Study on the Silica from Rice Husk Ash by XRD and XRF

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Abstract— This work presentented a laboratory studies on the preparation of rice husk ashes (RHAs) by burning temperatuers at 600˚C for 3hr, 4hr, 5hr and 6hr. Consequently, silica content of RHA obtained from heating 6hr was 83.57%, RHA (from gasifier) obtained from heating 6hr was 93.44% and RHA obtained from leaching and heating 6hr was 89.24% by X-ray fluorescence (EDXRF- Quen X). X-ray diffraction (XRD) and X-ray fluorescence (XRF) were applied for determination of crystallinity and analysis of mineral content rice husk ashes. In the process of silica, rice husk ash (RHAs) from rice mill with or without leaching with citric acid can get amorphous form, but rice husk ash (RHAs) from gasifier can get Amorphous Quartz form.

Index Terms— Amorphous form, Crystallinity, Mineral content, Rice Husk Ash, Silica, XRD, XRF.

1 Introduction

RICE husks are agricultural waste, accounting for about one-fifth of the annual gross rice production (545 million metric tons) of the world [1]. In Myanmar, rice husk is produced in abundance after every paddy harvesting season which amounts to more than 350,000 tons of rice husk generated annually according to the statistics complied by the Myanmar Ministry of Agriculture.

In general, rice husks and straws contain the metallic impurities of about 0.8~1% such as Potassium (K), Calcuim (Ca), Sodium (Na), Phosphorous (P), Aluminum (Al), etc. According to the soil contents, some hazardous metal elements may be included in them. It is reported that alkali metal impurities of K and Na cause the remained carbons in ashes, which are origanated in organics of husks. This is because the eutectic reaction between the alkali metals and SiO_2 element occurs in burning, and the carbon remains in the melt SiO_2 [2].

Leaching is an extraction of certain materials from a carrier into a liquid or removes the impurities of the materials by dissolving them away from the solids. The chemical process industries often used organic solvents for leaching process. Leaching has a varity of commercial applications, including separation of metal from ore using acid and sugar from beets using hot water. Chloride can also be leached from food. The main theory of leaching neglects mechanisms for holding the material on the solid [3].

The presence of silica ash causes a number of environmental problems related to pollution and disposal. Additionally, at high temperature, the products yield can cause health hazard to human such as silicosis since the products might contain crystalline silica, for instance, quartz and cristobalite. Therefore, useful applications of the rice husk are desirable to solve this problem. Furthermore, the cheap and low cost raw materil for the production of high value added product can be achieved by using silica generated from the combustion of rice husk [4].

There are two forms of silica: amorphous and crystalline. The combustion of rice husk under controlled atmosphere and temperature of less than 800˚C will generate the amorphous silica in the form of white powder and this silica ash which is transformed from the husk by complete burning constitutes 15-20% of the total weight of the husk. Above 800˚C, the ash contained a crystalline form of silica [4].

Rice husk (RH) consists of about 40% cellulose, 30% lignin group and 20% silica. When rice husk is burnt approximately one fifth of the original weights is obtained as a byproduct. Rice husk ash (RHA) contains over 80% of silica and a cmall proportation of impurities such as potassium oxide (K_2O), sodium oxide (N_2O) and iron oxide (Fe_2O_3), which can be removed by acid leaching [5].

The main objective of the present work is to compare silica from rice husk ash from with or without leaching of rice husk and rice husk ash from gasifier. This process has the combined of benefit not only producing valuable silica at lower cost but also reducing disposal as well as pollution problems.

2 Materials AND Methods

2.1 Materials

Rice husk was collected from the Kabar Kyaw rice mill in Patheingyi Township, Mandalay Division. Rice husk ash was prepared from rice husk obtained from rice mill by calcination and both calcination and leaching. Citric acid ($C_6H_8O_7$, 99.5% purity, analar grade) was used as a leaching reagent. Distilled water was used for washing.

2.2 Leaching of Rice Husk

Acid leaching of rice husk was carried out to remove soluble element impurities and increases the purity of silica content. While the 500 ml of 5% citric acid solution was heating at 80˚C for 15 min, 20 g of rice husk was added into the solution. Then, the mixture was heated again at 80˚C for 15 min. Rice husk was filtered and rinsed for three times with distilled water. Rice husk rinsed with distilled water was dried at 100 ˚C for 2 hr. Dried rice husk was packed in the plastic bag.

2.3 Preparation of Rice Husk Ash

Rice hsuk was cleaned, washed with water and distilled water thoroughly to remove adhering soil and dust. The washed rice husk was dried under sunlight for one day and packed in the plastic bag. Then, the dried rice husk with or without leaching

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were burnt in the muffle furnace at constant temperature of 600 ˚C for 3 hr to 6 hr. The heating rate was 20 ˚C/min. The samples were cooled down inside a desiccator. The rice husk ash obtained from different sources and burning times has a few characterization techniques related to the structure and the amount of silica produced were carried out. The characterization ofrice husk ash was done X-ray fluorescence (XRF-EDXRF Quan X) and X-ray differaction (XRD) for elemental analysis.
The majority of the weight loss occurs from 400 ˚C to 500 ˚C. The silica in the ash is still in an amorphous form. Above 600 ˚C, in some cases the formation of quartz may be detected. As temperature is increased, the conversion to other crystalline forms of silica progress with the formation of first crystallite and next, at higher temperatures, triymite [6].

3 Results and Discussion

The major chemical compound and chemical composition of rice husk ash at different sourses after burning at 600 ˚C for 3 hr to 6 hr are shown in Table 1. According to the data in Table 1, the calcinations step was to increase the relative amount of silicon oxide by reduction of the carbonaceous materials present in the rice husk ash as well as to burn out other undesirable component. Accoring to Table 1, the silica percent in the rice husk ash obtained frm gasifier is higher than that from the other rice husk ash at 600 ˚C for 6 hr.

The silica percent in the rice husk sh obtained from rice husk in rice mill at heating temperature 600 ˚C for up to 4 hr is higher than the silica percent in the rice husk ash obtained from rice husk leached with citric asid and calcinated at 600 ˚C for up to 4 hr because of using annealing temperature at only calcination. At calcination time 4 hr, the silica percent in the rice husk ash obtained form rice husk leached and calcinated at temperature 600 ˚C is higher than the silica percent in the rice husk ash obtained from rice husk (without leaching) calcinated at annealing temperature 600 ˚C.

The silica phase mixing with amorphous form and quartz is shown in Fig.1. It can be seen that silica phases in Fig.2 and Fig.3 that could be amorphous form. The silica phases in this rice husk ash are not only amorphous form but also quartz. Because the broad peak spanning 2θ angle range of 18-30˚ confirms an amorphous forms of slica and the major peak ofcrystalline quartz obtained from the rice husk ash in gasifier after heating 600 ˚C for up to 6 hr occur at 2θ angles of 20.5˚, 26.3˚, 39.43˚,43˚, 50˚ and 56˚ [7].

Source	Heating Time (hr)	Silica (%)	Silica Phases in Rice Husk Ash
RHA from rice mill	3	67.01	Amorphous
	4	72.67	
	5	79.32	
	6	83.57	
RHA from Gasifier	3	89.52	Amorphous Quartz
	4	90.47	
	5	92.18	
	6	93.44	
RHA (After Leaching with Citiric acid)	3	66.87	Amorphous
	4	68.62	
	5	81.54	
	6	89.24	

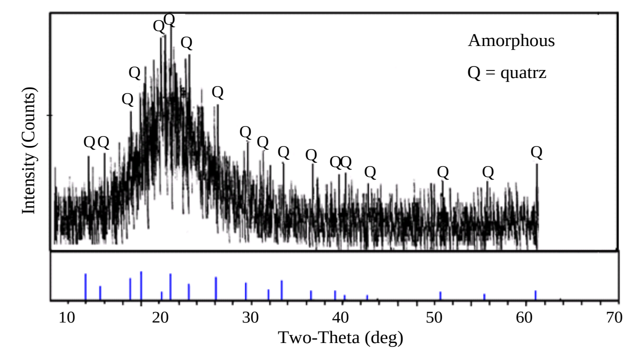

Fig. 1. XRD Patten of Rice Husk Ash Obtined from Gasifier at 600˚C for 6 hr

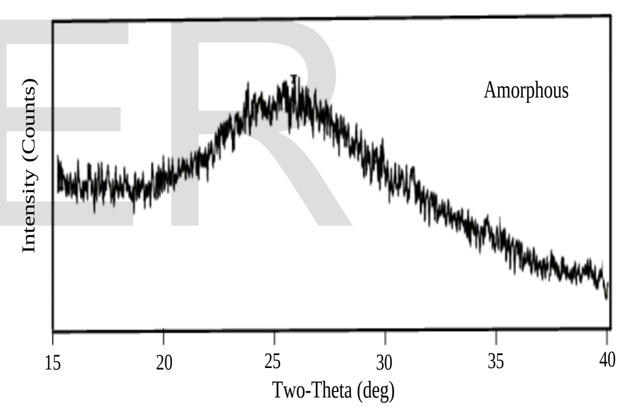

Fig. 2. XRD Patten of Rice Husk Ash Leached with Citric Acid and Calcinated at 600˚C for 6 hr

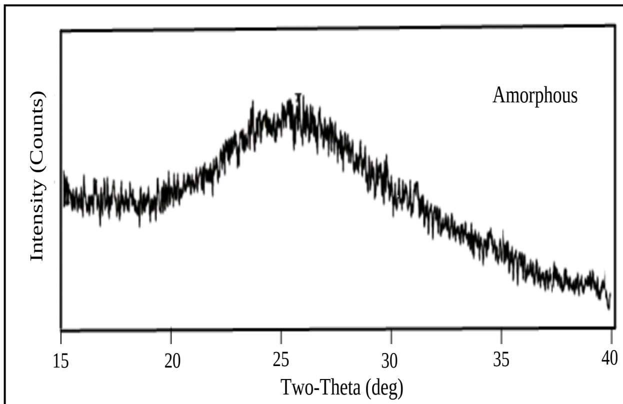

Fig. 3. XRD Patten of Rice Husk Ash Calcinated at 600˚C for 6 hr

The XRD patterns of silica at different sources are shown in Fig.1, Fig.2 and Fig.3.

4 CONCLUSIONS

This study revealed that the silica percent of rice husk ash from gasifier at 6 hr heating time was higher then that of rice husk ash from with or without leaching and heating at 6 hr because of increasing the relative amount of silica oxide. The amorphous silica must be obtained at the source of with or without leaching and heating at 600 ˚C. The crystalline silica would be obtained from RHA (from gasifier) at 3 hr to 6 hr heating time. The crystalline silica is less soluble than amorphous form of silica. So, rice husk ash with or without leaching obtained from calcinations at annealing temperature 600 ˚C for 6 hr was more useful than rice husk ash from gasifier.

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