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Study of China's biomass power generation technology

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Study of China's biomass power generation technology

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Abstract. With the rapid growth of the population and the continuous advancement of the times, the problem of energy shortage has become a problem that needs to be faced together in the world. To make use of new technologies to achieve rational use of energy has become a topic faced by researchers in various countries. Biomass power generation technology has been effective in mitigating such problems. Biomass power generation is one of the new energy generation technologies, with the advantages of low carbon emissions, environmental protection and sustainable development of new energy sources. Biomass power generation has attracted the attention of countries all over the world because of its good economic and social benefits. Based on this, this paper describes the concept and characteristics of biomass energy and the technologies that biomass energy is applied in power generation.

1. Introduction

With the development of human society, the demand for energy has become more and more urgent. The development and utilization of new energy has undoubtedly greatly alleviated the shortage of traditional fossil energy and provided hope for the sustainable development of mankind. China's energy demand is also on the rise, the gap is expanding, and the contradiction between energy and environmental protection is deepening. In order to achieve a healthy, orderly and organic development of the economy one step earlier, new energy is the best choice within the scope of existing technologies and capabilities.

Biomass is a relatively clean, low-carbon fuel, in which the nitrogen and sulfur contents are relatively low. As long as the correct combustion can not only greatly reduce the harmful substances in the exhaust fumes, it can even achieve zero emissions of carbon dioxide. Therefore, biomass energy has become a new type of renewable energy that has attracted much attention today, and has become an important part of the world's countries.

2. Biomass energy concepts and characteristics

Biomass energy refers to the organic matter produced by animals and plants, microorganisms themselves, and the energy-containing debris left after their death. The energy contained in living metabolites and residues is essentially derived from solidified solar energy. Organisms containing biological residues can be decomposed by aerobic or anaerobic respiration to produce the required thermal energy.

Fossil energy such as coal, oil and natural gas is also transformed from biomass energy. Biomass has the following characteristics compared to fossil fuels. (1) Renewability. Biomass can be regenerated through photosynthesis of plants. It is also a renewable energy source with wind energy and solar energy. It is rich in biomass resources and can ensure the sustainable use of energy. (2) The carbon dioxide has



zero emission characteristics during biomass utilization. The amount of carbon dioxide required for biomass to grow is equivalent to the amount of carbon dioxide emitted when it is used. Therefore, the net carbon dioxide emissions to the atmosphere are close to zero, and the large use of biomass energy can effectively reduce the greenhouse effect. (3) Biomass has low sulfur and nitrogen content, and low ash content. After combustion, nitrogen oxides, sulfur oxides and dust emissions are much smaller than fossil fuels, and it is a relatively clean fuel. (4) The biomass resources are widely distributed, the output is large, and the conversion methods are various. (5) It can learn from traditional energy utilization technologies, and compared with other non-traditional energy sources, there are fewer technical problems. (6) The biomass unit mass has a low calorific value.

3. Biomass power generation technology

3.1. Biomass direct combustion power generation technology

Biomass direct combustion power generation refers to the use of biomass energy after combustion to convert into steam for power generation, which is basically the same as the principle of coal-fired power generation. Different from raw materials, biomass direct combustion power generation mainly includes direct combustion power generation of industrial waste, straw, agricultural and forestry waste, livestock manure and other fuels.

The combustion process of biomass fuel is a strong chemical reaction process and a two-phase flow process, as well as mass transfer and heat transfer between fuel and air. Combustion must have fuel, adequate heat supply, and proper air supply.

Direct combustion power generation refers to the feed of biomass feedstock into a steam boiler suitable for biomass combustion to produce steam to drive the steam turbine, thereby driving the engine to generate electricity. Key technologies for direct combustion power generation include raw material pretreatment technology, fuel applicability technology for steam boilers, high efficiency steam turbine technology, and efficient combustion technology for steam boilers.

Process flow of direct combustion power generation. First, the biomass raw materials are pretreated by crushing, sorting, etc., and then stored in a fixed area; then, the raw material transport vehicle transports the boiler to burn, and the biomass chemical energy is converted into steam by heat exchange between the hot flue gas and the water. The heat energy provides high-temperature and high-pressure steam source for the steam turbine generator set to generate electricity, and realize the conversion of steam heat energy to mechanical energy and electric energy. Finally, the ash after combustion of the biomass is dedusted, sent to the ash pit by the ash conveyor and processed. The flue gas is discharged into the atmosphere by the chimney after being subjected to desulfurization and denitrification treatment.

The key factor affecting the efficiency of biomass direct combustion power generation is the combustion efficiency of biomass, and combustion equipment is the key factor affecting the direct combustion efficiency of biomass. Biomass fuel combustion equipment can be divided into large boilers, small boilers and cogeneration boilers according to the scale; according to the combustion form, it can be divided into bundle furnace, sheet boiler, granular layer furnace, etc.; it can be divided into wood furnace according to the use and combustion type. , pellet fuel furnace, fireplace, diesel new boiler, straw boiler, etc.

3.2. Biomass gasification power generation technology

The basic principle of biomass gasification power generation technology is to convert biomass into flammable gas, and then use flammable gas to promote gas power generation equipment for power generation. It solves the disadvantages that biomass is difficult to burn and distributes to a certain extent, and can fully utilize the advantages of compact and low pollution of gas power generation technology equipment.

The gasification power generation process includes three aspects: one is biomass gasification, which converts solid biomass into gaseous fuel; the other is gas purification, and the gasized gas contains certain impurities such as ash, coke and tar. Adding a purification system to remove impurities to ensure

the normal operation of gas-fired power generation equipment; Third, gas-fired power generation, using gas turbines or gas-fired internal combustion engines to generate electricity. In the power generation process, waste heat boilers and steam turbines can be added, and energy cascade utilization principles are adopted to improve power generation efficiency.

Process flow of biomass gasification power generation. The pretreated biomass feedstock is sent to the inlet gas furnace by the feed system. In the gasification furnace, the biomass is incompletely combusted due to limited oxygen, and a gasification reaction occurs to generate a combustible gas-gasification gas. The gasification gas preheating is generally recovered, that is, the high temperature gasification gas exchanges heat with the materials to heat the biomass raw materials, and then is cooled and purified by a cooling system and a purification system. In this process, solid particles, ash, tar, and condensate have been removed, and the purified gas can be used for power generation, and gas turbines, internal combustion engines, and the like are usually used for power generation.

Biomass gasification power generation technology is a unique way of different biomass utilization from other renewable energy sources. It has the following three characteristics. First, it has good cleanliness. Biomass itself is a renewable resource, which can effectively reduce the emission of sulfur dioxide, carbon dioxide and other gases. The gasification process generally has a low temperature and a very small amount of nitrogen oxides. Therefore, the amount of nitrogen oxides can be effectively controlled. The second is the flexibility of technology. Biomass gasification power generation can not only use internal combustion engines, but also gas turbines, and can be combined with the steam power generation system of waste heat boilers, and select appropriate power generation equipment according to the size of the scale to ensure reasonable power generation efficiency at any scale. Flexibility is well suited to the characteristics of biomass dispersion. Third, it has good economics. The flexibility of biomass gasification power generation technology ensures that the technology has better economics on a small scale, while the gas power generation process is relatively simple, the equipment is compact, and the biomass gasification power generation technology investment is small.

3.3. Biogas power generation technology

Biogas is a combustible gas produced by the decomposition and transformation of organic matter by various microorganisms under anaerobic conditions. Its main components are methane and carbon dioxide, with a methane content of 60% to 70% and a carbon dioxide content of 30% to 40%.

Methane in biogas is a strong greenhouse gas, which causes the greenhouse effect to be 23 times that of carbon dioxide. Today, advocating environmental protection has become a trend, and controlling methane and biogas emissions has become an important aspect of protecting the atmosphere. Biogas is not only biomass renewable energy, but also a medium-calorific fuel with better performance. The calorific value of pure fuel is 21.98MJ/m³. Therefore, the efficient use of biogas has the dual significance of controlling pollution and developing new energy. The biogas power generation technology that uses biogas as the fuel of the power machine to drive the generator to operate and obtain high-grade electric energy has become an international technical route.

The principle of biogas power generation is that biogas is the main fuel source for complex generators and steam turbines. The process of driving generators with engine power is a way to effectively use biogas energy.

Biogas energy undergoes chemical energy in the process of power generation - thermal energy - mechanical energy - electrical energy conversion process, its energy conversion efficiency is limited by the second law of thermodynamics, thermal energy can not be completely converted into mechanical energy, the Carnot cycle efficiency of thermal energy does not exceed 40%, most of the energy is discharged with the exhaust. Therefore, recycling the exhaust gas of the engine is a necessary way to increase the total utilization rate of biogas energy, and the total efficiency of the waste heat recovery biogas power generation system can reach 60% to 70%. From the perspective of energy utilization, hydrocarbon fuels can be used in a variety of power equipment such as internal combustion engines, boilers, and gas turbines.

3.4. Domestic waste incineration power generation

Incineration power generation of municipal solid waste is the incineration of combustible materials in domestic waste by incinerators. After high-temperature incineration, a large amount of harmful substances in the garbage are eliminated, thereby achieving the purpose of harmlessness and reduction, and at the same time, the recovered heat energy is effectively reused for heating and power supply. Waste incineration power generation can reduce the amount of garbage by about 80%, greatly solve the problem of land occupation, and standardize the treatment of bacteria and viruses in the garbage, which is more thorough than other treatment methods, and can also reduce secondary pollution to the surrounding environment.

Process flow of domestic waste incineration power generation. The garbage is transported by the transport vehicle to the power plant, weighed, transported to the loading gate and then discharged to the garbage pit. The storage tank volume is larger, and it can be stacked for three or five days. Then, the garbage that has been fermented and dehydrated in the pit is sent to the feeder by the crane, enters the grate, and finally burns in the incinerator. When starting the furnace, it is necessary to use the combustion-supporting device to spray fuel to assist combustion. After the start-up, the air of the blower is sent to the lower part of the grate through the steam-type air preheater to become hot air. Thus, the garbage is burned more fully, and the combustion-supporting device is turned off. The entrance of the blower is connected to the garbage pit, which maintains the negative pressure of the garbage pit and prevents the odor from leaking. At the same time, the air of the garbage pit is sent to the incinerator with a burning temperature of 800-900°C to burn, and the odor component is thermally decomposed and then made. Becomes odorless gas. The burnt ash is passed through the ash discharging device, the ash conveying machine, and then to the ash pit. The ash ash is equipped with a humidity control machine on the upper part of the ash conveying machine, so that the separated ash slag is automatically added with an appropriate amount of moisture, and becomes wet ash, which is reduced. The pollution of the surrounding air. The burning flame and the high-temperature flue gas pass the heat to the water through the heating surface of the single-furnace double steam drum natural circulation boiler, thereby generating superheated steam and driving the steam turbine generator set to generate electricity. After the gas passes through the boiler, and then passes through the denitration device and the desalination device, as well as the mechanical dust collector and the electric precipitator, the flue gas is sent to the chimney by the induced draft fan to discharge to the atmosphere. At this time, the flue gas discharged into the atmosphere should meet the national emission standards, and the central control room should centrally control and monitor the operation of the boiler and steam turbine generator set. In addition, it is preferable for the factory to provide a drainage treatment device to perform pretreatment before the water enters the public sewer.

The garbage should have a certain calorific value. When the low calorific value of the garbage is 3344KJ/kg, the incineration needs to be coal blended or fueled to support combustion; when the low calorific value of the garbage is greater than 5000KJ/kg, its combustion effect is better. According to incomplete statistics, the low calorific value of urban domestic waste is generally in the range of 3344~8360KJ/kg. The study found that the water content in the garbage is less than 50%, which has non-uniformity and variability. The change of garbage composition is affected by the region and season. There is still some difficulty in waste incineration. The composition of urban garbage is affected by the seasons and people's living habits, etc. It is related to the living standards of urban residents and the popularity of gasification. In order to ensure safety, hazardous wastes are strictly prohibited from entering the domestic waste incineration plant; the waste from the incineration plant is prohibited from being stacked randomly, and must be stored in a garbage storage bin with good anti-seepage performance and under negative pressure to avoid groundwater pollution and foul odor.

3.5. Biomass mixed combustion power generation technology

Mixed combustion power generation refers to the application of biomass raw materials to coal-fired power plants, using biomass and coal to generate electricity. There are three main ways of mixing combustion: the first is to directly feed the biomass raw materials into the coal-fired boiler, co-combust

with the coal, and then let the steam drive the steam turbine to generate electricity; the second is to use the gasifier to gasify the biomass raw materials. The combustible gas is then passed into a coal-fired boiler to be burned with coal to generate high-temperature steam to drive the steam turbine to generate electricity. The third is a parallel combustion method in which biomass and coal are separately sent to separate boilers for combustion to produce steam. Steam turbine power generation. Among the above three methods, the biomass raw material pretreatment technology is very critical, and the raw materials must be processed into fuels that meet the requirements of coal-fired boilers or gasifiers. Key technologies for mixed combustion include high-efficiency steam turbine technology, coal-to-biomass co-firing technology, coal-to-biomass combustible gas combustion technology, and more.

Due to the low energy density and large volume of biomass, energy consumption increases carbon dioxide emissions during transportation, and does not adapt to large-scale biomass power plants. The scattered small power plants have large investment, high labor costs, and low efficiency. Therefore, in large coal-fired power plants, the combined combustion of biomass and fossil fuels has become a new concept. It provides an opportunity for optimal blending of local biomass and fossil fuels, and many existing equipment does not require major changes, reducing investment costs. There is also a more positive impact: large power plants have good adjustability, and the co-firing devices can adapt to local biomass characteristics and can adapt to different mixed combustion.

Most coal-fired power plants burn pulverized coal, which is only suitable for crushing pretreated biomass. The study found that biomass and coal have a great potential for mixed combustion. In fact, this technology is very simple, mainly to reduce carbon dioxide emissions, is widely used in Scandinavia and North America in the northwest corner of Europe. In the United States, more than 300 power plants use biomass and coal co-firing technology with an installed capacity of 6000 MW. VERBUND, Austria's largest power supplier, conducted research on biomass in the following four ways: (1) Pulverizing biomass with a dedicated pulverizer Let it burn with pulverized coal in a coal-fired boiler; (2) Burn biomass on a grate in a furnace of a coal-fired boiler; (3) let the biomass burn in a separate system, and the heat generated is used in existing the boiler of the power plant; (4) gasification of biomass in the gasifier, gas as boiler fuel. The results show that (2) and (4) have strong practicability.

In the traditional thermal power plant, mixed combustion, in line with the biomass power generation process route, does not require gas purification equipment, and does not require a small power generation system, can directly benefit from large traditional power plants.

The main production systems for biomass and coal combustion power generation include electrical systems, combustion systems and soda systems. The combustion system mainly has a combustion part of the boiler, a biomass processing and transmission system. The soda system mainly includes boilers, condensers, turbines, feed pumps, and chemical water treatment and cooling water systems.

4. Conclusion

In summary, the application of biomass power generation technology is bound to be an important part of sustainable energy development compared to the scarcity and pollution of conventional energy sources. As a clean and renewable energy source, biomass energy plays an important role in meeting energy demand and accelerating the construction of an ecological economy. This paper first introduces the background of the development of biomass power generation technology, then introduces the concept of biomass energy and the characteristics of biomass energy. Finally, it elaborates five major biomass power generation technologies, and hopes to make people more comprehensive. More systematic display of biomass power generation technology, so that more people understand the importance of biomass power generation technology, and then promote the development of biomass power generation technology, and lay a useful foundation for environmental improvement.

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