Effect of Rice Husk Firing Temperature on Synthesis of Silica (SiO_2)

N. A. A. Ismail[1], M. Azham Azmi[2], S. Ahmad[3], H.Taib[4]

[1, 2, 3, 4]Faculty of Mechanical and Manufacturing Engineering, Universiti Tun Hussein Onn Malaysia, 86400 Batu Pahat, Johor, Malaysia

[1]ikamira.ismail@gmail.com, [2]azham@uthm.edu.my, [3]sufizar@uthm.edu.my, [4]hariati@uthm.edu.my

ABSTRACT

This paper presents the synthesis of silica (SiO_2) from rice husk at different firing temperatures. Due to the environmental awareness and to reduce air pollution, agricultural wastes specifically rice husk is used to produce SiO_2. Silica was prepared by washing with clean water without any chemical treatment. The rice husk was fired at 700, 800, 900, 1000, 1100 and 1200°C. In order to determine the effect of firing rice husk at different temperature, X-ray Diffraction (XRD) analyses were conducted. Crystalline silica were obtained at 1100°C and 1200°C firing temperature. At 900°C and 1000°C firing temperature, silica was observed to be in a transitional phase of amorphous into crystalline or it called as semi crystalline. However, at 700°C and 800°C silica remains to be in amorphous phases.

Keyword

Rice husk, Crystalline silica, Amorphous silica, X-ray diffraction (XRD)

Introduction

Natural silica (SiO_2) can be obtained from various the extraction of natural resources. Rice husk are potential to produce silica after undergoing several processes of cleaning, purification or modification and incineration. Contents of SiO_2 identified in rice husk are about more than 80% [1]. Rice husk ash obtained by rice husk firing at high temperature contains more than 90% of silica. The rice husk ashes produced were white in colour and grey to black ashes.

The black coloured rice husk ash is the unfired carbon in the silica due to burning process. In order to remove the remaining unfired carbon, the rice husk should be burnt at higher temperature of more than 700°C. Firing rice husk at different temperature would influence the existence of amorphous SiO_2 and crystalline SiO_2 or both [2]. Amorphous SiO_2 was detected in rice husk ash at lower burning temperature. Below 500°C, rice husk ash remains in form of amorphous SiO_2, while crystallization of SiO_2 overtakes after this temperature [3].

The objective of this study was to determine the firing temperature for crystalline SiO_2.

Experimental and Method

Washing/Cleaning

The rice husk from Muar was washed using tap water to remove unwanted residues.

Drying

The cleaned rice husk was placed on a canvas and left to dry under the sunlight for two days until the rice husk dry completely.

Firing

Dried rice husk was fired in the kiln furnace from room temperature to 700°C until 1200°C with heating rate of 10°C/min.

Sieving

Rice husk ash samples were sieved to pass through 25μm mesh sieve.

Characterization

The rice husk ash samples were characterised using X-ray diffraction (XRD) as to identify the crystallization of the samples and different phases of SiO_2 at different firing temperatures.

Results and Discussion

XRD patterns of the samples are shown in Fig. 1 and Fig. 2. Fig. 1 shows that crystalline structure for SiO_2 was not formed at firing temperature of 700°C and 800°C. This indicated by the appearance of single diffuse broad peak at about 21.764 2θ°. The broad peak is an indication of non-crystalline phase existence as stated by Ayswarya *et al.* [4]. Crystalline phase started to form at 900°C, as proven by the development of a more narrow and intense peak at 21.764 2θ°.

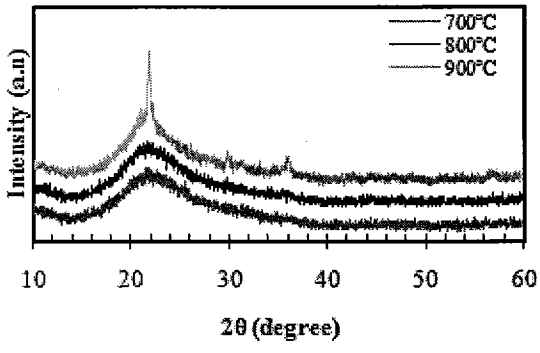

Fig. 1. XRD patterns of rice husk firing at 700°C, 800°C and 900°C.

The formation of crystalline phase of SiO_2 was increased after firing the rice husk at higher temperatures (1000°C, 1100°C and 1200°C) as shown in Fig. 2. More intense peaks appeared at 1000°C firing temperature because the formation of cristobalite and tridymite. The peaks were very narrow and intense at higher firing temperature (1100°C and 1200°C) which is reflecting higher crystallinity [5]. The phases detected were matched with the ICDD PDF database.

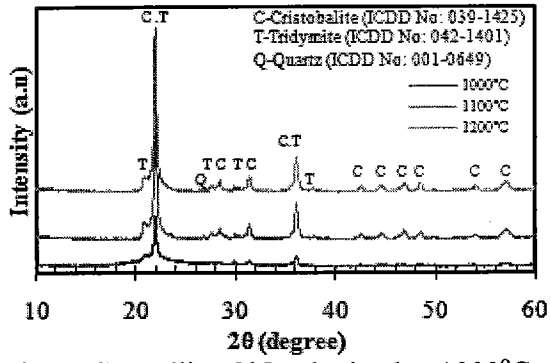

Fig. 2. Crystalline SiO_2 obtained at 1000°C, 1100°C and 1200°C rice husk silica firing.

Conclusions

Firing temperature of rice husk indeed affected the silica phase. Amorphous SiO_2 was formed by firing rice husk at 700°C and 800°C and completed crystalline SiO_2 formation occurred at 1100°C. Cristobalite, tridymite and quartz were found to be the major phases present in the SiO_2 obtained from rice husk.

References

[1] A. Onojah., A. N. Amah and I. M. Echi (2012). Polymorphs of Crystalline Silica from Rice Husk Ash. *Journal of Basic Physical Research*, 73-75.

[2] Y. Shinohara and N. Kohyama (2004). Quantitative Analysis of Tridymite and Cristobalite Crystallized in Rice Husk Ash by Heating. *Industrial Health*, 277-285.

[3] A. A. Boateng and D. A. Skeete. (1990). Incineration of rice husk for use as cementitious material: the Gunaya experience. *Cement and Concrete Research*, 795-802.

[4] E. P. Ayswarya, K. F. Francis, V. S Renju and E. T. Thachil (2012). Rice husk ash - A valuable reinforcement for high density polyethylene. *Material and Design*, 1-7.

[5] D. R. Lee (2005). Characterisation and the diagenetic transformation of non and micro-crystalline silica minerals. *Department of Earth and Ocean Science, University Of Liverpool*, 1-20.