Extraction of Silica Gel from Burnt Paddy Husk

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Abstract

Burning the fuel, rice hull to generate energy results in the waste product called rice hull ash (RHA). RHA is an abundant agricultural by-product. It is rich in silica (about 60%) and can be made into economically viable raw material which can be used for production of silica gels and powders. The present work deals with the production of silica particles. Acid washing prior to extraction resulted in silica with a lower concentration of minerals. Synthesis was done by precipitation using different acids namely, sulphuric acid and nitric acid which yielded nanosilica. The effect of different acids on the size and degree of agglomeration of the silica particles were studied and the formed silica is sorted out for various uses. This process is inexpensive, sustainable, environmental friendly and also suitable for large scale production.

Key words: rice hull, silica gels, agglomeration

Introduction

During the last two centuries, human activities such as the production and consumption of fossil fuels, as well as agricultural and industrial activities have caused an increase in the atmospheric concentration of greenhouse gases . Fossil fuel shortage and environmental problems have created the urgency for the exploitation of clean renewable energy . So, many countries have put forward plans to reduce carbon dioxide emissions and energy consumption.

Biomass is one of the most promising energy-carrying agent and can play an important role in environmentally friendly energy utilization. Rice husk (RH) is an important agricultural residue. Most of RH will burn as fuel to generate energy resulting in the waste product, rice husk ash (RHA). If these RHA are not utilized, it will result in tremendous waste generation, energy loss and environmental pollution. Therefore, it is very important to find ways to utilize RHA comprehensively.

RHA usually contains more than 60% silica (SiO_2), 10–40% carbon with minor mineral composition. Rice husk ash has a relatively high content of inorganic compounds, representing approximately 20% of the dry weight of the husk. Silica represents 94% of the total while the remaining 6% are K_2O, CaO, MgO, Al_2O_3, and P_2O_5 in decreasing concentrations. Silica (SiO_2) is a basic raw material that is widely used in electronics, ceramic, and polymer material industries. Because of its particles diameter, ultrafine silica powders have many technological applications, such as thixotropic agents, thermal insulators, composite fillers, etc.

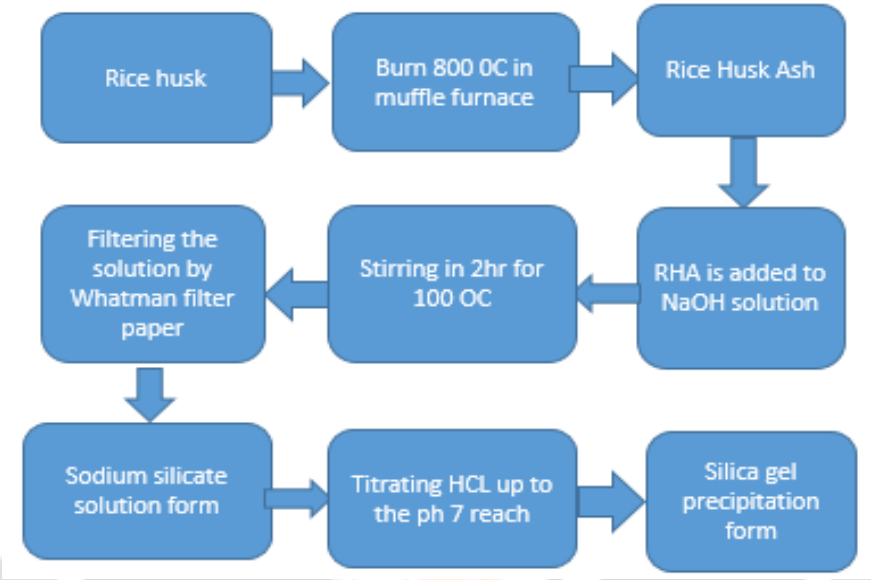
Silica also has been used as a major precursor for a variety of inorganic and organometallic materials which have applications in synthetic chemistry as catalysts, and in thin films or coatings for electronic and optical materials.

Silica gel from rice husk ash can be roughly prepared by ways, that is to say the thermal treatment with temperatures ranging from 500-1400oC. This method requires high temperature. The second way of preparation is leaching by acid or basic solutions and then neutralization by acid to produce silica gel. The latter consumes low energy, and is cost-effective compared to the current melting method. Besides this advantage, the process may decrease CO_2 emission due to the current manufacture of sodium silicate from the reaction of Na_2CO_3 and SiO_2.

The objective of this study was to investigate the effect of, washing RHA with Hydrochloric acids prior to alkali extraction, the degree of agglomeration and yield of silica.

Materials and Methods

Experimental Setup



Physical properties

Ash content

Three samples of each having 5g of rice husk was weighed out, then placed in a muffle furnace at 700°C for 2 hours, after the specified length of time the crucible holding the samples were removed and allowed to cool slightly then placed in a desiccators until cold. The differences in weights were noted and read averaged. Percentage of ash content was calculated from the weight loss data.

$$AC = \frac{WD12}{W1} * 100,$$

Where AC is the ash content of the rice husk, WD12 is the weight difference between before and after burning; W1 is the initial weight of the rice husk.

Moisture content

The percentage moisture content was found by weighing 1g of rice husk and placed in an oven; the samples were dried for 2 hour at 105°C to get rid of the moisture. The resulting sample were removed, covered and placed in desiccators. Triplicate experiment was conducted and the weight loss difference was recorded as moisture content, and the percentage of the moisture content was calculated from the data recorded before and after drying, percentage moisture content was calculated according to:

$$MC = \frac{WD}{W1} * 100\%,$$

where WD is weight difference between before drying and after drying, W1 is initial weight of rice husk.

Thermal treatment

Burning of rice husk

According to Mehta (1979) temperatures exceeding 700°C yield reactive amorphous ash [6]. Therefore 700°C was selected for burning of the rice husk, Rice husk was burned in electric furnace for 2 hours then the white ash was placed in desiccators to prevent the absorption of moisture. During combustion of rice husk, carboneous materials were burned and a clear white ash was obtained.

Silica Extraction

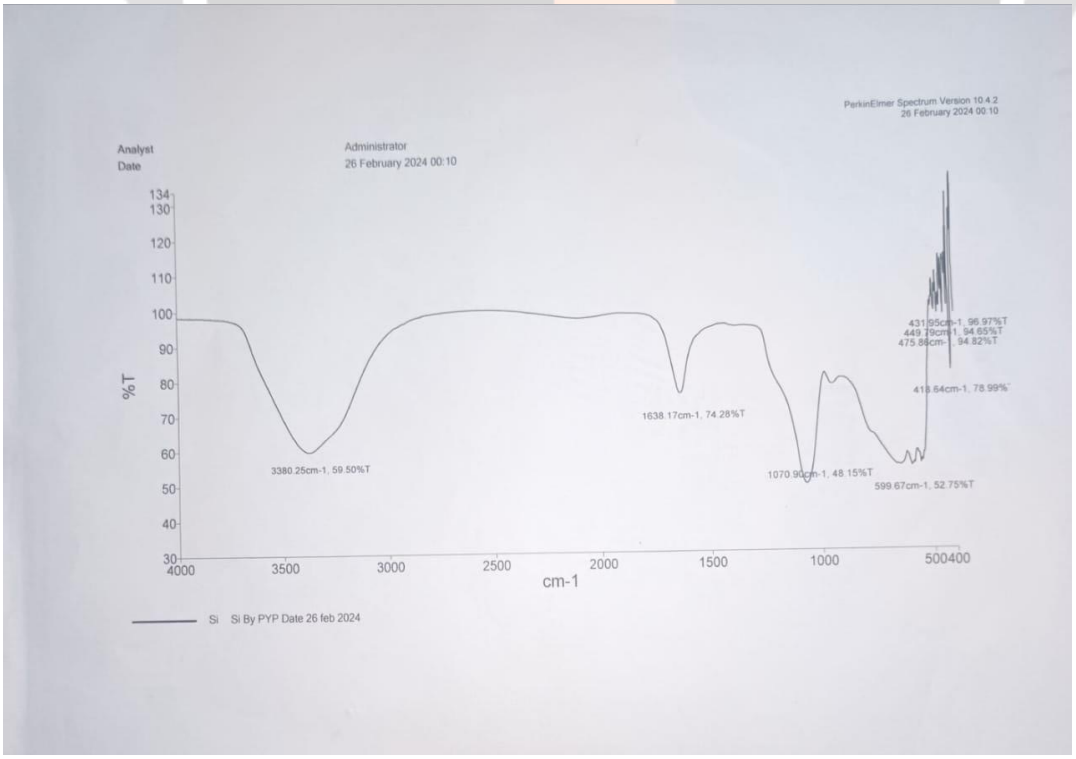
60 ml portions of 1N NaOH were added to the washed and unwashed RHA samples separately and boiled in a covered 250 ml Erlenmeyer flasks for 1 h with constant stirring. This step is to dissolve the silica and produce a sodium silicate solution. The solutions were filtered through Whatman No. 41 ash less filter paper, and the carbon residues were washed with 100 ml of boiling water. The filtrates and washings were allowed to cool to room temperature and were titrated against 1N HCl with constant stirring to pH 7. Silica gels started to precipitate when the pH decreased to <10.

Result and Discussion

Sr. No	Conc of NaOH	Conc of HCL	% yield of silica gel
1	1N	1N	46%
2	2N	1N	53.3%
3	3N	1N	60%

In the pre-treatment process we used Hydraulic acid for washing RHA. Silica is extracted from this pre-treated RHA using various concentrations of NaOH. It is found that the yield of silica gel is strongly dependent on the concentration of NaOH. The results are shown in the Table 1 . This study revealed that, the yield of Silica is (60%) when Hydrochloric acid was used for washing at 3 N concentration of NaOH.

Confermatory test



Conclusion

It was concluded from the study that, it was viable to extract the silica from Rice Husk Ash by Alkali extraction. Further, the results showed that, the percentage yield of extracted Silica is high when we used acid washed in spite of unwashed RHA. And also it is found that, the moisture content in the silica is low when acid washed RHA is used in place of unwashed RHA.

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