

Research Article

Synthesis of White Silica From “Joha Rice Husk” (A Special Rice Variety of Assam, India), Characterization and Determination of Its Point of Zero Charge (pH_{PZC})

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In this study, the rice husk (RH) of “Joha rice” a unique rice variety of Assam (Northeast India) has been used as raw materials for synthesis of ash and silica powder. The combustion of the husk at 500°C for 1 h followed by further treatment at 800°C for 2 h in muffle furnace produces white rice husk ash (RHA). One part of RHA was kept as untreated, and the another part was acid treated. Silica was extracted from the untreated ash in the form of sodium silicate by treating with 2.5M NaOH at the boiling temperature. Then, silica was precipitated from sodium silicate by slow addition of 2.5M H₂SO₄. The broad x-ray diffraction (XRD) pattern and characteristic peaks at d-spacing, 8.3792 and 4.1489 with specific 2θ at $\sim 21.3^\circ$ reveal the presence of amorphous SiO₂ as major phase in the ash (both acid treated and untreated). The characteristic Fourier transform infrared (FTIR) spectroscopic peaks at 470–450, 801, and 1100 cm⁻¹ for different modes of Si-O-Si vibrations also support the presence of silica. The scanning electron micrographs (SEMs) revealed the morphology of the RHA as fine particles undergoing agglomeration probably due to hydrogen bonding between surface silanol groups present. The irregular rough morphology is a characteristic of the amorphous nature of the samples. The energy-dispersive X-ray analysis (EDX) showed that RHA composition was dominated by elements Si and O for both untreated and acid-treated samples. For acid-treated sample, the amount of Si and O is found to be comparatively higher than the untreated one due to surface cleaning. The point of zero charge (pH_{PZC}) of the prepared samples was determined by a simple pH metric method. The pH_{PZC} of the untreated RHA was found to be $\sim 9.8 \pm 0.2$. However, almost similar pH_{PZC} values of the acid-treated RHA silica and commercial silica ($\sim 6.6 \pm 0.2$) indicate the effectiveness of acid treatment prior processing.

Keywords: acid leaching; point of zero charge (pH_{PZC}); rice husk (RH); silica

1. Introduction

Rice husk (RH), an agricultural byproduct, can be obtained in the form of amorphous, chemically reactive silica [1, 2]. This silica possesses versatile applications, serving as filler in polymers, adsorbent, catalyst support, high-strength concrete, and advanced materials preparation. The extraction of valuable materials from agricultural waste is crucial for fostering sustainability. As

India is a major rice producer, it is imperative to address the prevalent practice of burning or discarding RH waste in many rice-producing nations.

Therefore, exploring alternative utilization methods for RH is imperative. The complete combustion of husk yields high-purity white rice husk ash (RHA) silica [3]. Several studies have been conducted for the synthesis of “RHA” from “RH” due to the importance of the ash. A recent study compares the properties of RHA obtained by open air