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Review

Review on the physicochemical treatments of rice husk for production of advanced materials

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HIGHLIGHTS

- Applications of rice husk and its derivatives.
- Study the available technologies for production of SiC, pure Si, Si_3N_4, Mg_2Si, SiO_2 from rice husk.
- Explanation of different furnaces for production of rice husk ash.
- Study the available technologies for production of activated carbon from rice husk.

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ABSTRACT

Recently, much attention has been focused on the utilization of plant biomass to produce engineering materials, encompassing the technological/scientific aspects as well as the economic, environmental and social issues. Amongst the variety of agricultural wastes or biomasses available, rice-husk (RH) occupies a preeminent position, not only in terms of its amount produced worldwide, but also because of its unique chemistry-related features. In this sense, some attempts have been made to produce advanced materials – including SiO_2, SiC, Si_3N_4, elemental Si, Mg_2Si and more recently, active carbon –, using RH. The production of those mentioned advanced materials depends largely on the treatments used (physical and/or chemical) and the reactions involved in the process, such as pyrolysis, carbothermal and reduction processes. In this contribution, a critical review on the processing and application of rice husks (RHs) for the production of various silicon-based materials and of active carbon is presented. The review addresses the different processing methods, the effects of various process parameters on the pyrolysis stage, the influence of physical, chemical and thermal treatments, activating conditions and activated carbon consolidation mechanisms. A flow chart with all the possible routes to produce SiO_2 was purposely constructed.

Contents

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1. Introduction

Since the 1990s, natural fibers started to emerge rapidly for industrial applications. Several authors have reported recent progresses in the use of natural fibers (rice husk (RH), bagasse, breadfruit, coconut shell and coir, etc.) in composites. Natural fiber composites offer environmental advantages such as reduced dependence on non-renewable energy/material sources, lower pollutant emissions, lower greenhouse gas emissions, enhanced energy recovery, and end of life biodegradability of components [1]. Based on source and origin of natural fibers, they are classified into three large groups: animal, vegetable and mineral natural fibers. Due to the wide usage of vegetables and to their vast availability and renewability in short time periods as compared to the others, in this review paper whenever the term "natural fibers" appears in the text, we are referring to the vegetable ones, which are extracted from plants.

Depending on the part of the plant where they are extracted from, natural fibers can be classified into three categories. When determining the properties of natural fibers, one has to keep in mind that variability in properties depends on the growing environment: temperature, humidity, soil composition, air, age and body of the plant all affect the height of the plant, density and the strength of its fibers, etc. In addition, the way the plants are harvested and processed results in a variation of properties. Rice husk is a major agricultural by-product in rice growing countries like China and India, with 33% and 22% of the global rice harvest, respectively. Unique large-tonnage waste material from cultivation and processing of crops, dissimilarity in the composition and properties to some other plant wastes makes it as a potential material.