Review Article

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A Review on Biomass as Renewable Resource and its Conversion Technologies

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Abstract

Biomass is term used to describe all organic matter produced by photosynthesis existing on earth's surface. They include all water and land based vegetation and all waste biomass such as municipal solid waste, sewage and animal waste (manure), agriculture residues. The world's energy market has relied heavily on fossil fuels. We can use Biomass as energy source for sustainable development. Bioenergy consist on solid, liquid or gaseous fuels. Liquid extraction directly is used in Medicines, Shampoos, Construction materials, Paints, Fibres and fabrics, Lubricants, Plastic production etc. Solid and gaseous form can be used for the production of electrical power; so, we can use different methods for bio-energy production like hydrolysis, pyrolysis, gasification, combustion, fermentation etc.

Keywords: Biomass, Bio-energy, Bio-fuel, Pyrolysis.

Introduction

Through the process of photosynthesis, chlorophyll inplants captures the sun's energy by converting

carbon dioxidefrom the air and water from the ground into carbohydrates,i.e., complex compounds composed of carbon, hydrogen, andoxygen. When these carbohydrates are burned, they turn backinto carbon dioxide and water and release the sun's energythey contain. In this way, biomass functions as a sort ofnatural battery for storing solar energy. The exploitation of energy from biomass has played a keyrole in the evolution of mankind. Until relatively recently itwas the only form of energy which was usefully exploited byhumans and is still the main source of energy for more thanhalf the world's population for domestic energy needs.One of the simplest forms of biomass is a basic open fire usedto provide heat for cooking, warming water or warming the airin our home. More sophisticated technologies exist forextracting this energy and converting it into useful heat orpower in an efficient way. In the mid-1800s, biomass,principally wood biomass, supplied over 90% of U.S. energyand fuel needs, after which biomass energy usage began todecrease as fossil fuels became the preferred energy resources.This eventuality of fossil fuel and the adverse impact of fossilfuel usage on the environment are expected to be the drivingforces that stimulate the transformation of biomass into one ofthe dominant energy resources.Unlike fossil fuels, biomass is renewable in the sense thatonly a short period of time is needed to replace what is used asan energy resource. Biomass also is the only renewable energysource that releases carbon dioxide in use. However, therelease is compensated by the fact that the biomass grown usesthe carbon dioxide from the atmosphere to store energy duringphotosynthesis. If the biomass resource is being usedsustainably, there are no net carbon emissions over the timeframe of a cycle of biomass production. There are many ways to utilize Biomass for the production of Bio-energy.

Methods for extracting biomass:

Biomass can be converted to thermal energy, liquid, solidor gaseous fuels and other chemical products through a varietyof conversion processes. Bio power technologies are provenelectricity-generation options in the United States, with 10GWof installed capacity. All of today's capacity is based onmature, direct-combustion technology. Future efficiencyimprovements will include co-firing of biomass in existingcoal-fired boilers and theintroduction of high-efficiencygasification, combined-cycle systems, fuel cell systems, and

modular systems.Generally, the prominent bio power technologies arecomprised of direct combustion, co-firing, gasification,pyrolysis, anaerobic digestion, and fermentation.

Direct combustion:

This is perhaps the simplest method of extracting energy from biomass. Industrial biomass combustion facilities can burn many types of biomass fuel, including wood, agricultural residues, wood pulping liquor, municipal solid waste (MSW) and refuse-derived fuel. Biomass is burned to produce steam, the steam turns a turbine and the turbine drives a generator, producing electricity. Because of potential ash build-up (which fouls boilers, reduces efficiency and increases costs), only certain types of biomass materials are used for direct combustion.

Pyrolysis:

Pyrolysis is the application of heat to a feedstock in the absence of oxygen to break down the long chain molecules into short chain molecules. Typically, the feedstock is biomass or waste, and the process is used to produce a syngas (a mixture of hydrogen, volatile organic compounds, and carbon monoxide). Varying the process conditions allows the production of fluids similar to diesel, and a variety of other products.

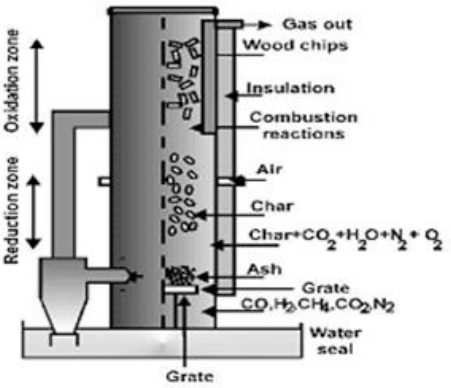
A more detailed understanding of the physical and chemical properties governing the pyrolytic reactions has allowed the optimisation of reactor conditions necessary for these types of pyrolysis. Further work is now concentrating on the use of high pressure reactor conditions to produce hydrogen and on low pressure catalytic techniques (requiring zeolites) for alcohol production from the pyrolytic oil. The advantage of pyrolysis and gasification are that they convert solid material into gases and vapours which are less costly to handle, transport and store. The gases will burn in boilers, gas turbines and reciprocating engines increasing fuel flexibility and security. Capturing and combusting the methane and carbon monoxide in syngas makes use of the energy in the gas and produces carbon dioxide which is a less potent greenhouse gas than methane and offsets fossil fuel energy production.

Gasification:

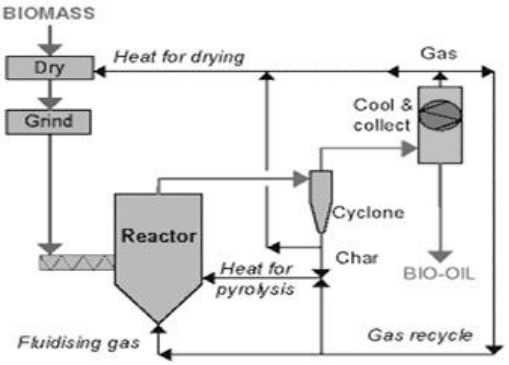
Gasification is a process that exposes a solid fuel to high temperatures and limited oxygen, to produce a gaseous fuel. The gas produced by the process as shown in Figure is a mix of gases such as carbon monoxide, carbon dioxide, nitrogen, hydrogen, and methane. The gas is then used to drive a high efficiency, combined-cycle gas turbine. Gasification has several advantages over

burning solid fuel. One is convenience – one of the resultant gases, methane, can be treated in a similar way as natural gas, and used for the same purposes.

Another advantage of gasification is that it produces a fuel thathas had many impurities removed and could therefore causefewer pollution problems when burnt. Under suitablecircumstances, it can also produce synthesis gas, a mixture ofcarbon monoxide and hydrogen which can be used to makehydrocarbon (e.g., methane and methanol) for replacing fossilfuels. Hydrogen itself is a potential fuel without muchpollution which can conceivably substitute oil and petroleumin a foreseeable future.



Gasification



Pyrolysis

Digestion:

Biomass digestion works by utilizing anaerobic bacteria. These microorganisms usually live at the bottom of swamps or in other places where there is no air, consuming dead organic matter to produce methane and hydrogen. We put these bacteria to work for us. By feeding organic matter such as animal dung or human sewage into tanks, called digesters, and adding bacteria, we collect the emitted gas to use as an energy source. This process is a very efficient means of extracting usable energy from such biomass. Usually, up to two thirds of the fuel energy of the animal dung could be recovered. Another related technique is to collect methane gas from landfill sites. A large proportion of household biomass waste, such as kitchen scraps, lawn clipping and pruning, ends up at the local tip. Over a period of several decades, anaerobic bacteria at the bottom of such tips could steadily decompose the organic matter and emit methane. The gas can be extracted and

used by capping a landfill site with an impervious layer of clay and then inserting perforated pipes that would collect the gas and bring it to the surface.

Fermentation:

For centuries, people have used yeasts and other microorganisms to ferment the sugar of various plants into ethanol. Producing fuel from biomass by fermentation is just an extension of this process, although a wider range of plant material from sugar cane to wood fiber can be used. For instance, the waste from a wheat mill in New South Wales is used to produce ethanol through fermentation. Ethanol is then mixed with diesel to produce diesehol, a product used bytrucks and buses in Australia. Technological advances will inevitably improve the method. For example, scientists in Australia and the U.S. have substituted a genetically engineered bacterium for yeast in the fermentation process. The process has vastly increased the efficiency by which waste paper and other forms of wood fiber is fermented into ethanol.

Benefits of bio-mass energy:

- Biomass energy is an abundant, secure, environmental friendly, and renewable source of energy. Biomass does not add carbon dioxide to the atmosphere as it absorbs the same amount of carbon in growing as it releases when consumed as a fuel.
- One of the major advantages of biomass is that it can be used to generate electricity with the same equipment or in the same power plants that are now burning fossil fuels.
- Biomass energy is not associated with environmental impacts such as acid rain, mine spoils, open pits, oil spills, radioactive waste disposal or the damming of rivers.
- Biomass fuels are sustainable. The green plants from which biomass fuels are derived fix carbon dioxide as they grow, so their use does not add to the levels of atmospheric carbon. In addition, using refuse as a fuel avoids polluting landfill disposal.

Alcohols and other fuels produced by biomass are efficient, viable, and relatively clean burning.

Disadvantages of biomass energy:

- Biomass is still an expensive source of energy, both in terms of producing biomass and converting it into alcohols, as a very large quantity of biomass is needed.
- One of the disadvantage of biomass is that direct combustion of biomass can be harmful to the environment as burning biomass releases carbon dioxide, which contributes to the warming of

the atmosphere and possible climatic change. Burning also creates soot and other air pollutants.

- Over-collecting wood can destroy forests. Soils bared of trees erode easily and do not hold rainfall. Increased runoff can cause flooding downstream.
- When plant and animal wastes are used as fuel, they cannot be added to the soil as fertilizer. Soil without fertilizer is depleted of nutrients and produce fewer crops.
- Biomass has less energy than a similar volume of fossil fuels.

Conclusion

The technologies include a large variety of thermal and thermochemical processes for converting biomass by combustion, gasification, and liquefaction, and the microbial conversion of biomass to obtain gaseous and liquid fuels by fermentative methods. Examples of the former are wood-fueled power plants in which wood and wood wastes are combusted for the production of steam, which is passed through a steam turbine to generate electricity.

Many of the processes are suitable for either direct conversion of biomass or conversion of intermediates. The processes are sufficiently variable so that liquid and gaseous fuels can be produced that are identical to those obtained from fossil feedstocks, or are not identical but are suitable as fossil fuel substitutes. It is important to emphasize that virtually all of the fuels and commodity chemicals manufactured from fossil fuels can be manufactured from biomass feedstocks. Indeed, several of the processes used in a petroleum refinery for the manufacture of refined products and petrochemicals can be utilized in a biorefinery with biomass feedstocks. Note also that selected biomass feedstocks are utilized for conversion to many specialty chemicals, pharmaceuticals, natural polymers, and other higher value products.

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