METHODS OF PROCESSING AND UTILIZATION OF BIOMASS ENERGY

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ABSTRACT

This article deals with possibility of biomass utilization and methods of its processing. Further deals with a heating power and characteristic of each biomass fuel. Sources of biomass fuels and their power potential are described. At the end are described two power plants, which represent two most frequent utilizations of biomass energy.

KEYWORDS

Biomass, energy, fermentation, combustion, gasification, heating value

1. INTRODUCTION

Biomass is defined as an organic material. It concerns of all live nature. When we speak about biomass in context with power engineering, we most often mean the wood and logging waste, straw and other farming residues and ejecta of stocks. When we pass away food energy, then the energy from biomass combustion is the oldest, which have humans ever utilized.

2. METHODS OF BIOMASS PROCESSING

Energy is possible to obtain from biomass trough the use of thermochemical or biochemical transformation.
We differ the biomass as "dry" (e.g . wood) and as "wet" (e.g . sewage) on figure 1.

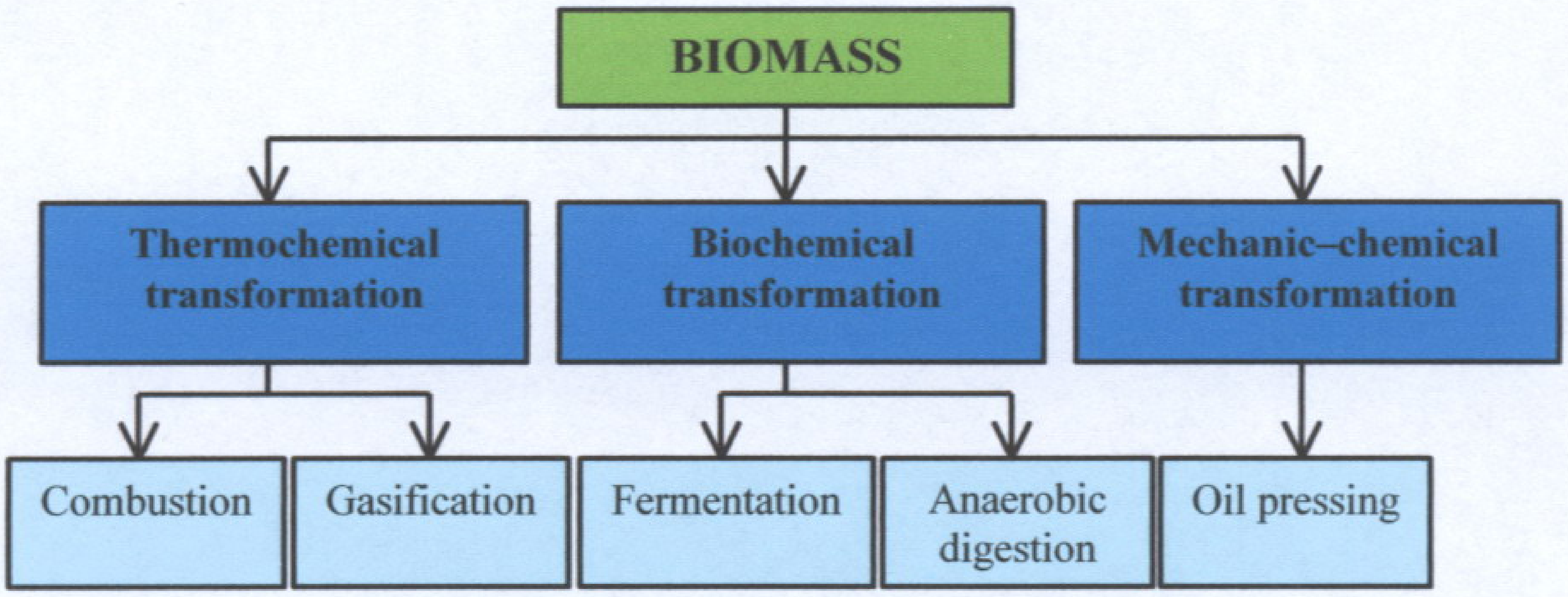

Figure 1: Energetics processes of biomass utilization [1]

Most often in power engineering we utilize two technology processing - direct combustion (condensing Rankin cycle) and anaerobic fermentation (biogas).

2.1. Direct combustion and gasification of biomass

From dry biomass by high temperatures are liberated the combustible gas components , so-called wood gas. The air causes the burning, i. e. it is a simple combustion. Concerning the warming without air, the wood gas is dissipated to the combustion area, where it is combusted like other gas fuels. Some part of formming warm is used to gasification the next biomass. The advantage is an easy power regulation, lower emiissions and higher efficiency. The wood gasification plants are used more and more. At first sight they dont vary from the common combustion plants [5].
Biomass is very complicated fuel, because the share of gasification parts during the combustion is very high (by wood about 70%, by straw about 8O%). The forming gases have various combustion temperatures. Therefore it also becomes, that in reality only part of fuel is combusted. By a smoke it is shown, whether the combustion is entire. The blacker is smoke, the worse is combustion. White smoke isn't caused by incomplete combustion, but by water vaporization from wood.
Condensing plants have generating capacity up to tens of MW.

2.2. Biogas, fermentation

It is combined heat and power cycle, where beside a heat production is also obtained an electrical energy. As a fuel is in combined heat and power plants used a biogas, gained from an anaerobic digestion. The biomass substrate is fouled with the absence of air on biogas, which compounds largely from: 65 – 80 % of methane
20 – 35 % of carbon dioxide.
Combined heat and power plant is composed of a power generator, most often powered by gas-engine or by gas-, steam- turbine. The piston engine is modified for biogas combustion. The off-heat from motor cooling system or from exhaust gases-water heat exchanger is utilized in gasification cycle and for object and water heating. Efficiency of power production is by these plant between 20 and 35 %, heat efficiency between 50 and 60 % and total efficiency up to 90 %. Combined heat and power plants have today the generating capacity up to hundreds of kW.

3. CHARECTERS AND HEATING VALUES OF BIOFUELS

Heating values of wood and next vegetable fuels balance not only according to kind of wood or vegetable, but also with a humidity, on which are these fuels more sensitive (see table 1). Storaged wood material at natural airing reduced its water content up to 20 % in one year. Rape straw at equal conditions up to 13 %.
1 kg of wood with zero water content has an energy content about 5,2 kWh. However it is practically impossible to fully dry the wood, a residual water content is about 20 % of raw wood material. Because some part of energy is during the combustion process consumed for an vaporization of the water, it is necessary to count with the energy content of about 4,3 to 4,5 kWh. By increasing the water content is the wood energy content decreasing, until the water content is so high, that the combustion is impossible. At the same time by increasing the water content is also hardly decreasing the combustion efficiency.

Fuel	Water content [%]	Heating value [MJ/kg]	Mass density [kg/m³]
Wood parts	0 10 20 30 40 50	18,56 16,40 14,28 12,18 10,10 8,10	355 375 400 425 450 530
Wood chips	10 20 30 40	16,40 14,28 12,18 10,10	170 190 210 225
Straw-corn	10	15,50	120 (boxes)
Straw-maize	10	14,40	100 (boxes)
Tow	10	16,90	140 (boxes)
Straw-rape	10	16,00	100 (boxes)

Table 1: Influence of fuel humidity on heating values and specific materiality [2]

4. BIOMASS POWER STATIONS

4.1. Biomass-fired thermal power station Zolling, 20 MW

The power station is situated on the premises of the hard coal power station 450 MW, near the city of Munich. E.ON Kraftwerke has built a large-scale biomass cogeneration station (see figure 2), which produces electricity in 110 kV grid and feeds heat into the existing district heating network. It includes the city of Freising and Munich Airport.

Figure 2: Technological scheme

The main biomass fuels are wood chips. These are bought from the specialized company, which transports them by heavy trucks. After the discharge, the wood chips pass throw the separation. It consists of three levels:

- In the first level are excluded all wood parts longer than 12 cm. This is done because of the parameters of the fire-grate boiler, since longer parts would not be burned.
- In the second level are excluded all parts containing any plastic material.
- In the third level are excluded all parts containing metals, which would probably create unpleasant melting on the fir grate.

Each of the level has its own container, which are then transported back to the company on their costs.
So sorted out wood chips pass then to two chip silos (2 x 500 m^3). Both full silos cover the fuel demand of the power station for 4 days. From the silos pass the chips by a conveyer to the boiler, where they burn one hour. The solid parts after the burning are used in waste disposal. The feed-water is cooled by air condensers.

Generating capacity	20 MW_{el} 30 MW_{therm}
Fuel	wood chips, quality AI-AIV
El. efficiency	31 %
Boiler Steam capacity Combustion temperature	fire grate 72 t/h 940 °C
Emission control	Calcite method, NO_x: SNCR
Annual fuel consumption	110.000 tun
Annual power production	100.000 MWh_{el} 4.700 MWh_{therm}
Redemption price	8,5 ct/kWh guarantee for 20 yrs
Total costs	45 mil. €

A I	crude
A II	glued, painted
A III	PVC cover
A IV	with preservatives, rails

Table 2: Technical specifications and quality of wood chips

4.2. Biogas Irlbach, 500 kW
The power station is situated near the city of Straubing, on the private land of the farm. As a medium for the biogas production is used a mixture of the farming and brewery rests, as seen in table 3. The station is connected to the 20 kV grid and the waste heat is used for heating the neighbouring castle and swimming pool.

Figure 3: Technological buildings of the biogas station

The whole yard is made of 5 reservoirs:
2 small at 200 m^3 – a) sewage reservoir
b) mixing reservoir
3 large – a) main fermenter 2.280 m3
b) end fermenter 2.280 m3
c) residue reservoir 3096 m3

The medium is transported from the neighbouring storages to a press, from where it passes by the conveyer to the mixing reservoir. There is the medium mixed with sewage and this mixture is pumped to the main fermenter, from where is extracted the most of biogas. The mixture is again pumped to the next fermenter, where the process ends and the biogas is also extracted. The residues are then pumped to last reservoir and are used for fertilization.

Biogas	CH_4 = 52 %
Annual biogas production	1.894.116 m^3
Motor	combustion
Generator	Asynch. 500 kW
Transformer	0,4/20 kV 630 kVA
Annual power production	2.500 MWh_{el}
Redemption price	18 ct/kWh
Total costs	2 mil. €

Medium	**Annual usage**
Maize	3.000 t
Farm silage	2.000 t
Plant silage	1.500 t
Corn	360 t
Sewage	1.600 t
Sugar beet	1.000 t
Potatoes	1.000 t
Brewery	900 t

Table 3: Parameters of the plant

5. CONCLUSION

We are expecting, that biomass will be progressively developing in near future. From energetic point of view will be the most utilized technology from all types of renewable sources [3].

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