

Biofuels – Energy from Waste and Wood – A Review

Dr Abhay Singh

Associate Professor

Department of Chemistry

K.L.P. College, Rewari, Haryana-123401

Corresponding Author's email id: abhay1968.as@gmail.com

Abstract

Biofuels can be derived directly from plants or indirectly from agricultural, commercial, domestic and industrial wastes. The use of waste biomass to generate energy can decrease waste management problems, pollution, greenhouse gases emission and the use of fossil fuels. There is a huge potential for bioenergy obtained from waste to decrease the speed of global warming. Brief summaries of various types of biofuels, generations of biofuels and the basic concepts involved in the thermochemical and biological conversions of biomass fuels are presented in this paper. Various processes such as combustion, pyrolysis, gasification, liquefaction, anaerobic digestion, aerobic composting and fermentation have been discussed.

Keywords: - Biofuels, Biomass, Thermo chemical, Biological.

INTRODUCTION

Biofuel, also called as agrofuel and is derived from biomass and may be in solid, liquid or gaseous form. Biofuels have changed, meeting new demands, conforming to public opinions, overcoming challenging issues and striving for a truly sustainable method for energy production. The reemergence of first generation biofuel technology was hailed as a salvation from the twin evils of

high oil prices and climate changes (1). However, it was soon discovered that this method of biofuel production increased global food prices. Second generation biofuel technology was design to produce energy from materials that would not impact the food chain such as wood and crop waste.

Biofuels can be produced from virtually any organic biomass but some materials

produce higher efficiencies than others. The biofuel can be burned directly or they can be mixed with conventional fuel. Due to diversity of biomass a wide range of technologies must be used to ensure that the energy is derived in the most efficient manner. The most common biofuel is bioethanol, a bioalcohol produced from sugar or corn for example. Biodiesel is another first generation biofuel produced by extracting oil from crops such as rapeseed, sunflower and palm oil(2). Biogas(3,4) and biohydrogen(4,5) can be produced using a number of processes such as pyrolysis, gasification or biological fermentation.

The waste buried in landfill site undergoes anaerobic digestion and generates gases. The gases so produced are called landfill gases (LFG). These gases can be burned and looked up as a source of renewable energy. The LFG comprises of almost 50% methane, which is the same gas as found in natural gas. The LFG can be used to generate electricity for public consumption or can be burned for heat.

Generations of Biofuels

First Generation Biofuels: First generation biofuels are produced directly from food crops by abstracting the oils for use in biodiesel or producing bioethanol

through fermentation. Crops has proved a very effective crop for use in biodiesel. However, first generation biofuels have a number of associated problems. The most contentious issue with first generation biofuels is fuel vs food. This has been blamed for the global increase in food prices the last couple of years.

Second Generation Biofuels: Second generation biofuels have been developed to overcome the limitations of first generation biofuels. They are produced from non-food crops such as wood, organic waste, food crop waste and specific biomass crops, therefore eliminating the main problem with first generation biofuels. Second generation biofuels are also aimed at being more cost competitive in relation to existing fossil fuels.

Third Generation Biofuels: The third generation of biofuels is based on improvements in the production of biomass. It takes advantage of specially engineered energy crops such as algae as its energy source. The algae are cultured to act as a low-cost high-energy and entirely renewable feedstock. It is predicted that algae will have the potential to produce more energy per acre than conventional crops.

Fourth Generation Biofuels: The fourth generation biofuels are aimed at not only producing sustainable energy but also a way of capturing and storing CO₂. Biomass materials, which have absorbed CO₂ while growing, are converted into fuel using the same processes as second generation biofuels.

TECHNOLOGIES

From the outset, the following waste and wood biomass products are considered for potential energy recovery:

1. Timber
2. Organic agricultural waste
3. Used vegetable oil
4. Solid faecal waste (human and livestock)

There are two processes for the conversion of biomass to energy. They are 1. Thermo-chemical and 2 Biological and it would appear that each of the biomass products under consideration above would fit into one of these two types of processes. Liquid biofuels are possible by-products of the conversion process and are viewed as transport fuels. Used vegetable oil will be considered in a similar way to any these biofuel by-products and will therefore not affect the decision on which process to employ to accept and convert the initial waste or wood products. This therefore leaves three other sources of biomass which can be dealt with using the following type of process

Waste/ Wood Products	Type of Conversion	Possible Processes
Timber	Thermo-chemical	Combustion, Gasification, Pyrolysis, Liquefaction
Organic agricultural waste	Thermo-chemical	Combustion, Gasification, Pyrolysis, Liquefaction
Solid faecal waste	Biological	Anaerobic Digestion

Thermo-Chemical Processes

1. Combustion: Biomass with a low moisture content is often used as a feedstock for combustion. This refers to the rapid oxidation of the feedstock as it is exposed to high heat in a boiler where steam, under high pressure, is passed through a turbine which powers a generator. The main types of combustion processes are: "fixed-bed combustion, fluidised-bed combustion and dust combustion".

2. Pyrolysis: Here, heat is used to chemically convert biomass into fuel. It occurs when biomass is heated in the absence of oxygen. A by-product of pyrolysis is pyrolysis oil that can be burned like petroleum along with biochar.

The pyrolysis of wood is a thermal decomposition carried out in a closed furnace with very limited air input (less than 10% stoichiometric). To start the process, a heat source is required, but when the temperature in the furnace reaches more than 2500C, the reactions that take place are exothermic and the process is self-maintained up to 6000C. There are some by-products of the pyrolysis of wood.

3. Gasification: The process of heating wood in a chamber until all volatile gases such as CO, H₂ and O₂ are released from the wood and combusted. The emitted wood gases are then superheated and mixed with air or pure oxygen for complete combustion. Gasification has the great advantage of having extremely high combustion efficiency and thereby generating minimal emissions.

Gasification is a quicker process than pyrolysis and differs by the presence of a limited quantity of air (20-80% stoichiometric). The main product of gasification is syngas, composed of CO and H₂, which can be of high quality if oxygen is used instead of air.

4. Liquefaction: Liquefaction is a conversion process resulting in liquid products such as methanol from biomass by direct or indirect process. Indirect, through gas phase and direct without gas phase, for example by rapid pyrolysis. This is a fast process where pressurized water is used to convert a liquid slurry of organic material into hydrocarbon oils and products. Direct liquefaction, or thermal depolymerization, has been

successful in producing a liquid oil while the newer indirect liquefaction has had success in producing syngas, ethanol and methanol.

Biological Processes

1. Anaerobic Digestion: Anaerobic digestion is a biological decomposition process where bacteria are used in controlled anaerobic conditions to break down biodegradable organic waste. The key by-product of anaerobic digestion is methane gas which is produced by the bacteria decomposing the organic waste and can be captured and used as a biogas. Carbon dioxide is also produced.

2. Aerobic Composting: Aerobic composting is similar to anaerobic digestion with the key difference being the presence of oxygen. The presence of oxygen means that different bacteria are employed in composting than in anaerobic digestion. Aerobic composting is generally considered to be a commercial process. It should also be noted that temperature, moisture content and good aeration are the main parameters for a good composting process. Aerobic composting also produces gases which can be captured and utilized for energy. In addition,

raw organic materials such as crop residues, animal wastes, food garbage, some municipal wastes and suitable industrial wastes, enhance their suitability for application to the soil as a fertilizing resource, after having undergone composting(6).

3. Fermentation: Fermentation is a biological process in which enzymes produced by microorganisms catalyze chemical reactions. These microorganisms digest sugars to produce the energy and chemicals they need for survival while giving off by-products such as carbon dioxide, organic acids, hydrogen, ethanol and other products(7), which are then collected and utilized for energy production.

CONCLUSIONS

- 1.** The use of waste biomass to generate energy can decrease waste management problems.
- 2.** The use of biofuels can decrease the pollution and can also decrease the green house gases emission.
- 3.** The increased use of biofuels decreases the demand of fossil fuels thereby decreasing their prices.

4. There is a huge potential for bioenergy obtained from waste to decrease the speed of global warming.
5. Increased use of biofuels include energy security reasons, environmental concern, foreign exchange savings and socioeconomic issues related to rural sector.

REFERENCES

- I. Stevens, C. V. and Verhe, R. G. (2004) Renewable Bioresources, Scope and Modification for Non-Food Applications, John Wiley & Sons Ltd. Chichester, pg 120.
- II. Stevens, C. V. and Verhe, R. G. (2004) Renewable Bioresources, Scope and Modification for Non-Food Applications, John Wiley & Sons Ltd. Chichester, pg 172.
- III. Anaerobic Digestion, The AD Community, An Independent website, <http://www.anaerobic-digestion.com/> Accessed on 03.11.2009.
- IV. Barber, K. Anaerobic Digestion Of Municipal Solid Waste : A Modern Waste Disposal Option On The Verge Of Breakthrough, Biomass and Bioenergy, Vol. 9, Nos 1-5, pp. 365-376,1995. Elsevier Science Ltd. Printed in Great Britain.
- V. Stevens, C. V. and Verhe, R. G. (2004) Renewable Bioresources, Scope and Modification for Non-Food Applications John Wiley & Sons Ltd. Chichester, pg 54.
- VI. Misra , R.V. Roy , R.N. and Hiraoka, H, On –Farm Composting Methods , Land and Water Discussion paper 2 , Food and Agriculture Organization of the United Nations <http://www.fao.org/docrep/007/y5104e/y5104e00.HTM> Accessed on 03.11.2009
- VII. Forest Encyclopedia Network, Bio-Chemical Processes , <http://www.forestencyclopedia.net/p2/p1138/p1185/p1201/p1219> Accessed on 03.11.2009