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Extraction Methods for Biomass Energy

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Abstract:

Biomass energy or bioenergy comprises any electric power; or any solid, liquid or gaseous fuel; or any other useful chemical product that is a derivative of an organic matter, be it directly from plant or indirectly from plant-derived commercial, urban, or industrial wastes, agricultural and forestry 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 as the energy comes from the sun and these biological material come from living or recently living organisms such as alcohol fuels, waste, wood, and gas (hydrogen). A wide variety of raw materials is derived from the bioenergy and formed in a number of ways. Biomass is produced by the wide range of potential feedstock's and a number of technologies and also process them and it is also considered as the combination of much different feedstock and technology. In this sense, it uses the different terms for a different end such as transportation or electric power. 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 (dead trees, tree stumps, and branches), yard clippings, wood chips, 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 transforms and excludes 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, in order to form carbohydrates during photosynthesis. Photosynthesis is derived from the solar energy, which is stored in the chemical bonds of the carbohydrates and other molecules contained within the biomass. Biomass has some advantages that follows:

- 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 oil, natural gas, and coal; biomass is the fourth chief energy resource that is assessed to be about 14% of global primary energy in which 3-4% primary energy is provided in the US. Biomass is used for cooking, electric power production, transportation, and heating (such as wood stoves in homes and for process heat in bioprocess industries). In and 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 pulp and paper industry that combines 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 application of biomass, by the employment opportunities that are created for the storage of biomass, cultivation, collection, and lastly 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. Making wine, changes biomass liquids into alcohol and a combustible fuel are formed by the process of fermentation. Corn is turning into ethanol or grain alcohol by this similar process that is assorted with gasoline to make gasohol. Biomass, carbon dioxide, and methane are produced by the collapsing of bacteria. In sewage treatment plants and landfills, this methane can be captured for example burned to heat and power. Biomass is transformed into energy (fuels in the state 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 transformed into energy (mainly in the state 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 that can convert solid biomass into convenient, and 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, lighting, mining, local pumping and refrigeration etc.) • Cooking
Producer gas	Small to Medium	• Cooking • Heating • Electricity (refrigeration, lighting, mining, local pumping, 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 grid distribution and industrial processing) • Heat produced by the process of heating

Methods of Extracting Biomass Energy

Through a variety of processes of conversion, thermal energy, liquid, solid or gaseous fuels and other products converted with the help of biomass. In the United States, electricity-generation is proved with 10 GW of mounted capacity by the help of bio-power technologies. Improvement of future efficiency which includes co-firing of biomass in existing combined-cycle systems, coal-fired boilers, 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).

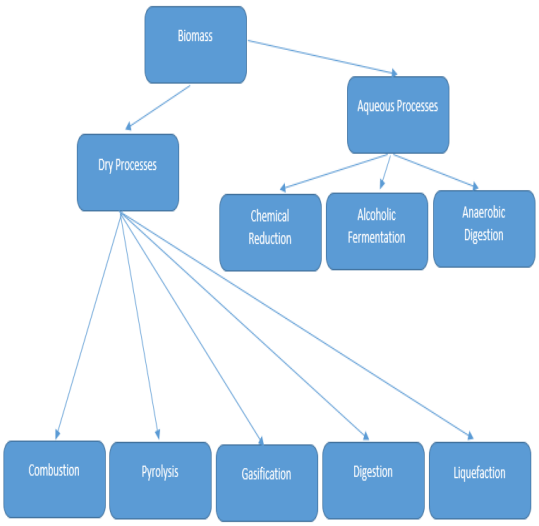

Figure 1: Biomass Thermochemical Technologies

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. Water and Carbon dioxide 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 transformed 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, which has the high-efficiency. It occurs in two phases, in the first phase, producer gas and charcoal are formed by the combustion of biomass and second is chemically reduced the water and carbon dioxide that are produced in the first phase which is forming hydrogen and CO. 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, transformation of biomass into liquid (bio-crude or bio-oil), solid, and gaseous portions in the presence of air to around 500 LC is called pyrolysis. In case of the use of flash pyrolysis, then produce the bio-oil and with an efficiency of up to 80%, it is capable of converting 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 equivalent amount of energy, thereby making the fuel more transferable. At higher temperature, charcoal burns rather than the actual biomass which is far more useful for the manufacturing procedures. 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 carbon monoxide and hydrogen (a potential fuel) (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 feeding dead organic matter which produces hydrogen and methane. Digesters are referred to as the one feeding on organic matter such as animal dung or human sewage into tanks and thus, collect the emitted gas that is used 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 a greater energy density by this technology and need less processing to produce merchantable products. This technology occurred at high-pressure thermochemical conversion process and low temperature that moved out in the liquid phase and it also requires catalyst and a high hydrogen partial pressure (Kurchania 2012).

Anaerobic Fermentation

Through bacterial action, decomposition of biomass in the lack 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 cooking, heating and as fuel for internal ignition 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 linked with other fuels which can generate less carbon dioxide and thus, produce lesser 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 carbon dioxide and methane of other gases such as hydrogen sulfide. Gases are produced by transforming the biomass in an anaerobic environment by bacteria with an energy of about 20-40% of the lesser heating value of the feedstock. The AD is extensively used and proven for treating high moistness content organic litters such as 80-90% moisture. This process is 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 to demonstrate that exposure to endotoxins and fungi lead to respiratory disorders among workers in biomass-fired power plants industries. It is also found that numerous gases may lead to increase in the risk of respiratory and neurotoxic diseases among all the workers in this industries and lead to some severe symptoms in case of hydrogen sulfide seepage in biogas plants. Some among people live to near this industries resulted to increase the risk of a number of symptoms and odor irritation that may be referred as an 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. Novel and enhanced modern bio-energy skills should be administered for reducing economic feasibility and the lack of energy that are against other agricultural sectors (food and textiles production) and corresponding energy sources and by which the utilization and mass production of biomass.

Laurijssen *et.al* (2010), in this paper, on energy concentration and CO2 discharges, through the impact of paper recycling over the total life-cycle and thus, uses the lowest energy for the production of paper. Uses the 14 Gj/t life-cycle energy for current use of borax and paper mix in the Netherlands. 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 the credits for recovered input fiber but also for the improved fibers that can be mined 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 escalate the availability of small rural industries to energy services which encouraging the public and private sector investments and participation. These are some factors such as equity, governance options, 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 agronomic appliances, like as steam and electricity generation in sugar cane industry. Extracting methods used for the improvement of future efficiency with the increment of removal of risk.

References:

Baskar, Chinnappan, et al. *Biomass Conversion the Interface of Biotechnology, Chemistry and Materials Science*. Springer, 2012.

Biomass. Available at: https://www.colorado.edu/GeolSci/courses/GEOL3520/Biomass.pdf

Freiberg, Alice, et al. "The Use of Biomass for Electricity Generation: A Scoping Review of Health Effects on Humans in Residential and Occupational Settings." *International Journal of Environmental Research and Public Health*, vol. 15, no. 2, 2018, p. 354., doi:10.3390/ijerph15020354.

Gavrilescu, Maria. "Biomass Power for Energy and Sustainable Development." *Environmental Engineering and Management Journal*, vol. 7, no. 5, 2008, pp. 617–640.

How Biomass Energy Works .*Hoosier Environmental Council*, July 2006, www.hecweb.org/wp-content/uploads/2010/04/how_biomass_energy_works_factsheet.pdf.

Kajikawa, Yuya, and Yoshiyuki Takeda. "Structure of Research on Biomass and Bio-Fuels: A Citation-Based Approach." *Technological Forecasting and Social Change*, vol. 75, no. 9, 2008, pp. 1349–1359., doi:10.1016/j.techfore.2008.04.007.

Kumar, Anil, et al. "A Review on Biomass Energy Resources, Potential, Conversion and Policy in India." *Renewable and Sustainable Energy Reviews*, vol. 45, 2015, pp. 530–539., doi:10.1016/j.rser.2015.02.007.

Laurijssena, Jobien, et al. "Paper and Biomass for Energy? The Impact of Paper Recycling on Energy and CO2 Emissions." *Resources, Conservation and Recycling*, vol. 54, 2010, pp. 1208–1218.

Li, Meihui, et al. "Biomass Energy Technological Paradigm (BETP): Trends in This Sector." *Sustainability*, vol. 9, no. 4, Aug. 2017, p. 567. Doi: 10.3390/su9040567.

Ogunleye, Ayobami Olanrewaju. "Biomass Energy Production." *Theseus.fi*, 21 Apr. 2010, www.theseus.fi/bitstream/handle/10024/13328/BIOMASS ENERGY PRODUCTION BY AYOBAMI OGUNLEYE.pdf?sequence=1.

Omer, Abdeen Mustafa. "Biomass Energy Resources Utilisation and Waste Management." *Agricultural Sciences*, vol. 03, no. 01, 2012, pp. 124–145., doi:10.4236/as.2012.31016.

Sharma, Bhavtosh, et al. *Energy Resources: Development, Harvesting, and Management*. Bishen Singh Mahendra Pal Singh, 2016.

Sriram, Nisha, and Mohammad Shahidehpour. "Renewable Biomass Energy." *IEEE*, 2005, pp. 1–6.

Various Methods of Producing Electricity from Biomass. Available at: http://www.magnanimitas.cz/ADALTA/0202/papers/J_piech.pdf

Xiu, Shuangning, et al. *Biorefinery Processes for Biomass Conversion to Liquid Fuel*. INTECH Open Access Publisher, 2011.