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Extraction Methods for Biomass Energy

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Abstract:

Biomass energy or bioenergy includes any electric power or any solid, liquid or gaseous fuel or useful chemical product that derived from organic matter, whether directly from plant or indirectly from plant-derived commercial, industrial or urban wastes, forestry and agricultural residues. In recent years, one of the most encouraging renewable energy technology is biomass energy which is increasing attention all over the world. For power generation, biomass is used globally as a bioenergy resource worldwide. In this paper, discuss the biomass, biomass as a renewable energy source, technologies for extracting power from biomass and conversion of biomass into energy. This conversion biomass is broadly divided into four categories which include Agrochemical, Biochemical, Physical and Thermochemical. In which thermochemical contain the extracting methods such as pyrolysis, anaerobic digestion to methane, combustion, liquefaction, and gasification.

Keywords: *Biomass Energy, Gasification, Combustion*

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Introduction

Biomass is a biological material which is a renewable energy source because the energy comes from the sun and these biological material come from living or recently living organisms such as waste, alcohol fuels, wood, and gas (hydrogen). A wide range of raw materials is derived from the bioenergy and produced in a variety of ways. Biomass is produced by the wide range of potential feedstock's and variety of technologies and also process them and it also considered as the combination of much different feedstock and technology. In this sense, uses the different terms for a different end such as electric power or transportation. Electricity generated and heat produced by growing the plant that is the part of biomass. While still alive, the plant can also be generated the electricity that is included in the living biomass. Biomass is still used in which incineration included that have forest residues (branches, dead trees, and tree stumps), wood chips, yard clippings, and garbage are frequently used. Biomass also includes plants and animals that are used for the production of chemicals or fibers and biodegradable wastes that can be used for burning as fuel. Fossil fuels are an organic material that excludes and transformed by the geological process into substances such as petroleum or coal. In the world, biomass as an important force component that is derived the development of products for economic development (Sriram and Shahidehpour, 2005; Kurchania, 2012; PIECH 117).

Through photosynthesis, the renewable organic matter has derived the biomass that is generated by plants. Biochemical "building blocks" of biomass is formed by combining the plants to carbon dioxide from air and water from the ground to form carbohydrates during photosynthesis. Photosynthesis is derived from the solar energy that is stored in the chemical bonds of the carbohydrates and other molecules contained in the biomass. Biomass has some advantages that follow:

- Widely available of biomass
- Its technology is well understood for the production and conversion.
- For small and large applications, it's well suitable.
- Only requires low light intensity and low temperature (535ºC) for production and utilization.
- It includes the advantages of storage and transportation.
- With low or negligible pollution, linked the biomass.

After coal, oil and natural gas, biomass is the fourth largest energy resource that is estimated at about 14% of global primary energy in which 3-4% primary energy provided in the US. Biomass is used for cooking, electric power production, heating (such as wood stoves in homes and for process heat in bioprocess industries) and transportation. In worldwide, generation of biomass power is about 35,000 MW in which 7000 MW from forest-product industry and agriculture in the US and also 7000 MW capacity is found in paper and pulp industry that combined with power and heat systems (Kurchania, 2012).

Conversion of Biomass into Energy

In the modernized world, the energy of biomass has a great importance, for example, they are converted and produced efficiently and more convenient forms such as electricity, gases, and liquid of cost-competitively. In industrialized countries, only 3% of primary energies consumption that is represented by modern biomass and value remains over the recent years. In the rural sector, providing energy by the power of biomass that is important. In the utilization of biomass, by the employment opportunities that are created for the cultivation, storage of biomass, collection, and transportation. "Co-firing" process is defined as to increase the use of biomass energy that is burning and mixed with coal in power plants. Three technologies consist of biomass conversion: Thermochemical, Biochemical and chemical technologies.

Thermochemical: Plant matters only heated but not burned that breaks down into solids, liquids, and gases. Further processed and refined by these products that are useful fuels such as methane and alcohol. Plants released the methane which is captured by the biomass gasifiers and burn it in a gas turbine that produces electricity. By using high temperature to energy, converted the biomass feedstocks into electricity, bioproducts, fuels, and heat.

Biochemical: Carbohydrates are broken by the bacteria, yeasts, and enzymes. Make wine, changes biomass liquids into alcohol and a combustible fuel are formed by the process of fermentation. Corn is turning into grain alcohol or ethanol by this similar process that is mixed with gasoline to make gasohol. Biomass, methane and carbon dioxide are produced by the breakdown of bacteria. In sewage treatment plants and landfills, this methane can be captured for example burned to heat and power. Biomass is converted into energy (fuels in the form of liquid and gaseous) with the help of biological agents.

Chemical: Soybean and canola oil is biomass oil that can be chemically converted into a gasoline additive

and a liquid fuel similar to as diesel fuel. Biomass feedstock is converted into energy (mainly in the form of liquid fuels) with the help of chemical agents (Gavrilescu, 2008; www.ucsusa.org).

Byproducts are produced by the help of these three technologies that are valuable for bio-based products. Some technologies exist which can convert solid biomass into convenient, clean energy carriers. Technologies are given below in table that is as follows:

Table 1: Various Technology for Biomass Converted into Energy (Gavrilescu, 2008)

Technology	Scale	Provides the Energy Services
Biogas	Small	• Heating • Electricity (communication, local pumping, lighting, refrigeration, mining etc.) • Cooking
Producer gas	Small to Medium	• Cooking • Heating • Electricity (refrigeration, lighting, local pumping, mining, communication etc.)
Ethanol	Medium to Large	• Cooking • Vehicle transportation
Steam turbine	Medium to Large	• Heat produced by the process of heating • Electricity (for grid distribution and industrial processing)
Gas turbine	Medium to Large	• Electricity (for industrial processing and grid distribution) • Heat produced by the process of heating

Methods of Extracting Biomass Energy

Through a variety of processes of conversion, thermal energy, solid, liquid or gaseous fuels and other products converted with the help of biomass. In the United States, electricity-generation is proved with 10 GW of installed capacity by the help of bio-power technologies. Improvement of future efficiency which includes co-firing of biomass in existing coal-fired boilers and combined-cycle systems, modular systems, the introduction of high-efficiency gasification and fuel-cell systems. Biomass thermochemical technologies are consists of some technologies which is as follows: Direct combustion, Gasification, Liquefaction, Pyrolysis, and Digestion (Sriram and Shahidehpour, 2005; Li, Luo, and Lu, 2017).

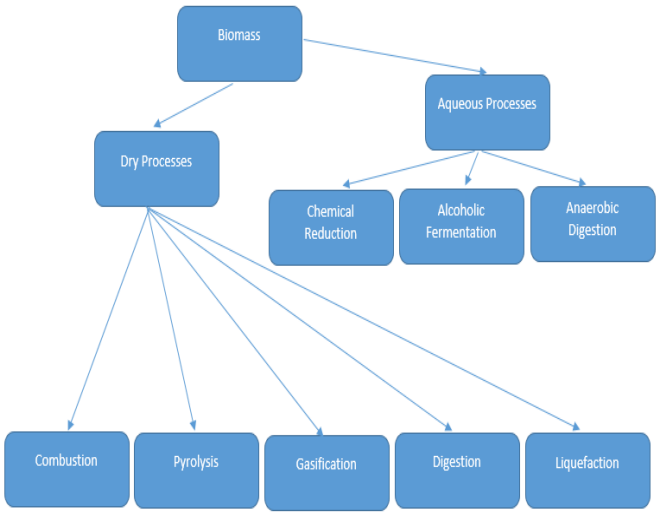

Figure 1: Biomass Thermochemical Technologies

Combustion

The principle of combustion: By the exothermic heat of reaction, the process of release of heat for oxidation of the combustible components of fuel. But in a practical point of view, the process of combustion is an interaction of energy, fuel, and environment.

By burning of fossil fuel, generating heat and energy that is the process of combustion and with an existing fuel, it can be burned either directly or co-firing and produced heat, electricity, and steam. When the reaction is processed between hydrocarbon and oxygen in the air then it produces heat, called combustion. Carbon dioxide and water are produced by the process of reaction when hydrocarbon burns in the air and this process creates ash, nitrogen oxide, sulfur dioxide, nitric oxide and carbon monoxide. To achieve the highest combustion efficiency by control of this process with the lowest emissions of pollutants. Biomass converting into the energy which is well known by the method of combustion. Three things are required before ignition and combustion could take place.

- Availability to be a burn of the fuel
- To the supply of oxygen in the presence of air
- To start and continue the process by the availability of heat (Rawat 2016; Oguneleye 2010)

Gasification

The principle of gasification: Without leaving any solid carbonaceous residue, solid or liquid material is converted into a gaseous fuel called gasification. The ratio of supplied of actual air to the theoretical air required called the equivalence ratio (ER).

ER = Air used in reaction / Stoichiometric air required

Gaseous fuel is produced by the exposes a solid fuel to high temperature in the presence of limited oxygen that is the process of gasification. By this process, produces many gaseous such as carbon dioxide, methane, carbon monoxide, hydrogen and nitrogen and these gases are used to drive a combined-cycle gas turbine that has the high-efficiency. It takes place in two stages, in the first stage, producer gas and charcoal are formed by the combustion of biomass and second is chemically reduced the carbon dioxide and water that are produced in the first stage which is forming CO and hydrogen. The composition of the gas is:

- 18-20 % hydrogen
- An equal portion of CO
- 2-3 % of methane
- 8-10 % carbon dioxide
- Nil nitrogen

At high temperature, gasification is based on the formation of fuel gas in the presence of steam or air by partially oxidizing raw solid fuel. From 3 to 100 KW, this technology can use for groundnut shells, wood chips, sugar cane bagasse and other similar fuels due to which capacity was generated. Gasification has various advantages such as convenience in which methane and resultant gas can be treated as natural gas, produce a fuel in which removed the impurities and creates some pollution problems when it burnt (Sriram and Shahidehpour 2005; Omer 2011).

Pyrolysis

The principle of pyrolysis: In an inert atmosphere, solid waste's pyrolysis refers to as the thermal decomposition of wastes. Evolved a mixture of gaseous products, water-insoluble oils, tars and an aqueous solution of methanol, acetic acid and other organic compounds and production of solid waste that consist of the inert content of waste and a char in this process. Various products are generated that is based upon the heating rate and final temperature at which, waste is exposed. The fraction of initial wastes is greater by increasing the heating rate and final temperature due to which it is converted into liquid and gaseous products.

By heating the biomass, conversion of biomass into solid, liquid (bio-crude or bio-oil) and gaseous fractions in the presence of air to around 500 LC is called pyrolysis. In case of use of flash pyrolysis, then produce the bio-oil and with an efficiency of up to 80%, it's able to the conversion of biomass to bio-crude. This bio-oil can be used as a feedstock for refineries and used in turbines and engines that also being considered. The volatile matter is derived off and the charcoal is left behind by the heating of biomass, this process is called pyrolysis. Because of the charcoal, this process doubles the energy density of original material due to which half the weight of biomass that contains the same amount of energy and making the fuel more transportable. At higher temperature, charcoal also burns rather than the original biomass which is more useful for manufacturing processes. To develop the recently collect the volatiles matter rather than the loss of system by the techniques of pyrolysis and this collected volatiles matter produces a gas in the form of hydrogen (a potential fuel) and carbon monoxide (Li, Luo and Lu 2017; Sriram and Shahidehpour 2005).

Digestion

By utilization of anaerobic bacteria, digestion did the works and it contains microorganism that usually lives at the bottom of swamps or in other places where no presence of air and consuming dead organic matter which produces hydrogen and methane. Digesters are referred to as feeding organic matter such as human sewage or animal dung into tanks and collect the emitted gas that uses as an energy source. Extracting the usable energy that's the meaning of this process, is very efficient. Recover the two-thirds of fuel energy of animal dung that is useful and collect of methane gas from landfill sites and lawn clipping, kitchen scraps and pruning from household's biomass waste at the local tip (Sriram and Shahidehpour 2005).

Liquefaction

To produce the higher quality of greater energy density by this technology and require the less processing to produce marketable products. This technology occurred at high-pressure thermochemical conversion process and low temperature that carried out in the liquid phase and it also requires a high hydrogen partial pressure and catalyst (Kurchania 2012).

Anaerobic Fermentation

Through bacterial action, decomposition of biomass in the absence of oxygen is the process of anaerobic digestion (AD). This process is also a process of fermentation and developed the mixtures of gaseous products such as carbon monoxide and hydrogen. Biogas is produced by the anaerobic fermentation which can be used for heating, cooking and as fuel for internal combustion engines. Biogas is the type of fermentation, this is called biogas fermentation which is a microbiological process. Through the action of microorganism, livestock manure, straw and agricultural and industrial waste is a various kind of organic matter that can be converted into methane in anaerobic conditions. Methane can be compared with other fuels which can generate less carbon dioxide and produces fewer atmospheric pollutants per unit of energy (Li, Luo and Lu 2017).

Anaerobic Digestion (AD)

Biogas is defined as the converted the organic material into a gas in anaerobic digestion (AD). With small quantities, biogas is a mixture of methane and carbon dioxide of other gases such as hydrogen sulfide. Gases are produced by converted the biomass in an anaerobic environment by bacteria with an energy of about 20-40% of the lower heating value of the feedstock. The AD is widely used and proven for the treating high moisture content organic wastes such as 80-90% moisture. This process also called the "fermentation" but usually called the "digestion" (PIECH 117).

Review of Literature

Freiberg *et.al* (2018), stated that in occupational and residential settings, scattered the power generation that result is come from the conversion and combustion of biomass and fall the impact on human health. This research is conducted that to exposure to endotoxins and fungi and respiratory disorders among workers in biomass-fired power plants industries. It is also found that multiple gases may lead to increase the risk of neurotoxic and respiratory diseases among to all workers in this industries and occur the some sever symptoms in case of hydrogen sulfide leakage in biogas plants. Some among people live to near this industries resulted to increase the risk for several symptoms and odor irritation that may be referred by perception about air pollution.

Kajikawa and Takeda (2008), dictated that renewable and sustainable energy is growing by the interest of biomass and bio-fuels which is globally provide the consumer with energy but mostly traditional domestic heating and cooking. New and improved modern bio-energy technologies should be administered for reducing the lack of energy and economic feasibility that are against other complementary energy sources and agricultural sectors (food and textiles production) by which the mass production and utilization of biomass.

Laurijssen *et.al* (2010), in this paper, on energy intensity and CO2 emissions, fall the impact of paper recycling over the total life-cycle and uses the lowest energy for the production of paper. Uses the 14 Gj/t life-cycle energy for current use of paper and borax mix in the Netherland. Approximately 75% rate of recycling in the Netherlands. Between paper grades, exist large variations in heat and electricity that use during production, filler content, recyclability and fiber furnish and it uses over the life-cycle. According to paper, give the paper grade not only took the credits for recovered the input fiber but also for the recovered the fibers that can be extracted from energy sources.

Gavrilescu (2008), stated that greater diversification and income opportunities are provided by the bioenergy projects for forestry, agriculture, and agro-industries that will increase the value of rural resources and increase the access of small rural industries to energy services which encouraging the public and private sector investments and participation. These are some factors such as governance options, equity and gender equality especially in women's sector are stimulated by the development of socially and culturally sustainable biomass.

Conclusion

Biomass energy plays an important renewable energy source with the highest versatility and can be made available in solid, liquid and gaseous. Biomass energy source is one of the most available opportunities for forest and agricultural development, increase rural infrastructure and additional jobs while no other energy source is available. It is used for large scale in heating appliance and electricity, an industrial application such as black liquor recovery boiler, hog-fuel boilers and in agricultural appliances such as electricity and steam generation in sugar cane industry. Extracting methods used for the improvement of future efficiency with the increment of removal of risk.

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