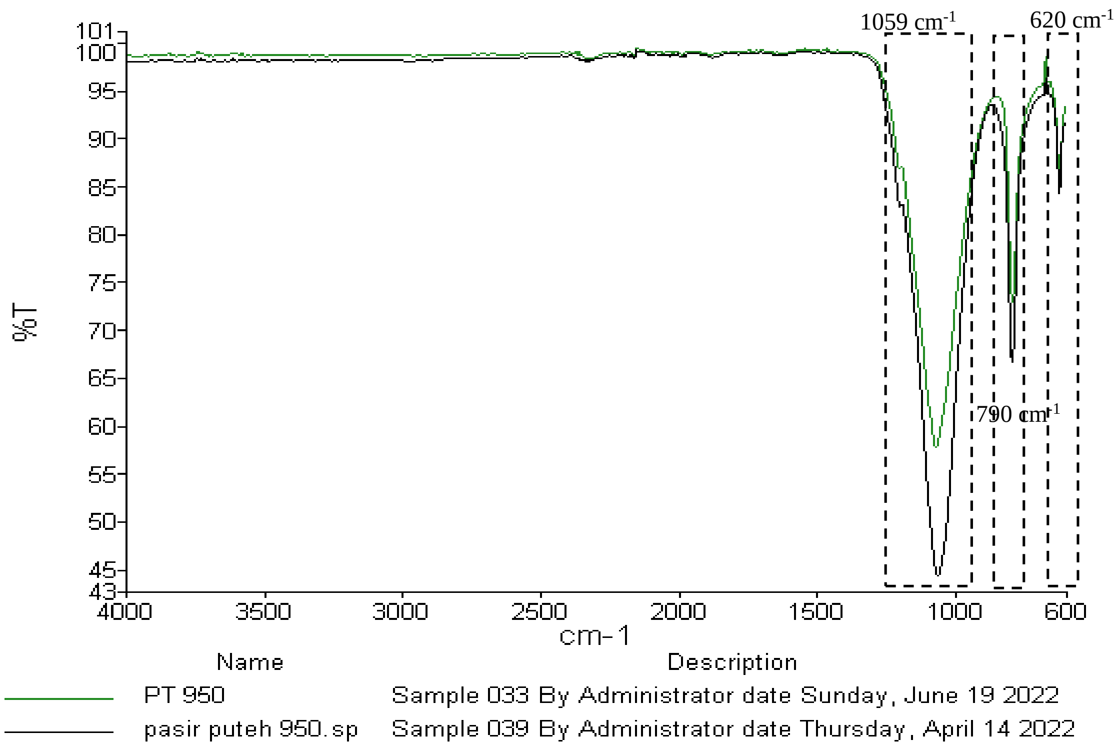

Figure 6: FTIR spectra of Pasir Puteh and Pasit Tumboh crystalline silica

4. Conclusion

A presence of crystalline silica for all sample after combustion process due to sintering profile as proceed to gather the analysis to be taken. Comparison for both Pasir Puteh and Pasir Tumboh can be conclude that the element composition has been observed by analysis of SEM, EDX, TGA and FTIR. As for this experiment, increasing of heat in burning can change the content and percentage of silica content in both rice husk from Pasir Puteh is decreasing in silica meanwhile Pasir Tumboh were increasing. This means that presence of silica in Pasir Tumboh rice husk is higher than Pasir Puteh rice husk.

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