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Comprehensive Utilization of Rice Husk Resources

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Abstract

Rice husk has long been treated as agricultural waste in countries where rice is grown. However, it is actually a source of silica, as rice hulls contain about 20% silica. Research has shown that what can be recycled as a resource is the amorphous silica in the ash obtained after calcination of rice husk, which can be used for the production of insulators, high performance cements, aerogels, adsorbents and also as silica fertilizer in agricultural production. By reviewing and citing a large number of domestic and international references on the physicochemical properties and comprehensive utilization of rice husk research, we analyse rice husk pretreatment technology, rice husk preparation methods, the use of silica in rice husk and look forward to the application value of rice husk ash.

Keywords

Rice husk; Rice husk ash; Pretreatment; Progress.

1. INTRODUCTION

Rice is one of the staple foods of Asians and is the most widely grown and productive crop in the world. As a major agricultural country, China's total annual rice production is close to 200 million tonnes, a volume that already exceeds 30 per cent of the world's total production and ranks first in the world. During the processing of rice, rice hulls are stripped from the grains as a major by-product, and their mass accounts for about one-fifth of the rice grain, thus it can be estimated that the total amount of rice hulls produced in China is nearly 40 million tonnes per year. Most of these rice hulls are regarded as agricultural waste, and the large amount of rice hulls that accumulate over a long period of time take up a lot of limited space and can easily become mouldy and

deteriorate due to moisture, polluting the environment as well as breeding bacteria and spreading disease. Therefore, it has become an increasingly urgent issue to make effective use of rice hulls. For a long time, the use of rice husk resources has been unsatisfactory, except for a small portion used as primary fuel, feed, construction materials or burning for power generation, most of them are discarded as agricultural waste, which not only seriously pollutes the environment, but also poses a potential safety risk of spontaneous combustion in piles. With the advent of the global fossil resource crisis, people are beginning to attach importance to various biomass renewable resources. Rice husk, a member of the biomass family, is favoured by researchers because of its large volume, cheap accessibility and clean and renewable nature. Extensive research has been carried out at home and abroad on the comprehensive utilization of rice husk resources, and a number of rice husk-based high value-added products have been developed, achieving obvious economic benefits.

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2. APPLICATIONS OF RICE HULLS

At present, the use of rice husk can be divided into three main categories according to its chemical composition: the first category is to use the lignin, cellulose and hemicellulose contained in it to produce chemical products with high added value. The second category is the use of the silicon source contained in rice husks to produce inorganic compounds containing silicon such as silica, silica and water glass. The third category is the use of the carbon and hydrogen elements contained in rice husks, which are burned as fuel to provide a heat source. It can also be classified according to application areas: in agricultural production, rice hulls can be used as feed for livestock, rice and other silicon-loving products.

In the chemical industry, it can be used to prepare ethanol, activated carbon and chemical materials such as silica and water glass. In the chemical industry, it is used to prepare ethanol, activated carbon, silica, water glass and other chemical materials. In the food industry, it is used to make edible sugar and as an auxiliary for pressing and filtering. In the environmental field, rice husk can be used to treat waste water or as a decontaminant. In addition, as a biomass, rice hulls can be used to produce silicon composite products such as pure silicon, rubber, magnesium silicide and isomeric catalysts. With a calorific value of 12.5-14.6 MJ/kg, which is about half the calorific value of standard coal, rice hulls can be used as a cheap source of heat. In addition rice husk can also be applied to power generation, turning it into a treasure and saving resources.

3. OVERVIEW OF RICE HUSK ASH

3.1. Composition of rice husk ash

Rice husk removes most of the combustible organic matter during the combustion process, so rice husk ash contains mainly silica and some unburned carbon, in addition to a small amount of alkali metal oxides. The composition of rice husk varies from species to species and the average composition of rice husk ash and its percentage content are shown in Table 1.

Table 1. Main composition of rice husk ash

Substance	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	Na_2O	K_2O	Loss
Content	87.20	0.15	0.16	0.55	0.35	0.24	1.12	3.68	8.17

3.2. Application value of rice husk ash

3.2.1 Application of rice husk ash in industry and construction

Xiaoping Zeng[1]Research has shown that rice husk ash is actually an excellent insulator with low thermal conductivity, high melting point, low stack density and high void space, which can be used in the casting process of steel to prevent rapid cooling of the steel and ensure uniform solidification of the steel. In addition rice hull ash has applications in the construction of low-cost buildings and the production of high-performance cements. It has now been found that adding rice hull ash to cement can improve its resistance to compression and enhance its performance. It can also be used in the production of insulators for the steel industry, in the production of high quality flat steel and in the cement manufacturing industry.

3.2.2Aerogel

Tang Q[2] et al. prepared silica aerogel from rice husk ash by supercritical carbon dioxide drying method is a very light white mesoporous solid material with a high specific surface area of 597.7 m2/g and a high porosity of 98.3%, but its bulk density is as low as 38.0 kg/m3 and the pore size inside the aerogel mainly varies in the range of 10-60 nm.

3.2.3Sorbent

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A study by Feng QG et al[3]. on the adsorption of cadmium ions (Cd(II)) and zinc ions (Zn(II)) from binary aqueous solutions from rice husk ash showed that the maximum adsorption of both ions by rice husk ash occurred at p H = 6.0, and the lower the initial concentration of both ions the higher their adsorption ratios. Under the same experimental conditions, the adsorption capacity of rice husk ash for Zn(II) was stronger than that of Cd(II) for both ions in either separate or mixed solutions, but the adsorption effect was better for both substances, so that rice husk ash can adsorb both Cd(II) and Zn(II) ions from the wastewater either alone or simultaneously. Other applications of rice husk as an adsorbent include the use of rice husk ash to prepare adsorbents for flue gas desulphurisation, the use of rice husk ash to clean up water bodies contaminated with crude oil and diesel oil, and the use of rice husk ash to adsorb organic substances such as pyridine.

4. PRE-TREATMENT TECHNOLOGY FOR RICE HULLS

4.1. Biological method

Biological methods use some bacteria or related enzymes to treat organic matter such as cellulose and lignin in the rice husk, degrading and destroying its fibrous reticulation and thus improving the accessibility of reagents. [4] Biological treatment is gentle, maintains the original fine structure of rice husk Si O2 and, in combination with acid treatment, produces a product quality comparable to that of gas-phase Si O2, but the long pretreatment period limits its application. particles. Zhao Yuping[5] et al. showed that rice husk ash prepared from rice husk treated with white rot fungi had a high number of micropores and a 2.43 times higher specific surface area than the untreated one, showing excellent structure and properties.

4.2. Thermochemical treatment method

The thermochemical treatment method is divided into the combustion method and the high temperature pyrolysis method. In the process of thermochemical transformation of rice husk, as the temperature rises, the water evaporates first, and then the organic matter in the rice husk undergoes oxidative decomposition, volatilisation, and after the organic matter and carbon are burnt out, a solid residue is obtained, i.e. rice husk char or rice husk ash, which can be regarded as a derivative of rice husk, and then used as a silicon source to prepare high performance silica. Different rice husk power plants are less consistent in quality due to the heat treatment techniques used, stability, etc. The ability to retain the inherent relic structure of the rice husk during the heat treatment process will directly affect the final application performance of the product silica. Controlled combustion conditions of the incineration method, such as good ventilation conditions, slow heating rate, low incineration temperature, etc., can achieve high-quality rice husk ash output on a large scale. Studies have shown that if low temperature followed by high temperature incineration is used, rice husk ash with lower carbon content and low potassium content and high heat utilisation of rice husk can be obtained to produce high purity silica[6,7] . It has also been found that if the rice husk ash is crushed by ball milling and acid treatment and then directly calcined, high purity silica can also be produced.

4.3. Acid and alkali treatment method

Acid treatment decomposes some of the organic matter and reduces the difficulty of subsequent silica extraction; it also removes alkaline metal oxides from the rice hulls, preventing them from forming crystals with the silica in the rice hulls at lower calcination temperatures and promoting the mineralisation and crystallisation of silica[8] .

The alkali treatment uses the ability of alkali to break cellulose and hemicellulose linkages under boiling conditions, saponify the ester bonds between hemicellulose and lignin, and leach SiO2 from rice hulls. the rate of leaching is closely related to the concentration of the alkali

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solution, temperature and contact time, and sodium hydroxide solutions are often used. The alkali treatment method usually requires only boiling at atmospheric pressure, has a higher reaction rate for alkali extraction, is simple to operate and has certain advantages over other methods.

4.4. Combined pre-treatment technology

The use of a single pretreatment method is often inefficient or under harsh conditions and with little operational flexibility, so more attention has been paid to the combined technology of multiple pretreatment methods that can effectively play their respective roles in significantly increasing the decomposition rate of organic matter or improving the structure of organic matter to achieve effective separation of the components. Ultrasonic and microwave synergistic acid treatment, alkaline hydrogen peroxide oxidation, steam blasting treatment technology, and combined washing and drying technology have been reported[9] etc. The results show that the pretreatment effect of the combined technology is better than that of the single technology.

5. CONCLUSION AND OUTLOOK

Making good use of rice hulls not only reduces pollution and quietens the environment, but also creates economic benefits, saves resources and benefits mankind. There are many other ways and means of utilising rice husk. Broadening the application of rice husk in multiple fields has important economic and social benefits. However, the current research is still insufficient, mainly because the product is relatively single, there are not many ways to produce rice husk on a large scale and effectively use it, and there are still problems with practical and non-polluting industrialisation processes.

If we can scientifically develop products from cheap rice husk that are urgently needed in agriculture, industry, construction and health care, especially some high-tech products in the field of biomass energy research, it will largely improve the utilisation rate of rice husk, thus creating greater economic benefits, as well as improving people's quality of life, optimising the structure of rice production, reducing environmental pollution and achieving food value-added. It is also of great importance to improve people's quality of life, optimise the structure of rice production, reduce environmental pollution and add value to food.

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