Influence of pretreatment on the pozzolanic activity of rice husk ash

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1. Introduction

Rice husk is a fibrous material with a high silica content, the following values may be considered typical: ash 20%, lignin 22%, cellulose 38%, pentosans 18%, and other organics 2%. The ash contains nearly 90% silica. Silica in ash with suitable characteristics shows a high reactivity with lime. This material with good and constant properties can be obtained only by burning rice husk under well-defined conditions. In the paper there are detailed pictures of the thermal decomposition characteristic and pozzolanic activity of rice husk ash (RHA for short in the following) in the pretreated condition.

2. Experimental

2.1 Materials

In this study RHA was obtained by burning rice husk in a batch furnace at temperatures of 350℃, 450℃,500℃,550℃, 600℃, 700℃,800℃,900℃,1000℃,and 1100℃ for 4 hour, by which RHA can be produced in large quantities.

Acid leaching pretreated RHA was prepared by leaching rice husk with 1N of HCl. After leaching, the husk was thoroughly washed with water and then dried at 105℃.

2.2 Experiments

X-ray diffraction (XRD) analysis was conducted. Specific surface area determinations were performed by BET method with an N_2 isothermal adsorpmetion test. The estimation of the pozzolanic activity of RHA was used by conductivity measurement proposed by Luxan et al. method.

3. Results and discussion

3.1 Effect of pretreated and burning temperature on the silica form in RHA

The ash residues from acid-treated samples were completely white in color. But, under similar conditions light brown ash was obtained from another husk samples. The reason is that certain metallic ingredients present in husk are removed due to leaching in HCl. In order to achieve the white ash and the less amount of carbon, it can see from figure1 that after the acid leaching pretreatment the heating temperature was raised than the untreated sample.

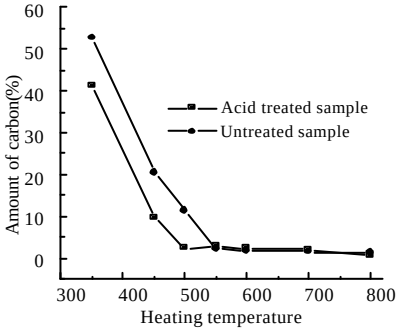

Figure 1 Relation between the amount of carbon and the heating temperature of RHA

The form of silica in the RHA at different temperatures was investigated by XRD. The results were shown in figure 2. It can be found that untreated sample at 700℃ and acid treated sample at 1000℃ mainly consists of amorphous SiO_2. And on increasing the temperature of ash of RHA over to 800℃(untreated sample) and 1000℃(acid treated sample), the β–tridymite form of silica are observed, which shows that the amorphous SiO_2 has changed to crystalline SiO_2. The results also show that after acid pretreatment rice husk it can put off the formation of cristobatite phase from amorphous silica in RHA. Table 1 shows the BET experiment results of RHA, the acid pretreated sample with large specific surface area and pore specific

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volume, but such results can not increase the water absorption (At moisture 90%, one day, the water absorption of untreated sample was 24.12%, and acid pretreated sample was 23.79%), which may not directly affect the workability of concrete.

3.2 Effect of pretreatment and heating temperature on the pozzolanic activity of RHA

Table 1 The BET experiment results of RHA

Sample	UR55-4*	UR60-4*	ADR60-4**	ADR70-4**	ADR80-4**
Heating temperature℃	550	600	600	700	800
Maintaining time (h)	4	4	4	4	4
Specific surface area (m^2/g)	164	86	270	311	257
Pore specific volume (cm^3/g)	0.32	0.24	0.37	043	0.34
Monolayer volume (cm^3/g)	37.70	19.76	62.08	71.46	59.03

Note: *untreated sample, **acid concentration (1NHCl), treated time (4h)

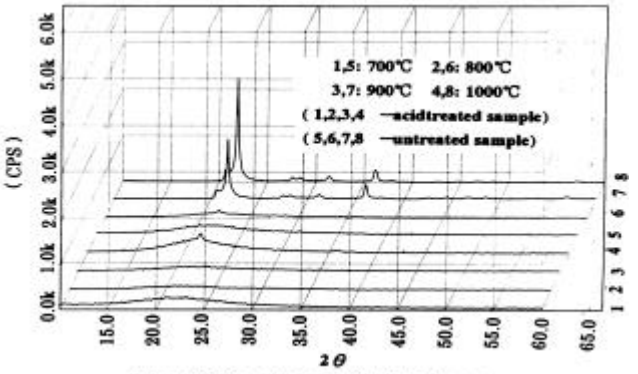

Figure 2 XRD patterns of RHA at different temperatures

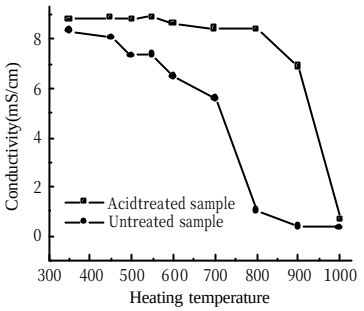

Figure 3 relation between the change in conductivity and the heating temperature of RHA

Figure 3 shows the change in conductivity of the $Ca(OH)_2$ solution added with the RHA. It can be seen that the RHA with acid leaching pretreated has greatly changed in conductivity and continuously delay to 1000℃ (the untreated RHA is 800℃),which corresponding have very good pozzolanic activity. There is a sharp reducement of the variation at 800℃ (untreated RHA) and 1000℃ (acid treated RHA), As a result, there is that the amorphous SiO_2 has been changed to crystalline SiO_2 (figure 2). As a result, for getting good pozzolanic activity RHA with acid pretreated, the final burning temperature should not be over 1000℃.

On the other hand, when sample is heating at low temperatures, for instance below 500℃ (untreated sample)and 550℃ (acid treated sample), there is also has larger change in conductivity, But it is not represented that the sample has good pozzolanic activity. Because much carbon has existed in it (figure 1), the carbon existing in it is very active which can also result in a large variation in conductivity by physisorption and chemisorption.

4. Conclusions

(1) After pretreating the rice husk with HCl it can put off the formation of cristabolite phase from amorphous silica in the RHA, and the amorphous silica in the RHA can maintained to 1000℃.

(2) RHA with HCl pretreatment has large specific surface area (257m^2/g-311m^2/g) and do not increase the water adsorption.

(3) RHA with HCl pretreatment has a great influence on the pozzolanic activity of RHA. A well-treated and burnt RHA has large change in conductivity; the maximum of the change in conductivity is 8.61mS/cm. It shows that this RHA has very good pozzolanic activity.

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