Proceedings of the 2nd International Conference on Functional Materials and Civil Engineering
DOI: 10.54254/2755-2721/70/20240971

Research on the potential of biomass as a chemical energy source

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Abstract. Biomass is an important renewable energy source, derived directly or indirectly from photosynthesis in plants. At present, the world relies heavily on traditional fossil energy, which are hydrocarbons or their derivatives, formed by the accumulation of ancient fossils over time. This paper analyzes and compares the energy produced by various chemical energy sources, as well as their environmental impact and energy efficiency to study the feasibility of substances as bio-energy sources. As energy is indispensable for the survival of human beings, how to discover more green energy and utilize it will become a major challenge for us in the future. Biomass, as a kind of chemical energy has the potential to solve the problem of lack of chemical energy. This paper finally concludes that biomass is feasible as a future chemical energy source, and its super renewable capacity and its nature for solar energy tell us about its huge potential.

Keywords: Biomass, Chemical Energy Source, Bio-energy Source, Renewable Energy

1. Introduction

As a renewable and environmentally friendly energy resource, biomass energy has been widely concerned and emphasized by countries around the world. It has a very broad application prospect, involving many aspects such as urban and rural energy issues, sustainable development and environmental protection issues, and energy security and national strategic issues. As an energy choice for sustainable development, biomass energy can help reduce greenhouse gas emissions and environmental pollution. In China, the current biomass resources are about 461 million tons, and the carbon emission reduction is about 218 million tons, while in the future biomass energy will make great contributions to China’s carbon peak in 2030 and carbon neutrality in 2060 in various fields. It is believed that in the near future, biomass energy will be combined with carbon capture and storage technology to realize negative carbon emissions.

2. Conversion of Biomass into Chemical Energy

2.1. Forms of Biomass Exploitation and Utilization

Biomass energy is a kind of renewable energy that mainly refers to the substances produced by living organisms, such as plants, animals and microorganisms, which can be converted into utilizable energy through chemical, physical and biological methods. And it is essentially converted from solar energy. Biomass has a wide range of energy sources, including wood, crop waste and municipal solid waste At

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the same time, with a greater variety of uses, it can be directly burned for heating and lighting and power generation, and can also be converted into liquid or gaseous fuel for transportation and industrial production. However, biomass still faces many challenges. Not only for the government, but also for individuals, most people's understanding of biomass energy is still stuck on burning wood in earthen stoves. Some governments even define biomass as a highly polluting fuel second only to coal.

Therefore, the following are some forms of biomass energy development and utilization.

(1) Biogas and its comprehensive utilization: multi-level utilization of organic waste.

(2) Fuelwood forest and fuel-saving stove: open source and energy saving.

(3) Biomass curing technology: the use of agricultural and forestry waste to press fuel, and easy commercialization.

(4) Biomass pyrolysis gasification: the use of wood chips, fuelwood, straw, rice husk, leaves, sawdust, garbage, etc. into combustible gas.

(5) Biomass pyrolysis liquefaction: the use of waste, straw, wood chips and other thermal decomposition into oil, methanol and other liquid fuels.

(6) Alcohol production by biomass fermentation: the use of cellulose, sugarcane, sugar beet, sweet sorghum, potatoes, etc., to produce fuel ethanol by microbial fermentation.

(7) Biomass power generation technology: the use of waste, bagasse and other high cellulose and lignin raw materials, incineration and gasification power generation.

(8) Energy plants: fuel or petroleum substitute products extracted from plants rich in hydrocarbons.

2.2. Technologies for Biomass Development and Utilization

Among the various forms of biomass energy conversion, biomass direct power generation, alcohol production by biomass fermentation, and biogas technology have achieved large-scale production applications; biomass curing molding and some gasification technologies have begun large-scale production and utilization; most of the other technologies are still in the experimental or pilot stage.

2.2.1. Biogas Technology. At present, 525X10 farmers in China have built biogas digesters, using human and animal manure and agricultural organic residues to produce biogas, which has greatly alleviated the tension of rural energy, while the comprehensive utilization through multiple channels has effectively promoted the prosperity of rural economy. There are more than 600 large and medium-sized biogas projects in the country, 3X10 'multi-mouth biogas ponds, with a total volume of 137X10 m, an annual output of 5499X10' m of biogas, and an annual treatment of wastewater and livestock manure of 520X104. Among them, there are 583 centralized gas supply stations, with 8.3X10 users, and an average household gas consumption of 431 m.

2.2.2. Fuel Ethanol Production through Microbial Fermentation. Brazil has made large scale use of sugarcane to produce ethanol as automobile fuel to replace oil imports. In the United States, corn and potato are used to produce ethanol. China's Hainan Laude Company is preparing to build a 2X10 t annual biomass fuel plant in Haikou City. The plant will produce ethanol fuel, single-cell protein feed and carbon dioxide (dry ice) using tuber with high yield in Hainan as raw materials.

2.2.3. Direct Combustion and Power Generation Technology. In 1992, there were about 1,000 wood-burning power plants in operation in the United States, with an installed capacity of 65 x 10°W and an annual generation capacity of 42 x 10 kW·h., with an investment of about $2,000 - $3,000 per kilowatt and a cost of 4- $6 cents. From an economic analysis point of view, the larger the scale of production, the lower the product cost. This conversion mode has three kinds of technical support: (1) specific energy forest production technology, including seed selection, cultivation and planting; (2) a special set of processing equipment technology; (3) conversion energy production equipment, which mainly refers to combustion furnaces, steam power generation equipment, etc.

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2.2.4. Fixed Forming Technology. The technology involves the pressurization or pyrolysis of sparse, low calorific value biomass to form solid, high calorific value energy products. Its product forms mainly include wood stick (block) fuel and carbonized stick (block) fuel, and mass production has been developed in some areas.

2.2.5. Pyrolytic Gasification Technology. Most foreign countries use pressurized combustion gasification technology to drive gas turbines, as well as production gas methanization, fluidized bed or fixed-bed pyrolysis gasification. China has mainly researched and developed the pyrolytic gasification technology of fluidized bed, fixed bed and small gasifier. The DN-600 gasifier technology of China Agricultural Machinery Academy has been produced by many manufacturers, with an annual output of more than 400 sets; Guangzhou Energy Institute of Chinese Academy of Sciences has developed a circulating fluidized bed powder gasifier for 4-6t wood powder per day and a small biomass gasification power plant with an output power of 2-2.5 kW. These devices have been put into use in some wood mills; The XFL-1000 biomass gasification unit developed and produced by Shandong Energy Research Institute has good prospects for development, using straw as raw material and building centralized gas supply stations in rural areas to produce low calorific value gas for civilian fuel.

3. Applications of Biomass as a Chemical Energy Source

Biomass energy is used as a feedstock for the production of chemicals, plastics, fibers and other materials. The upstream bio-based raw materials include lignin, cellulose, starch, polysaccharides and vegetable oils, which are obtained through biosynthesis, bioprocessing, bio-refining processes such as ethanol, ethylene, succinic acid, lactic acid and other bio-based monomers, which are further processed to obtain bio-based material products. Among them, the three major categories of bio-based plastics, bio-based fibers and bio-based rubber have been born with some representative products. This includes bio-based plastic products of polylactic acid (PLA), carbon dioxide copolymer (PPC), polyhydroxyalkanoate (PHA), polycaprolactone (PCL), bio-based polyamide (PA), bio-based polyurethane (PU); Bio-based fiber categories of PLA fiber, PHBV and PLA blend fiber, PTT fiber, PBT fiber and fiber (tencel), bamboo pulp fiber, hemp pulp fiber and other bio-based new cellulose fiber; Bio-based rubber category polyester bio-based synthetic rubber, bio-based itaconate rubber, soybean oil based elastomer, bio-based polyurethane elastomer and so on.

At present, biobased materials have been widely used in packaging, catering, electronics, automobiles, agriculture and forestry, horticulture, toys, textiles and other terminal market segments. Among them, packaging is the largest application field of bio-based materials. In 2020, the total consumption of bio-based materials in the world will be 2.11 million tons, with the consumption in the packaging field accounting for 47%, followed by the consumption in the catering and textile fields, accounting for 12% and 11% respectively [1]. Multinational companies such as BASF, Dow and DuPont have long been committed to the research and development of biobased materials, which has promoted the commercialization process of biobased materials worldwide. At present, China’s bio-based materials are still in the initial stage of development, which is a booming sunrise industry. In recent years, there has been a gradual increase in the number of new enterprises entering the industry. After several years of development, there have been key enterprises with high growth such as Kaisai Biology, Lianhong Xinke, Jinfa Technology, Huasheng Chemical, Jiaao Environmental Protection, Zanyu Technology, Excellence New Energy, and State Innovation Biology.

4. Challenges and Solutions for Biomass as a Chemical Energy Source

The sustainable supply of biomass energy is a key issue that needs to address the challenges of planting, harvesting and processing of biomass resources.

4.1. Uncertainties and Related Issues in the Biomass Cultivation in Agriculture and Forestry

The uncertainty involved in this link mainly stems from factors such as the quality of agroforestry inputs, the growth process of agroforestry crops, the natural environment and planting willingness. The

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uncertainty of the quality of agroforestry inputs is mainly attributed to speculation by the producers of agroforestry inputs. At the same time, due to the long time interval between planting and harvesting of agricultural and forestry crops, if the problematic agroforestry crops are identified only in the growth process, then by the "rigid" constraints such as crop ripening and irreversible crop growth process, the total output of agricultural and forestry biomass has a huge uncertainty, hindering the sustainable development of agricultural and forestry biomass power supply chain from the source of the supply chain.

In the growth of agroforestry crops, the natural environment is an important external factor in determining their yield. When the natural environment reduces the quantity or quality of agroforestry biomass supply, the sustainable development of the agroforestry biomass power supply chain will be affected. In addition, farmers' planting willingness is also an important factor affecting the sustainability of the agroforestry biomass power supply chain. Changes in farmers' planting willingness can lead to variations in the type of feedstock supply for agroforestry biomass power generation, affecting the smooth operation of the agroforestry biomass power generation supply chain.

4.2. Uncertainties and Related Issues in the Collection of Biomass Feedstocks from Agriculture and Forestry

The uncertainties involved in this link are mainly derived from factors such as biomass quality, biomass quantity, biomass type, biomass price, biomass collection location and processing equipment operation. Among them, the uncertainty of biomass supply quantity is one of the most important uncertainties in the raw material collection process. Jiang Yunjian believes that for agricultural and forestry biomass, on the one hand, biomass collection depends on planting, harvesting and other operational activities, the interval period is relatively fixed, and the seasonal characteristics of agricultural and forestry biomass supply are significant. On the other hand, under the joint action of farmers' planting intention and natural environment, the supply of agricultural and forestry biomass at different time periods and different locations presents the characteristics of variability [2]. Tan Qinliang studied different raw material supply models in the supply chain of agricultural and forestry biomass power generation. In this study, the quantity of raw material supply was selected as a fuzzy variable, and a straw raw material supply model was established. Through model derivation and an example model, it was proved that farmers' sensitivity to price fluctuations of biomass raw materials was different under different models [3]. Sadhan Kumar Ghosh conducted a study on the sustainability of the agroforestry biomass power supply chain and concluded that: The supply of agricultural and forestry biomass raw materials is the main factor affecting the sustainable development of the supply chain of agricultural and forestry biomass power generation. Among them, government policies are important factors affecting farmers' choice of biomass energy utilization mode, economies of scale and biomass energy utilization efficiency [4]. In the overall goal of building a moderately prosperous society in an all-round way, China specifically points out that in the next 20 years, "the capacity for sustainable development will be continuously enhanced, the ecological environment will be improved, the utilization rate of resources will be significantly increased, the harmony between man and nature will be promoted, and the whole society will embark on the development path of increased production, prosperous life and sound ecology [5]." In the "Tenth Five-Year Plan for the Development of New and Renewable Energy Industries [6]," the efficient use of biomass energy is considered one of the priorities of development.

5. Conclusion

It can be seen that biomass, as an ideal renewable energy source, is increasingly being emphasized by countries around the world. However, current biomass utilization is primitive, inefficient and polluting. This paper concludes that biomass has the potential to become an indispensable part of the future sustainable energy system, and it is estimated that by mid-century, the substitution rate of existing fuels by biomass produced using new technologies will account for more than 40% of the total global energy consumption. In conclusion, the future direction of biomass energy research should be multifaceted, including improvement of production efficiency, development of efficient conversion technologies,

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integration with other forms of energy, environmentally friendly research, and economic research, so as to promote the development and application of biomass energy and contribute to the sustainable development of the energy sector.

References

[1] Wang Kun, Ji Xiuling, Lan Kun & Huang Yuhong. (2023). The research progress of the core single separation and purification technology of bio-based materials.
[2] Zhang Shengyi, Zhang Jie & Wang Tong. (2020). Under uncertain conditions, the problem of sustainable development of agricultural and forestry biomass power generation supply chain.
[3] Tan Qinliang, Wang Ruiwu, Pan Xinxin, Zhang Xingping & Zhang Chong. (2017). The study of fuzzy supply of biomass power generation fuel supply chain model. China Soft Science (02), 123-131.
[4] zhou Jin. (2024) .opeening-up China's Bright Path. China Press Release (English version) (01), 20-23.
[5] Ahmed, M. A., & Moniruzzaman, S. M. (2018, February). A Study on Plastic Waste Recycling Process in Khulna City. In 4th International Conference on Civil Engineering for Sustainable Development (ICCESD 2018), Khulna (pp. 9-10).
[6] Haixing ZHANG,Yuan FENG,Yanxiang JIA,Pengqi LIU,Yong HOU,Jianbo SHEN... & Fusuo ZHANG.(2024).China's agriculture green development: from concept to actions.Frontiers of Agricultural Science and Engineering(01),20-34.