EXTRACTION SILICA FROM RICE HUSK WITH NaOH LEACHING AGENT WITH TEMPERATURE VARIATION BURNING RICE HUSK

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ABSTRACT

Silica can obtain by utilizing rice husk (RH). This study uses NaOH leaching agents with temperature variations of 600, 700, 800, 900°C at burning RH. Rice husk ash (RHA) reacted with NaOH 10% at 90°C at 240 rpm for 2 h, then the addition of HCl until pH 7 and drying to become SiO₂. Extracted silica characterization using FTIR showed silanol and siloxy groups, XRD showed that silica dominates by quartz and calcite, XRF showed components of SiO₂ and Si. Variation temperatures of 600, 700, 800, 900°C at burning RH made different components SiO₂ and Si.

Keywords: Rice Husk, Silica, Leaching, NaOH, Si.

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INTRODUCTION

RH is a byproduct of rice processing that accounts for roughly 20% of the bulk grain weight.¹ RH components include 70-80% organic elements such as lignin, cellulose, and others. Mineral components such as silica, alkalis, and trace elements make up the remaining 20-30%.² RH has high silica content. Silica extract from RH in a simple method like liquid extraction as NaOH leaching agent.³ The burning process controlled at high temperatures will produce RH rich in silica content for various chemical processes. Silica or silicon dioxide compound (SiO₂) use as an adsorbent, desiccant, filter media, and catalyst compound. Silica was the primary raw material in the glass industry, ceramic, refractory industry, and raw materials for silicate solutions, silicon, and alloy.⁴ The resulting silica of the RH has several advantages compared to silica minerals. Silica from RH has many refined grains, is reactive, is obtained quickly at a relatively cheap cost. Furthermore, it is supported abundant raw materials that can be updated.⁵

RHA has the function of binding heavy metals and can loosen the soil, making it easier for plant roots to absorb nutrients.⁶ RHA is a pozzolanic (pozzolanic) material which contains silica and alumina compounds.⁷ The utilization of RHA as pozzolanic material in cement provides several benefits, including increased strength, durability, reduced cost, and use of waste to reduce carbon dioxide emissions. In addition, RHA was a substitute material in the manufacture of refractories, ceramics, and insulating material.⁸ Silica obtained from plant, coal ash, and geothermal mud is amorphous and more reactive due to hydroxyl groups (silanol, Si-OH).⁹ Pre-treatment techniques of biomass using the oven heating method, soaking and washing using warm water,¹⁰ alkaline metal hydroxides solutions such as NaOH¹¹ and KOH,¹² acid solution,¹³ and ionic solvent.¹⁴ This study uses NaOH leaching agents to obtain silica. This method breaks the chemical bonds in RH using NaOH and then binds silicon with oxygen to obtain SiO₂.¹⁵

EXPERIMENTAL

This study uses NaOH leaching agents with temperature variations of 600, 700, 800, 900°C at burning RH. The initial content of RH from Deli Serdang, Sumatra Utara. RH burned at the furnace with temperature variations of 600, 700, 800, 900°C. RH was stirred and heated with 10% NaOH at 90°C, 240 rpm for 3 h. The filter rinses with 100 mL of distilled water after using Whatman filter No. 41. To make a gel, filter the

(sodium silicate) and add 37% HCl (pH 7). For 24 h, the gel will store. Using distilled water, filter and rinse silica gel to create silica powder. Silica gel dried at 150°C for 2 h. Characterization of the silica powder using FTIR, XRD, XRF.

RESULTS AND DISCUSSION

RH heated with temperature variations 600, 700, 800, and 900°C in a furnace. RHA decreased weight after the furnace. Silica powder produced by RHA at burning RH variation temperatures of 600, 700, and 800°C did not significantly differ. However, at 900°C, there was a significant decrease in Silica powder because 10% NaOH at burning RH temperature 900°C could not bind silica¹⁶, as shown in Fig.-1.

RHA was extracted used leaching with NaOH 10% to obtain SiO₂, then stirring at temperature 90°C with 240 rpm for 3 h. Silica compounds dissolve quickly in alkaline solutions and precipitate into acidic solutions. Heating will speed up the reaction rate, and stirring will speed up the contact between the solute and solvent and reduce.¹⁷

Sodium Hydroxide (NaOH) completely dissociated and formed sodium (Na⁺) ion and hydroxide (OH⁻) ion. OH⁻ was nucleophile would be attacked Si on SiO₂.¹⁸ Electronegative O atom broke double size and obtained SiO₂OH⁻ then releases H⁺ ion. Atom O, the double bond broke again and obtained SiO₃²⁻ which then dehydrogenation of OH binds to H⁺ ion and includes water molecules (H₂O). The negatively charged SiO₃²⁻ molecule would bind to two Na⁺ ions and form sodium silicate (Na₂SiO₃). To separate the filtrate and the residue, sodium silicate (Na₂SiO₃) was filtered. The Na₂SiO₃ was mixed with 37% HCl to create a gel group for 24 h.

As a precipitating agent, HCl is using. When HCl was adding, the ion exchange between Na⁺ and H⁺, resulting in the formation of silicic acid. Add HCl to a pH 7 because if pH is less than 7, the precipitate formed will dissolve again. It is because the addition of HCl uses to reacted with NaCl. There is little exchange of Na⁺ and H⁺ ions. At pH 7, silica that has been precipitated and is insoluble expect to remain silica. Because of HCl addition to the precursor, siloxy (Si-O-) protonate to silanol (Si-OH). The addition of HCl resulted in a significant concentration of protons (H⁺) in the Na₂SiO₃ and the formation of silanol groups from multiple siloxy groups (Si-O). With HCl as a catalyst, the silanol group will attack by siloxy group (O-Si-O-) to create a siloxane bond (Si-O-Si). A Whatman No. 41 filters filter the precipitate, which has a small pore size that prevents the sediment from passing through. Because of the excess acid, the precipitated silica was washed and heated at 150°C for 2 h to remove the Cl⁻ ion. As a result of the heating, the silica gel transforms into SiO₂ powder.¹⁹ Table-1 shows the FTIR analysis of the functional group.

Table-1: FTIR of Silica with Temperature Variation at Burning RH

Temperature variation at Burning RH(°C)	OH stretching (cm ⁻¹)	OH bending (cm ⁻¹)	Si-O-Si- (cm ⁻¹)	Si-OH bending (cm ⁻¹)	Si-O- (cm ⁻¹)
600	3404.23	1637.07	1061.67	795.93	445.51
700	3398.28	1458.39	1042.51	798.70	447.03
800	3398.28	1637.09	1062.28	795.56	448.66
900	3398.28	1637.07	1065.57	796.41	448.66

Results XRD of silica showed that the crystal area (peak) was quartz and calcite. The search-match RHA data showed that the peak that appears is quartz dominant at an angle (2θ): 5-90°. There are two identified phases namely quartz, and calcite. XRD patterns of silica with NaOH 10% formed crystalline peaks in the quartz phase in the amorphous phase²⁰. The diffraction pattern showed a shift in the top position. It is possible because SiO₂ begins to form at pH 7. Still, many impurities may reduce. NaOH also plays a significant role in forming sodium silicate (Na₂SiO₃) to produce SiO₂. Not all SiO₂ reacted with NaOH to form Na₂SiO₃ made to shift, as shown in Fig.-2.

Table-2 showed the XRF of silica variation temperature RHA. It showed the highest percentage of SiO₂ and Si components with variation temperature that showed SiO₂ and Si highest percentage from RHA at temperature 600°C.

Table-2. XRF of component SiO₂ dan Si variation temperature at Burning RH

Temperature at Burning RH (°C)	Component SiO ₂ (%)	Component Si (%)
600	44.4	24.3
700	31.8	16.3
800	43.8	23.9
900	39.5	20.3

Fig.-1: Weight of Silica Powder with Variation Temperature at Burning RHA

Fig.-2: XRD Patterns of Silica with Variation Temperature RHA

CONCLUSION

The burning of RH with variation temperatures gives different components SiO₂ and Si. From burning RH variation temperatures 600, 700, 800, 900°C represented highest SiO₂ and Si at 600°C RHA with SiO₂ (44.4%) and Si (24.3%).

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