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Research Progress on Pyrolysis and Gasification Characteristics of Waste Bacterial Packets

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Abstract

In recent years, China has taken the initiative to assume the responsibility of international environmental protection, vigorously advocated the development of low-carbon green energy strategies, and put forward the goals of "carbon peaking" and "carbon neutrality". Research related to the biomass field is gradually being explored, but some new composite biomass research has not yet been carried out, including waste bacterial packets. The disposal methods of waste bacteria packages are small, occupy a large area and pollute the environment, and need to be solved urgently. As a relatively mature biomass treatment technology, biomass pyrolysis gasification technology can perfectly deal with the problems related to waste bacterial packages. This paper introduces the research results related to biomass pyrolysis and gasification, which can be applied to the treatment of waste bacteria packs and provide reference for the treatment of waste bacterial bags.

Keywords

Carbon Neutrality; Clean Energy; Waste Bacteria Package; Pyrolysis Gasification.

1. Introduction

In recent years, China has vigorously advocated the development of low-carbon green energy strategy and put forward the goals of "carbon peaking" and "carbon neutrality" [1]. Making full use of clean and renewable energy is an important way to achieve the dual carbon goals, and it is also an effective means to achieve environmental protection and solve the problem of energy shortage. At present, there are many types of clean energy, but there are also many limitations [2]. For example, solar energy, wind energy, etc. have high usage costs and high regional requirements . When used in biogas, it not only has a long waiting time, but also is prone to explosions in summer, making it not suitable for widespread use in rural areas . Natural gas, clean oil, etc., although less harmful to the environment when used, are not renewable. Biomass combustible, combustion products only CO2 and H2O, and renewable, is an environmentally friendly renewable clean energy, biomass gasification to produce clean gas helps to improve energy efficiency, for improving human survival and development environment has a good application prospect [3].

As a renewable energy source, biomass combustible energy can effectively replace fossil energy, but the clean and efficient utilization of biomass combustible energy is a major problem that the energy industry needs to solve [4]. Although biomass pyrolysis gasification technology has been widely used in many fields, there are still a large number of technical problems in the actual process, including unclear influence of temperature on pyrolysis gasification, unclear types of gasification products, and in-depth research on reaction mechanisms, which seriously hinder the high efficiency and environmental protection of biomass conversion and utilization. Due to the many types of biomass and their different characteristics, this leads to many and complex reactions involved in biomass pyrolysis gasification [5]. There are also many influencing factors of biomass pyrolysis and gasification, including gasification temperature, gasification medium and raw material particle size.

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Therefore, the research on pyrolysis and gasification of various types of biomass is continuing, and the characteristics of biomass pyrolysis gasification need to be extensively and deeply explored. Understanding the characteristics of biomass pyrolysis gasification and finding the best working conditions of biomass gasification technology has also become a hot spot in extensive research in various universities. Among them, the treatment method of edible fungus package has become a new direction for researchers.

Edible fungus package is the media waste left after the edible fungus cultivation harvests the product. With the development of the edible fungus industry, edible fungus residue is produced in large quantities, and China produces at least 400×104 tons of fungus residue every year. The treatment and utilization of fungus residue is an important problem urgently needed to be solved in the current edible fungus industry research, the more common way to use edible fungus waste is to directly return the fungus residue to the field as fertilizer, or to reprocess the production of fungus residue into feed, fertilizer, but in general, the current edible fungus residue utilization technology is not mature enough, the treatment means are limited, the application scope is narrow, resulting in a large number of waste fungus bags after use after being piled up in the open. After the waste fungus package is discarded in the open, it will not only cause waste and occupation of space, but also easy to ferment and breed flies after wet in rainy days, causing certain damage to the environment, and affecting the human living environment while causing certain pollution to water sources, restricting local economic development.

At present, there are many types of gasification media for biomass pyrolysis gasification, including N2, O2, CO2, air and water vapor. Biomass pyrolysis gasification technology can convert waste bacteria packages into combustible gas and high calorific value pyrolysis oil through high temperature environment and gasification atmosphere, solve the problem of waste bacteria package dumping and provide high-quality energy for human beings, and lay the foundation for the industrial application of biomass gasification in the future.

2. Research Progress

Zhang et al. [6] studied the effects of reaction temperature and catalyst type on hydrogen production by biomass water vaporization in a fixed-bed reactor, and the experimental results showed that regardless of whether a catalyst was added, the temperature increase was conducive to improving the H2 yield, and compared with the catalyst-free gasification, K2CO3 and CH3COOK could be activated to form catalytic compounds, thereby promoting the formation of biomass water vaporization H2. However, KCl can hardly be activated and can lead to high coke yields, KCl inhibits the production of H2. Yan et al. [7] studied the effects of bed temperature and vapor flow on syngas yield and composition of biomass water vaporization in a fixed-bed reactor using biomass coke as raw material. It has been concluded that higher gasification temperatures and the introduction of appropriate steam can improve gas yield and carbon conversion efficiency. It works best at 850 °C, with a dry gas yield of 2.44 Nm3/kg and a carbon conversion efficiency of 95.78%. Chaurasia et al. [8] developed a set of two-stage downsuction fixed-bed gasification reaction equipment, studied the generation and cracking process of tar during the gasification reaction of rice husk in the reactor, and the results showed that the increase of temperature led to an increase in CO content and a decrease in tar yield, resulting in a higher proportion of combustible, and finally established a corresponding kinetic model.

Zhang et al. [9] studied the gasification characteristics of substances in three different gasification media, N2, N2 and water vapor, N2 and air, and experimentally found that increasing the temperature significantly reduced the precipitation of tar. Steam and O2 also have a positive effect on the destruction of tar. When the temperature reaches above 1200 °C, the tar can be completely decomposed. Peng et al. [10] studied the air-vaporization characteristics of wood chips in the fluidized bed, and explored the effects of different residence times and gasification temperatures on the catalytic activity of metal catalysts. The results show that with the increase of temperature and

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the increase of catalyst loading, the higher the tar cracking rate, and at the same time conducive to the preparation of high-purity H_2, the addition of catalyst Ni/Al_2O_3 can effectively improve the tar cracking rate when the residence time is 60 minutes, and the mixing of Ni/Al_2O_3 and CeO_2 further improves the tar cracking efficiency. Zribi et al. [11] used thermogravimetric analyzers to study the pyrolysis gasification of charcoal when CO_2 was mixed with N_2 at different percentages CO_2 (40%, 70%, and 100%) and at different gasification temperatures (750 °C, 800 °C and 900 °C). The mass loss curve was found to be consistent with the usual lignocellulosic gasification behavior. In addition, an increase in temperature or CO_2 percentage has a positive effect on conversion rate, gasification rate and coke reactivity. In addition, CO_2 acts differently from steam, and with the addition of steam, the gasification is faster and more reactive.

Nam et al. [12] studied the gasification of coffee husks in CO_2, H_2O and mixed atmospheres, focusing on the pyrolytic gasification characteristics and behavior of coffee husks. The results showed that the coffee shell began to degrade at 245 °C and reached the maximum weight loss rate at 310 °C (R_{max} = 0.4 %°C-1). Coffee shell charcoal gasifies at 20% H_2O (in terms of N_2) about 2 times faster than at 20% CO_2 (in terms of N_2), which is comparable to wood gasification. Especially in the mixed atmosphere, CO_2 and H_2O have an inhibitory effect on the gasification reactivity activity. Tawatbundit et al. [13] studied the effects of hydrothermal treatment, 0~5% $KMnO_4$ content and pyrolysis temperature of 300 ~ 400 °C on the preparation of activated carbon from sugarcane leaves, and compared them with non-hydrothermal treatment. The yield of activated carbon prepared by hydrothermal method (20.33 ~ 36.23%) was higher than that of activated carbon prepared by non-hydrothermal method (16.40 ~ 36.50%), and the yield of activated carbon was higher (22.08 ~ 42.14%) under the same $KMnO_4$ content. Hydrothermal and pyrolysis temperature have a certain effect on improving the carbon content and aromatic hydrocarbon properties of synthetic activated carbon. In addition, the use of $KMnO_4$ increased the O/C ratio and the content of C-O, Mn-OH, O-Mn-O and Mn-O surface functional groups. M. Zribi et al. [14] studied the vaporization of particles produced by mixing olive milling solid waste, impregnating or not impregnating olive milling wastewater and pine wood chips under different steam, N_2 atmospheres. Charcoal required for gasification test was prepared by pyrolysis in a fixed-bed reactor. The tests were performed at different temperatures (750 °C, 800 °C, 820 °C, 850 °C and 900 °C) and atmospheres consisting of different proportions of N_2 and water vapor (10%, 20% and 30%). The results show that the increase of partial pressure or temperature of water vapor positively affects the conversion rate and coke reactivity by accelerating the gasification process. The mass change curve is similar to the usual lignocellulosic gasification process.

At present, the research on biomass gasification technology in the direction of biomass pyrolysis gasification is relatively mature, and gasification tests are mainly carried out in fixed beds and fluidized beds, and the biomass gasification effect is good, and industrialization can basically be achieved. The gasification process and gasification results of biomass can meet the requirements. Biomass gasification technology is widely used, and the gasification reaction equipment is generally large in scale and has a high level of automation. The application of biomass gasification technology mainly includes: biomass gasification power generation; Biomass gas for city heating; biomass gasification to synthesize methanol or dimethyl ether; Hydrogen production from biomass gasification; Biomass gasification synthesis ammonia, etc. However, the relevant research on waste bacteria bags involves little, the research theory has not been deepened, the treatment methods and technologies related to waste bacteria bags are not mature, and the scientific treatment of waste bacteria bags urgently needs to be solved.

3. Results and Prospects

Nowadays, fossil energy is in danger of depletion, the development of traditional energy has stagnated or even retreated, and the need to find new alternative energy is very urgent, so the world is paying more and more attention to the new energy industry. The research on biomass pyrolysis and gasification is gradually deepening, but due to the wide variety of biomass and the increase in the use of composite biomass, the pyrolysis gasification research of biomass is not comprehensive. Among them, the problem of waste bacteria package treatment has also appeared in recent years, the efficiency of the traditional treatment method of waste bacteria package is low, and the processing amount is small, so that the waste bacteria package can not be quickly cleaned up, a large number of accumulation of waste, not only covers a large area, but also pollutes the environment, and needs to be solved urgently. Biomass pyrolysis gasification technology can well process a large number of waste bacteria packages and produce combustible gas to provide us with clean energy, which is worth promoting in large quantities, so the relevant characteristics of waste bacteria packages and pyrolysis gasification characteristics need to be explored, and the market in pyrolysis gasification related fields of waste bacteria packages is very broad.

(1) To carry out research in biomass-related fields, it is first necessary for countries to issue relevant policies, encourage relevant enterprises to carry out business in the biomass field, improve the industrial structure of biomass-related markets, form a complete industrial chain, and contribute to the market economy. In recent years, countries around the world have also recognized the importance of biomass-related fields and have introduced relevant preferential policies to provide policy support for the biomass field.

(2) Major universities and research institutes should conform to the trend of the times and the direction of development, and actively participate in the research in the field of biomass. Carry out the establishment of related majors, recruit talents in biomass related fields, provide comprehensive teaching for students, and better cultivate talents needed by society.

(3) Teachers and students in school should have firm beliefs, clear goals, learn biomass-related knowledge, actively explore biomass-related issues, graduate material pyrolysis and gasification characteristics, provide theoretical and technical support for industrial development, and provide impetus for the promotion of biomass pyrolysis gasification technology.

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