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DETERMINATION RICE HUSK AMORPHOUS SILICA IN ALOR DISTRICT AS AN ADDITIVE ON THE MANUFACTURE OF COMPOSITE PORTLAND CEMENT

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ABSTRACT:

Research on the determination of amorphous silica in Alor rice as an additive in the manufacture of portland composite cement has been carried out. The aim this to determine the concentration of amorphous silica in the form of oxides in rice husk ash with variations in time and combustion temperature. Washed rice husks are heated in an oven at 100 °C for 24 hours. After that rice husk is heated in the furnace with variations in temperature and time. Rice husk ash originating from the furnace combustion is then cooled for 24 hours and smoothed in a blender for 3 minutes, then sifted on the number size 230 sieve and analyzed using X-RD and X-RF. X-RD results showed that the rice husk ash samples were amorphous with the name Chitopentaose caprate ($C_{200}H_{363}N_5O_{38}$). While the results of X-RF at combustion with a temperature of 700 °C and time of 4 hours obtained amorphous silica at 97.50% with a very low CaO concentration of 0.467%.

Keywords : amorphous silica, rice husk ash, cement additives, portland composite cement, chito pentaose caprate

ABSTRAK:

Penelitian tentang penentuan silika amorf sekam padi kabupaten Alor sebagai aditif pada pembuatan semen portland komposit telah dilakukan. Tujuan peneliatian ini adalah untuk menentukan konsentrasi silika amorf dalam bentuk oksida di dalam abu sekam padi dengan variasi waktu dan suhu pembakaran. Sekam padi yang telah dicuci bersih dipanaskan dalam *oven* pada suhu 100 °C selama 24 jam untuk mendapatkan sekam padi kering *oven*. Setelah itu sekam padi dipanaskan pada *furnace* dengan variasi suhu dan waktu. Abu sekam padi yang berasal dari pembakaran *furnace* kemudian didinginkan selama 24 jam dan dihaluskan dalam *blender* selama 3 menit, kemudian diayak pada ayakan nomor 230 (63µm) dan dianalisis menggunakan *X-RD* dan *X-RF*. Hasil *X-RD* menunjukkan bahwa sampel abu sekam padi berbentuk *amorf* dengan nama mineral *Chitopentaose caprate* ($C_{200}H_{363}N_5O_{38}$). Sedangkan hasil *X-RF* pada pembakaran dengan suhu 700 °C dan waktu 4 jam diperoleh silika amorf sebesar 97,50% dengan konsentrasi CaO yang sangat rendah yakni 0,467%.

***Kata kunci** : silika amorf, sekam padi, aditif semen, semen portland komposit,chitopentaose caprate*

I. INTRODUCTION

Rice husk is a by-product of the rice milling process which is usually used as an alternative fuel for burning bricks, or simply burned in the rice mill area and the ashes are used only for rubbing ash (Soeswanto and Lintang, 2011).

Rice production in Indonesia has increased from year to year. Data from the Indonesian Central Bureau of Statistics shows that rice production in Indonesia from 2008 to 2011 was 60,325,925; 64,398,890; 66,469,394, and 66,740,946 tons, respectively (Suryamin, 2012). When rice grains are ground, 78% of the weight is rice and 22% is grain skin (Nugraha and Antoni, 2007). Thus, it can be said that rice husk waste from 2008 to 2011 was 13,271,703.5 tons, 14,167,755.8 tons, 14,623,266.7 tons and 14,683,008.1 tons and will increasing every year as long as rice is still a staple food. Such a large amount if not processed properly results in the potential for rice husk to become agricultural waste which triggers problems with the environment. The use of rice husk which is commonly found is in the form of bran which is used as a material for making feed for poultry with relatively inexpensive hargan. Therefore rice husks must be utilized directly or changed through simple chemical processes into high value material products (Ekebafe *et.al.*, 2011). Rice husk has a lot of potential that can be developed, one of which is as a source of silica. Rice husk contains in silica the most compared to other rice byproducts.

The chemical content in the skin of rice or rice husk consists of 50% cellulose, 25-30% lignin, and 15-20% silica. When burned at a temperature of 500 ° C - 700 ° C, 75% of the grain skin burns out and 25% by weight will turn to ash known as rice husk ash which has a reactive silica content (amorphous silica) of around 20% - 90%, (Nugraha and Antoni, 2007; Karim *et. al.*, 2012; Sapei L. *et al*., 2012). Amorphous silica in various conditions is considered to be more reactive than crystalline silica and has a complicated spherical structure. Silica can be used as a catalyst, mixture in ink, concrete hardener, detergent and soap components, and as a hardening element in brick making. Silica has hygroscopic properties so that it can be used as a water absorbent material.

Another application of rice husk is used as a filter against arsenic in water (Kalapathy and Proctor, 2000), as an adsorbent to oil on the surface of the water (Chou *et. al.*, 2001), as an adsorbent to phenol in solution (Mahvi *et .al*., 2004), as an adsorbent for metal ions in solution (Srivastava *et.al*., 2006), as an adsorbent for decreasing the peroxide value of traditional coconut oil (Wahjuni and Kostradiyanti, 2008), and making rice husk briquettes as alternative fuels.

According to Chungsangunsit *et al*. (2009), 10% from the smoke of rice husk combustion be in the form of CO_2 gas while the effect on global warming when compared to some other industrial materials can be shown in Table 1.

Table 1 Comparison of CO_2 gas emissions in some industrial materials

Influence against global warming	**Rice husk**	**Coal**	**Oil**	**Natural Gas**
CO_2 (kg/MWh)	17.16	1,269.19	813.15	569.27
Comparison	1.00	73.96	47.38	33.17

Some results of the study indicate that existence are differences in the concentration of chemical components of rice husk ash as shown in Table 2.

Table 2 Data on the concentration of chemical components of rice husk ash

No	**Researcher**	**Country**	**Component (%)**			
			CaO	**SiO_2**	**Al_2O_3**	**Fe_2O_3**
1.	Della, *et.al.*, 2002	Brazil	0.54	94.95	0.39	0.26
2.	Folleto *et.al.*, 2006	Brazil	0.83	94.40	0.61	0.03
3.	Putra, 2006	Indonesia	-	88.92	0.67	0.61
4.	Bakri, 2008	Indonesia	0.65	72.28	0.37	0.32
5.	Silva, *et.al.*, 2008	Brazil	0.22	97.53	-	0.21
6.	Salas, *et.al.*, 2009	Kolumbia	0.49	99.00	< 0.01	0.13
7.	Karim, *et.al.*, 2012	Malaysia	0.90	92.50	1.20	2.10

Physical characteristics of rice husk ash according to Nugraha and Antoni (2007) and Karim *et.al.* (2012) as shown in Table 3.

According to Zhang (1996) although the particle size of rice husk ash is larger than cement, with high reactivity because it has high levels of amorphous silica, it can improve the quality of cement.

Table 3 Physical characteristics of rice husk ash

Particle shape	**Particle size (μm)**	**Surface area (m^2/kg)**	**density (kg/m^3)**
Cellular, Irregular	5 - 10	20 - 50	2.0 – 2.4

According to Putra (2006), rice husk ash can be classified as pozolan because it contains SiO_2 + Al_2O_3 + Fe_2O_3 greater than 70% in accordance with the quality of the required ingredients. Pozolan does not have cement properties but with fine grains it can react with lime out and water forms adhesives at normal temperatures (Wiryasa, *et.al.*, 2006). Whereas to overcome absorption of water in the large amount on the cement, the volume and size of the cement composite cavity must be reduced by adding pozolan material at the cement matrix used (Bakri dab Baharuddin, 2010).

Some researchers such as Ajiwe *et.al*. (2000); Putra (2006); Sakr (2006); Silva *et.al*. (2008); Habeeb and Fayyed (2009); Bakri and Baharuddin (2010); Givi *et.al*. (2010) have proven that the use of rice husk ash as an additive in Portland Cement can significantly increase the compressive strength of concrete or mortar and reduce the percentage of water absorption. To obtain the pozolan quality best, were carried out in variations in temperature and time making rice husk ash.

II. MATERIALS AND METHODS

2.1. Location and time of research

This research was conducted at the Physical Chemistry Laboratory of the Faculty of Mathematics and Natural Sciences, University of Hasanuddin Makassar, as well as the Research and Development Laboratory of the Faculty of Mathematics and Natural Sciences, Hasanuddin University, Makassar, from March to July 2013.

2.2. Materials and Research Tools

The material used in this study is rice husk from the rice mill Alor district, East Nusa Tenggara.

The tools used in this study consisted of a measuring cup (capacity of 500 ml), digital scales (capacity of 2000 grams), thermometer, furnace (type 6000 Bamste termolyne), basin, bucket, oven, plastic bag, sieve no. 230 (230 mesh) = 0.063 mm (63 µm), blender, X-RF (Thermo Scientivic), and X-RD (Shimadzu 7000).

2.3. Research Procedure

To simplify the processing of data, made matrix a comparison of the variation temperature and time of burning rice husks as shown in Table 4

Table 4 Comparison matrix of variations in burning rice husks

Comparison	**2 hours**	**4 hours**	**6 hours**
600 °C	Aa	Ab	Ac
700 °C	Ba	Bb	Bc

2.4. Making rice husk ash

Prepared to rice husk, washed with clean water to separate the dirt that is attached and dried for several days until it reaches a dry air condition. The burning of rice husk to produce ash was carried out according to the method carried out by Bakri (2008), Salas, *et. al*., (2009), and Della, *et. al*., (2002) with some adjustments based on the research situation and conditions. Rice husk is heated in an oven at 100 ° C for 24 hours to obtain dry oven rice husk. After that rice husk is heated in the furnace (Barnsted Thermolyne 6000 type) with temperature and time variations as shown in Table 4. Rice husk ash originating from furnace combustion is then cooled for 24 hours and smoothed in a blender for 3 minutes. Rice husk ash is then sieved at number size 230 (63µm) and stored in a sealed plastic bag before analysis.

2.5. Characterization of materials

The use of XRD method in this study to determine the crystallinity of rice husk ash samples, and the XRF method is to determine the chemical components of rice husk ash.

III. RESULTS AND DISCUSSION

3.1. Rice Husk Ash

Increased temperature with a speed of 10 ° C / 40 seconds automatically and occurs in 3 stages, namely the heating stage (takes place at a temperature of 0 ° C - 350 ° C), the stage of complete combustion (takes place at 350 ° C - 500 ° C), and the stage of ash formation (takes place at a temperature of 500 ° C - 700 ° C). the final results obtained were 77% of rice husk burned and the remaining 23% in the form of ash known as rice husk ash (ASP). Furthermore, samples of rice husk ash were smoothed and sieved with sieve number size 230 (230 mesh) = 0.063 mm (63 µm).

3.2. Characteristics of Rice Husk Ash

Characterization using the X-Ray Diffraction (X-RD, Shimadzu-7000) method is intended to determine the crystallinity of result of burning rice husk ash samples at a temperature of 700 ° C and 6 hours as shown in Figure 1.

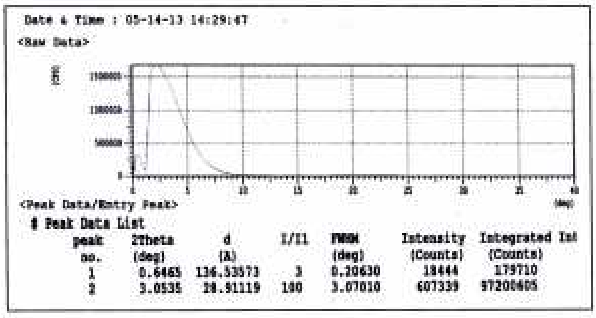

Figure 1 Results of characterization of rice husk ash by XRD method

Figure 1 shows that rice husk ash samples are amorphous with the name Chitopentaose caprate mineral ($C_{200}H_{363}N_5O_{38}$). The characterization was continued by using the X-Ray Fluorescence (X-RF, Thermo Sciencitivic) method to determine the chemical components of rice husk ash with the results as in Table 5.

Table 5 Results of characterization of rice husk ash samples

Component	**Rice Husk Ash**					
	Aa	**Ab**	**Ac**	**Ba**	**Bb**	**Bc**
CaO	0.484	0.484	0.516	0.490	**0.467**	0.502
SiO_2	97.49	97.43	97.27	97.76	**97.59**	97.33
Fe_2O_3	0.066	0.040	0.065	0.052	**0.057**	0.106
Al_2O_3	-	-	-	-	-	-

The characterization results show that rice husk ash samples can be classified as pozolan material because they contain SiO_2 + Al_2O_3 + Fe_2O_3 > 70%. Based on Table 5, it was chosen to burn rice husk on the Bb ie burning at 700 ° C for 4 hours, because it has a low concentration of CaO and high SiO_2 with the aim that the SiO_2 component can play an active role as an additive in the manufacture of Portland Composite Cement.

IV. CONCLUSION :

Rice husk ash used is burning at a temperature of 700 ° C with a time of 4 hours because it has good pozolan properties, characterized by high concentrations of SiO_2 and low concentration of CaO, so that it can be used as an additive to the process of making cement.

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