Progress in the Resource Utilization of Biomass and Desulfurization Ash

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Abstract

As a classical technology, low-temperature pyrolysis is used for the clean conversion of carbon-based solid waste. It has the advantages of low energy consumption and investment saving. It is especially suitable for the collaborative conversion of desulfurization ash and cellulose lignin biomass. Therefore, in this study, through the analysis of the existing resource utilization methods of biomass and desulfurization ash resources, it discusses the shortcomings in the current research, and then explores the possible technical route of the collaborative catalytic pyrolysis of biomass and desulfurization ash, so as to carry out the preliminary research for the clean transformation of solid waste.

Keywords

Biomass; Desulfurization Ash; Resource Utilization; Modeling.

1. Introduction

There is relatively prominent structural contradiction between energy supply and consumption in China [1], in order to optimize the energy structure, the development and utilization of secondary energy sources such as solar energy, wind energy and biological energy is of great importance. According to the blue book recently released by the Biomass Energy Industry Branch of China Industrial Development Promotion Association, the annual production of major biomass resources in China is about 3.494 billion tons, the energy utilization of biomass resources is about 461 million tons, and still about 3.033 billion tons of biomass resources have not been energy utilization. According to incomplete statistics, the steel industry produces about 20 million tons of desulfurization ash, which places a burden on the ecological environment and national economic development. The inefficient utilization of biomass has caused more serious air pollution. The illegal stacking of desulfurization ash not only forms dust, but also causes obvious environmental problems. Using pyrolysis as a traditional method of resource utilization of biomass and desulfurization ash, under the background of "double-carbon constraint", it has the comparative advantages of lower energy consumption and investment saving compared with the process routes of gasification and liquefaction.

2. Research Progress in Biomass Resource Utilization

The primary problem of biomass resource utilization is the establishment of biomass pyrolysis product model in the reaction process and the research of catalysts needed to obtain certain products. In the utilization of biomass, there are the same insights at home and abroad, that is, economic benefits should be taken into account to realize resource utilization. Jyoti Prasad Chakraborty et al [2] reviewed biomass treatment methods, the components and disadvantages of biomass as a renewable energy source, the biomass pretreatment, the pyrolysis process of energy extraction from biomass and the various dimensions of the process, and the future development prospects of the biomass pyrolysis reaction are reviewed. In order to regulate the biomass pyrolysis products, the establishment of the biomass pyrolysis mathematical model is the top priority. So far, great progress has been made in establishing the mathematical model of biomass pyrolysis products, Przemysław Maziarka et al [3] reviewed the modeling methods of biomass thermolysis systems based on computational hydrodynamics, Ku Xiaoke et al [4] explored the effects of the reactor temperature, water vapor / carbon molar ratio, excess air ratio, particle size, and biomass type on the gasification properties. Although the heavy experiments spend a lot of time and energy, with the popularization of machine learning and the intersection of biomass and machine learning greatly reduce the number of experiments while improving the accuracy of the biomass mathematical model of pyrolysis, and saving human and material resources. Guo Pengkun et al [5] reviewed the progress of computer simulation in biomass conversion including biomass gasification, liquefaction, physical transformation and biological transformation. Based on this basis, the application progress of using computer simulation technology to assist biomass transformation research is summarized, including process simulation Aspen Plus and PRO / based on thermodynamic model and dynamic model, molecular simulation Gaussian 09w and Materials Studio based on quantum chemistry, for multiple parameter interaction effects analyzed and optimized for conditional optimization simulation Design Expert et al. At the same time, it summarizes the application of full life cycle assessment (LCA), artificial neural networks (ANNs) and numerical simulation in the transformation of biomass, and the development and application of computer simulation in biomass transformation are proposed, pointing out that the model should continue to study the biomass transformation process, avoid models that simplify the real process, and further proposes the research on the reliability of the simulation effect through the combination of different simulations. Zhu Yilin et al[6]in order to accurately predict the yield distribution of biomass pyrolysis gasification and fit the real process of biomass transformation, the optimization analysis based on the comprehensive calculation method of biomass pyrolysis gasification was carried out, and the reliability of the simulation effect was enhanced through the combination of different simulations was also verified[5], which provides guidance for the distribution of biomass material pyrolysis gasification and process parameters.

The biomass pyrolysis temperature is maintained at high temperature, so that it is crucial to explore the appropriate catalysts to reduce the activation energy of the reaction, improve the reaction rate and improve the yield of the target products to save energy and improve the economic benefits. Xiong Zuhong et al. [7] chose dolomite and nickel base as the catalyst to study the catalytic pyrolysis of the biomass. For the purpose of extracting the biomass gas by pyrolysis, the temperature selection of 600-700℃ is more appropriate. Although many achievements have been made in the catalyst research by scholars at home and abroad, the current biomass catalytic technology has not been implemented in large-scale industry due to the non-recyclable characteristics of pyrolysis catalysts.

3. Research Progress in the Resource Utilization of Desulfurization Ash

The main component of calcium bisulfite in desulfurization ash is also one of the main limitati ons on the utilization of desulfurization ash. However, three methods are generally used at ho me and abroad: low-temperature catalysis method, high-temperature oxidation method, and e lectrochemical oxidation method. However, each method has certain disadvantages. Some sch olars have proposed to apply desulfurization ash in the building materials industry, Chen Qiao -nv [8] analyzes the physical and chemical properties of dry desulfurization ash from different

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sources, and guide the application direction of dry desulfurization ash in the building material s industry. J. K. Solem-Tishmack et al [9] Studies have been done on the application of desulfur ization ash to wall materials. Nevertheless, Iribarne et al[10] is thought that the expansion of t he sulfate volume will affect the wall surface, not only that, under normal circumstances, Yao L u et al[11] has been demonstrated that calcium thulfite is difficult to oxidize no matter whethe r catalyst exists or not when calcium thulfite is below 100℃, which reflects the oxidation of ca lcium thulfite in catalyst under the action, the oxidation modification of $CaSO_3$ is necessary for comprehensive utilization of desulfurization ash. In addition, due to inconsistent results relate d to $CaSO_3$gel performance [12,13,14,15], high oxidation cost of calcium sulfite, unsuitable for industrial production, new application technology to be developed, and no suitable oxidation process and equipment, desulfurization ash has not been applied on a large scale in the buildin g materials industry.

Compared with the disadvantages of the application of desulfurization ash in the building mat erials industry, R. R. Wendell et al[16]adding high calcium flue gas desulfurization by-product s to acid soil to reduce soil aluminum toxicity took the lead in applying desulfurization ash to s oil improvement, Wang J et al[17] study shows the effectiveness of the application of flue gas d esulfurization by-products in recycling soil, and also shows the optimal soil physical and chem ical properties of improved germination rate and yield of sunflower. He Jianyun [18] uses dry / semi-dry desulfurization ash to thermal decompose potassium feldspar to produce the prepa ration process of soil amendments with K, Ca, Si and Mg as the main elements. Although desulf urization ash application in building materials industry has many difficulties, desulphurized as h relies on improved desulfurization agent in soil improvement and has basically realized larg e-scale industrial production with its own advantages, there are still certain disadvantages in t he application level that desulfurization ash as a soil improvement needs to be attached to oth er substrate, can effectively play a role [19].

Therefore, a large number of desulfurization ash in China still adopts the landfill method, and this measure not only wastes land resources, but also may cause secondary pollution. In the future, the key to the comprehensive utilization of desulfurization ash transformed gypsum and resource utilization is to explore advanced technologies and safe and reliable intelligent equipment with high efficiency, low cost and suitable for industrial production, but the relevant research needs to be further promoted.

4. Conclusion and Prospect

The release of the 14th Five-Year Plan once again emphasizes that we will continue to deploy ecological and environmental governance, foster and strengthen the clean energy industry, and implement and strengthen the control of land and space use. In order to achieve the goals of the 14th Five-Year Plan, it is of great significance to help the national carbon peak, carbon neutrality, and the resource utilization of biomass and desulfurization ash. Most of the previous studies focus on unilateral resource utilization. If biomass resources and desulfurization and ash solid waste can be transformed together through collaborative pyrolysis, the possibility of win-win situation can be explored:

1. It is well known that Ca series catalysts can promote the production of small molecular free radicals in biomass during pyrolysis, thus improving the yield of pyrolysis gas phase substances. Rich in $CaSO_3$ desulfurization ash, as solid waste produced by the thermal power plant dry desulfurization process, which is not only not effectively used for a long time, but also causes environmental pollution. Consider using the desulfurization ash as a catalyst to promote the improvement of pyrolysis gas yield and calorific value in the biomass pyrolysis process, and then through the thermal condensation of biomass pyrolysis, the soil improvement agent is

prepared with semi-coke substrate rich in desulfurization ash while preparing high calorific value gas fuel.

2. Through relevant research, combined with biomass catalytic pyrolysis is another promising new way to improve the quality of biomass pyrolysis products, relying on pyrolysis biomass directional catalytic conversion technology production of gas fuel can partially replace and supplement the traditional fossil resources route, explore the desulfurization ash as catalyst, research biomass catalytic pyrolysis conversion technology, not only can efficiently use biomass energy, master pyrolysis products distribution, prepare high value-added chemical products, and in the process of generating half coke, to achieve the purpose of desulfurization ash harmless treatment.

3. Mathematical modeling plays a key role in the process of biomass pyrolysis that regulates the relationship between the improvement of pyrolysis gas yield and thermal value and desulfurization ash in the process of biomass pyrolysis, so as to achieve the purpose of the maximum consumption of desulfurization ash while realizing the resource utilization of biomass.

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