

The percentage of "volatile matter, fixed carbon, and ash contents" is determined or evaluated through proximate analysis. On occasion, biomass containing high moisture content needs extra heat or energy before it can be ignited; thereof, this type of biomass material is better suited in producing biofuels. The low melting point of the dissolved ash contents in biomass fuels causes fouling and slagging issues in the boiler, and if left untreated,

3. Higher heating value (HHV)

The total energy released by a kilogram of fuel when it is fully combusted expressed as (kJ/kg).

Biomass conversion technology

A wide variety of conversion technologies is available for manufacturing premium fuels from biomass

Biomass Conversion Technologies

	<i>Conversion Process</i>	<i>Solids</i>	<i>Principles Products Liquid</i>	<i>Gases</i>	<i>Further Treatment</i>	<i>Premium Fuels</i>
Wet	Anaerobic Digestion			Methane ^b and carbon dioxide	Carbon dioxide removal	Methane
	Fermentation		Ethanol		Distillation	Ethanol
	Chemical Reduction		Mixture of oils		Fractional distillation	Hydrocarbon liquids
	Liquefaction	Char	Pyroligneous	Fuel gas ^b	Steam	Methane
	Gasification	Char	acids oils and	Fuel gas ^{a,c}	reforming and/or	Methanol or
Thermal Process	Steam-gasification	Char	tars	Methane ^c	shift reaction	Higher Alcohols
	Hydrogenation		Mixture of oils		Fractional distillation	Hydrocarbon liquids
	Oil Extraction		Vegetable oil		Esterification	Diesel Substitute

The choice of the process is determined by a number of factor—the location of the resource and its physical condition, the economics of competing processes, and the availability of a suitable market for the product.

Biomass conversion, or simply bioconversion can take many forms: (1) direct combustion, such as wood waste and bagasse (sugarcane refuge), (2) thermochemical conversion, and (3) biochemical conversion.

Thermochemical conversion takes two forms: gasification and liquefaction, *Gasification* takes place by heating the biomass with limited oxygen to produce low heating value gas or by reacting it with steam and oxygen at high pressure and temperature to produce medium heating value gas. The latter may be used as fuel directly or used in liquefaction by converting it to methanol (methyl alcohol CH_3OH), or ethanol (ethyl alcohol $\text{CH}_3\text{CH}_2\text{OH}$) or it may be converted to high heating value gas.

Biochemical conversion takes two forms. Anaerobic digestion and fermentation. Anaerobic digestion involves the microbial digestion of biomass. (An anaerobe is a micro-organism that can live and grow without air or oxygen, it gets its oxygen by the decomposition of matter containing it). It has already been used on animal manure but it also possible with other biomass. The process takes place at low temperature upto 65°C, and requires a moisture content of at least 80 per cent. It generates a gas consisting mostly of CO₂ and methane (CH₄) with minimum impurities such as hydrogen sulfide. The gas can be burned directly or upgraded to synthetic natural gas by removing the CO₂ and the impurities. The residue may consists of protein rich sludge that can be used as animal feed and liquid effluents that are biologically treated by standard techniques and returned to the soil.

Fermentation is the breakdown of complex molecules in organic compound under the influence of a ferment such as yeast, bacteria, enzymes, etc. Fermentation is a well-established and widely used technology for the conversion of grains and sugar crops into ethanol. About 500 million gal ethanol per year by 1985, were produced in the limited states by the use of surplus grain. It is intended for mixing with gasoline to produce *gasohol* (90% gasoline, 10% ethanol). This process requires high cost and high energy required. One scheme considered for reducing costs of ethanol production by fermentation is in finding less expensive grains or sugars and a process that requires less energy. Glucose produced by hydrolysis of an abundant carbohydrate polymer called *ligno cellulose* is being considered for the former.

Wet processes

Anaerobic digestion:

Biogas is produced by the bacterial decomposition of wet sewage sludge, animal dung or green plants in the position of oxygen. Feedstocks like-wood shavings, straw, and refuse may be used, but digestion takes much longer. The natural al decay process, anaerobic decomposition' can be speeded up by using a thermally insulated, air-tight tank with a stirrer unit and heating system. The gas collects in the digester tank above the slurry and can be piped off continuously. At optimum temperature (35°C) complete decomposition of animal or human faces takes around 10 days. Gas yields depend critically on the nature of the waste-pig manure, for example, is better than cowdung or household refuse. Each kilogram of organic material (dry weight) can be expected to yield 450-500 litres of biogas (9-12 M.J) at atmospheric pressure in a modern batch or continuous feed unit-one and a half to two digester volumes of gas per day. The residue left after digestion is valuable fertilizer. It is also rich in protein and could be dried and used as animal feed supplement.

Fermentation.

Ethanol (ethyl alcohol) is produced by the fermentation of sugar solution by natural yeasts. After about 30 hours of fermentation the brew (or beer') contains 6-10% alcohol and this can readily be removed by distillation. Traditionally, the fibrous residues from plant crops like sugar cane bagasse have been burnt to provide the heat. Suitable feed stocks include crushed sugar cane and beet, fruit etc. Sugar cane also be manufactured from vegetable starches and cellulose, maize, wheet grain, or potatoes, for example, must be ground or pulped and then cooked with enzymes to release the starch and convert it to fermentable sugars. Cellulose materials like wood, paper waste or straw, require harsher pre-treatment typically milling and hydrolysis with hot acid. One tonne of sugar will produce upto 520 litzes of alcohol; a tonne of grain, 350 litres and a tonne of wood, an estimated 260 to 540 litres. After fermentation, the

residue from grain hydrolysis with hot acid. One tonne of sugar will produce up to 520 litres of alcohol; a tonne of grain, 350 litres and a tonne of wood, an estimated 260 to 540 litres.

Chemical reduction. Chemical reduction is the least developed of the wet biomass conversion processes. It involves pressure—cooking animal wastes or plant cellulosic slurry with an alkaline catalyst in the presence of carbon monoxide at temperatures between 250°C and 400°C. Under these conditions the organic material is converted into a mixture of oils with a yield approaching 50%. If the pressure is reduced and the temperature increased, the product is a high calorific value gas.

Dry Processes

Pyrolysis. A wide range of energy-rich fuels can be produced by roasting dry woody matter like straw and wood-chips. The material is fed into a reactor vessel or retort in a pulverised or shredded form and heated in the absence of air. (Air would cause the products of pyrolysis to ignite). As the temperature rises the cellulose and lignin break down to simpler substances which are driven off leaving a char residue behind. This process has been used for centuries to produce charcoal.

The end products of the reaction depend critically on the conditions employed; at lower temperatures around 500°C-organic liquid predominate, whilst at temperatures nearer 1000°C a combustible mixture of gases results.

Liquefaction. Liquid yields are maximized by rapid heating of the feedstock to comparatively low temperatures. The vapours are condensed from the gas stream and these separate into a two-phase liquor the aqueous phase (pyroligneous acid) contains a soup of water-soluble organic materials like acetic acid, acetone and methanol ('wood alcohol'); the non-aqueous phase consists of oils and tars. These crude products can be burnt (with some difficulty), but it is usually more profitable to up-grade them to premium fuels by conventional refining techniques.

Other pyrolysis products include fuel gas—essentially carbon monoxide and hydrogen and carbon char. The gas is generally burnt to maintain the temperature of the reactor; the char can be manufactured into briquettes for use as solid fuel.

Pyrolysis can also be carried out in the presence of small quantities of hydrogen (gasification'), water (steam gasification') or by direct hydrogenation)

Gasification:

Pyrolysis of wet biomass producing and very for maximising gas yields is to alternative technique little liquid blow small quantities of air or oxygen into the reactor vessel and to blow the temperature to over 1000°C. This causes part of the feed to burn. Fuel gas from air-blown gasifiers has a low calorific value (around 5 MJ/m³) and may contain up to 40% inert nitrogen gas overall yields of 80-85% can be expected. Fuel gas from oxygen-fed systems has a medium calorific value (10-20 MJ/m³). This gas can either be burnt or converted into substitute natural gas (methane) or methanol by standard catalytic processes. Methanol yields of around 50% can be achieved from biomass.

Steam-gasification. Methane is produced directly from woody matter by treatment at high temperatures and pressures with hydrogen gas. The hydrogen can be added or, more commonly, generated in the reactor vessel from carbon monoxide and steam. Recent analyses suggest that steam gasification is the most efficient route to methanol. Net energy yields of 55% can be achieved although higher yields are likely in the future as the technology is developed.

Hydrogenation. Under less severe conditions of temperature and pressure (300-400°C and 100 atmospheres), carbon monoxide and steam react with cellulose to produce heavy oils which can be separated and refined to premium fuels.

Biodegradation

Biodegradable material can be defined as a substance that can be decomposed by bacteria or other organic matter and does not add to the pollution. Biodegradable waste is waste that is present and can be damaged by organic matter such as bacteria (e.g. bacteria, fungi and a few others), abiotic elements such as temperature, UV, oxygen, etc. Other examples of this contamination of food items, kitchen waste and other natural waste. Microorganisms and other abiotic elements together divide complex organisms into living organisms that eventually hang in the soil. The whole process is natural which may be faster or slower. Therefore, environmental problems and the dangers caused by biodegradable wastes are low.

There are 3 types biodegradation,

Bio-deterioration:

Biodeterioration is sometimes described as high-level degradation that changes the mechanical, physical and chemical properties of a material. This stage occurs when the material is exposed to abiotic factors in the external environment and allows further deterioration by weakening the structure of the material. Other abiotic factors influencing these initial changes are pressure (equipment), light, temperature and chemicals in the environment. Although biodeterioration usually occurs as an early stage of environmental degradation, in some cases it may be accompanied by biofragmentation.

Biofragmentation of polymer is a lytic process in which bonds within a polymer are separated, producing oligomers and monomers in their place. The steps taken to separate these resources also vary based on the presence of oxygen in the system. Separation of micro-organisms in which oxygen is present in aerobic digestion, and degradation of substances in which oxygen is absent in anaerobic digestion. The main difference between these processes is that the anaerobic reaction produces methane, while the aerobic reaction does not (however, both reactions produce carbon dioxide, water, a type of fossil and new biomass). Additionally, aerobic digestion usually occurs much faster than anaerobic digestion, while anaerobic digestion does a better job of reducing the volume and weight of the substance.

Assimilation:

In the simulation phase, the resulting products from biofragmentation are then synthesized into smaller cells. Some of the products from the separation are easily transported inside the cell by membrane carriers. Once inside the cell, the products enter the catabolic pathways that can lead to the production of adenosine triphosphate (ATP) or its cellular structure.