The chemical analyze of combustion and the energetic exploitation of biomass

Stefan Adrian, Tudor Prisecaru

The chemical analyze of combustion and the energetic exploitation of biomass: *Biomass and biomass residues for Romania is an important source of renewable energy that is not used properly and efficiently used as fuel for energy purposes. Theory of combustion is used especially in energy assessment studies evaluating waste biomass fuel technology, with energy traces specific to the burner installations. An efficient operation of the plant for the extraction of heat from solid fuels is not possible without a thorough knowledge of all types of biomass and biomass residues used and how they are processed using specialized equipment. Projects are evaluated by analyzing the technical research institutes and studying solid fuels and biomass combustion parameters of the system. The most important knowledge in this paper are related to the properties of biomass burning and burning intensity evaluated on time. This knowledge and how to reduce the amount of ash and foreign particles there size and main properties are vital. Influence biomass fuel particles and prove to be very useful for technical experts.*

Key words: *Energy, Biomass, Waste Biomass, Biomass Analysis, Combustion, Biomass Burning.*

INTRODUCTION

Biomass fuels and their technical parameters are evaluated in terms of energy efficiency of local necessity and importance. The biomass combustion is a very complex chemical process with several stages and can be studied and calculated for economic and technical.

The paper is a study regarding theoretical speed of biomass and technical indicators on biomass residues and local design technology.

The results of biomass waste are sorted, evaluated and processed in accordance with the values and needs locale. Energy characteristics of waste biomass are analyzed in terms of efficiency and the energy. The best technical solution for heating using biomass residues plant is chosen. Then ash and volatile material are analyzed by appropriate technology [1].

Potential of biomass energy plant in Romania

Romania is a country with a wide variety of renewable energy sources with tremendous potential.

The most important renewable energy source is biomass, at this moment it represent about 67 % of the total energy potential.

Biomass production of grain crops varies annually depending on the degree of use of agricultural land development conditions that influence productivity and production. For example in 2011 the amount of plant biomass was 4-5mil.tone untapped wheat and straw, maize 7-8 mil.tone of 1.6 to 1.8 million tones barley, rice and industrial crops oatmeal. The unused residual biomass (stems and husks) was estimated: 2.7 million tons of sunflowers, canola and 150mii tons to 20 000 tons in soybean. There are between 20 and 35 % of the harvested plant biomass and energy value that is estimated at over 202 mil.tep. [2, 3].

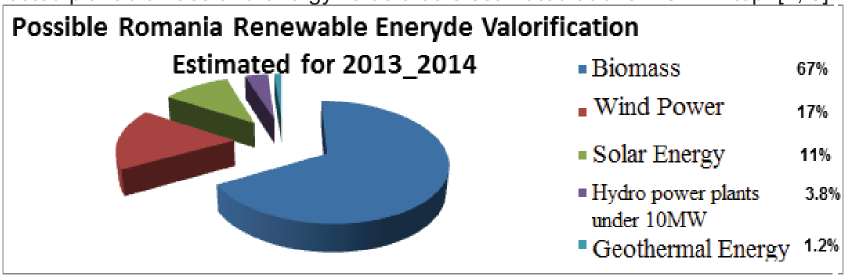


Fig.1. Possibly recoverable potential of renewable energy in Romania estimated in 2013 [3]

Corn, wheat and sunflower are the most important sources of biomass energy plant with a potential important locally. Crumbled corn and cobs can be compacted in the form of pellets or briquettes with a power that can compete with woody biomass. The existence of a quantity of sunflower seed husks and briquettes or pellets soy can significantly raise the energy value of the fuel.

Table 1. Romania's renewable energy potential estimated at the end of 2013

Renewable energy source	The annual energy potential	Energy equivalent (million tonnes oil equivalent [toe])	Aplications
Solar energy : Thermal Photovoltaic	60×10^6 GJ 1160 GWh	1433 93,2	Thermal energy Electrical energy
Wind power	23000 GWh	1978	Electrical energy
Hydro energy and hydropower plants under 10MW	38000 GWh 5800 GWh	3004 316	Electrical energy Electrical energy
Biomass	328×10^6 GJ	7697	Thermal energy
Geothermal energy	4×10^6 GJ	87,8	Thermal energy

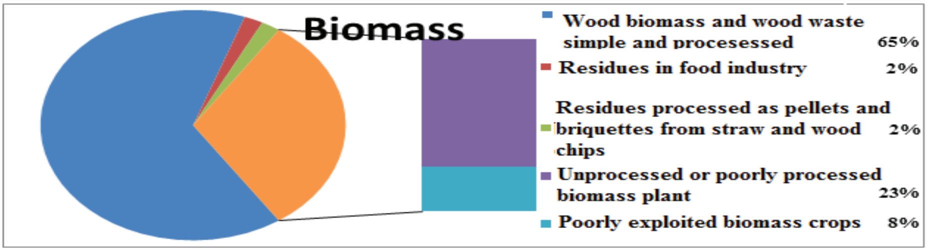


Fig.2. The most important sources of unused biomass energy in 2013 [4]

Biomass combustion theory and working conditions

Efficient and complete combustion is a prerequisite for biomass and wood fibers used as fuel to a high rate of energy use. As a result, the combustion has to ensure complete destruction of the biomass and to avoid the formation of undesirable compounds such as volatile matter and soot.

Emissions caused by incomplete combustion are mainly a result of either:

- Inadequate mixing of air and fuel into the combustion chamber, the local area of the fuel rich combustion energy;
- Lack of available oxygen;
- Combustion temperatures too low;
- Residence time too short;
- Small radical concentrations in special cases, for example, the final stage the combustion (combustion of the char phase).

These variables are all connected. However, in cases where oxygen is available in sufficient quantities, the temperature is the most important variable speed due to the exponential of influence on the reaction. An optimization of these variables will be contributions from low levels of all emissions of incomplete combustion [1].

Modeling the processes kinematics for outbreaks

The law of motion of a particle assumed spherical and that are only interacting with the surrounding gas stream and under the influence of gravity.

Apply the principle of conservation of momentum ρ_p.

$$\rho_p \frac{\pi\delta^3}{d\tau}\frac{dV_p}{d\tau} = \frac{\pi\delta^2 \rho_g C_d \left|V_g - V_p\right|}{2}\left(V_p - V_p\right) \tag{1}$$

Knowing momentary particle velocity V_p, V_g, gas velocity is known and considered constant, aerodynamic drag coefficient C_d depends on the coefficient of Reynolds R_e and has the value given by:

$$C_d = \frac{24}{R_e}\left(1 + 0.15R_e^{0.687}\right) \tag{2}$$

Reynolds coefficient R_e depends on the kinematic viscosity v_g and is calculated by the following relation:

$$R_e = \frac{\left|V_p - v_g\right|}{v_g} \tag{3}$$

The basic principle in mind for the construction of this model was to superimpose the effects of chemical reactions than mechanical processes that occur in the outbreak, taking into account the various experimental results obtained in practice.

Finally, the variation in time is to achieve a minimal set of variables such as fuel mass of a particle, its speed, and eventually burning speed rate of evolution of volatile matter and particle temperature.The assumptions underlying the model of writing

The basic assumptions of this simple analytical model are:

a) fuel combustion process will be studied at the level of particles containing fixed carbon, volatile matter and a sensitive volume of sterile, all known proportions;

b) will be considered perfectly spherical particles;

c) in the jet particles do not interact with each other by mechanical means;

d) shall be deemed particle combustion process ended when the percentage of carbon will be exhausted, reducing the particle size of the granules characteristic of ash - for simplicity will consider all the fuel was dehydrated and hence will not be relationships present chemical decomposition of water vapor;

e) study the entire jet of particles with this model is knowing the law of distribution of diameters in the process of grinding and characteristic elements of oxidizing air flow [2].

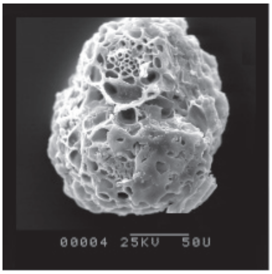
Biomass combustion

Biomass combustion melts to form cenospheres, but usually retains its original shape. There are a very large variety of substances and complex particles in every type of biomass. The indicators for shooting and kinematic form factor makes modeling very difficult [6].

Following the biomass combustion process gradually lose all moisture and volatile matter mass turns burning in the furnace. The decrease in volatile materials you strictly on the nature of plant biomass used and can called energy footprint.

Plant biomass combustion is affected by various parameters:

- Humidity (8-20%),
- Cellulose content (20-24%);
- Lignin content (27-29%);
- Particle size and size distribution (10-300μm);
- Catalyst effects are considerable (very important) below 900 °C but less important at higher temperatures.

a) 

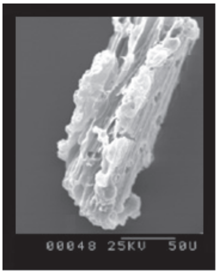
b) 

Fig.3. Biomass fine particles from samples melted in the plant burner: a) corn cobs (left), b) wheat straw (right)

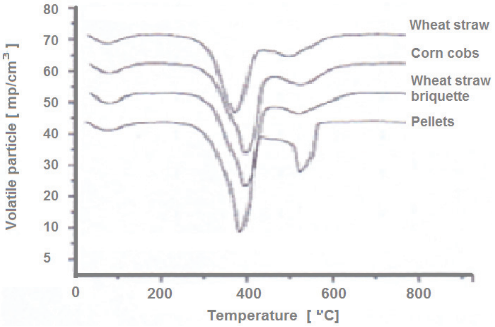


Fig.4. Diagram energy footprint of biomass fuel to the burner and the amount of volatile

Biomass combustion plant

Dry plant biomass combustion theory resembles that of wood but has some peculiarities and the four phases of recovery of the energy content of biomass burning in a plant burner.

Combustion of biomass is a process that involves binding and then drying the biomass volatilization.

In the process biomass is described as consisting of volatile, tar and charcoal burning Furnace intermediates as illustrated below:

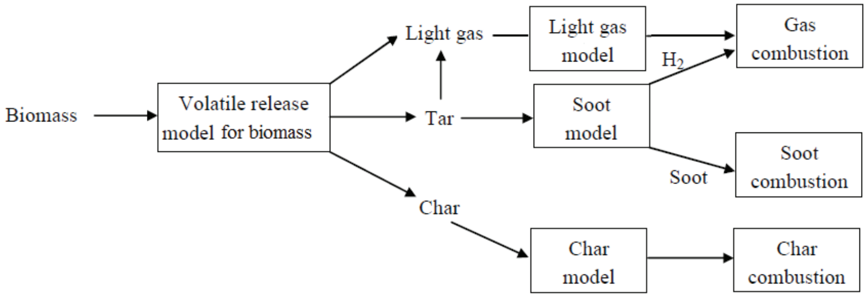


Fig.5. Models and scheme development of the combustion process [6]

Drying times regimes of biomass pyrolysis, combustion and ash formation depend on the particle size and can be considered thermal zones.

In the first case the temperature is considered constant around the fuel particle ignition and pyrolysis.

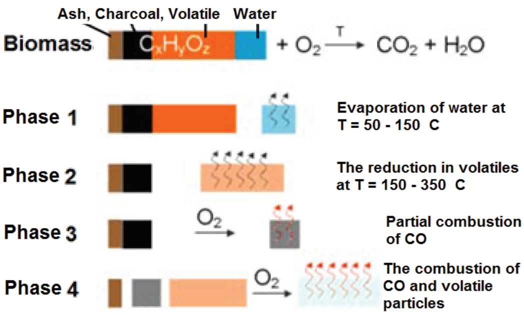


Fig.6. Stages for the development of plant biomass combustion [7]

Theoretical speed for burning biomass

The burning of biomass particle crushing plant stalk and cob corn for a fluidized bed [9]. Given the evolutionary stages of combustion in the burner will take into account the three parameters that affect the rate of burning of biomass:

- ✓ Excess air coefficient λ (to power the burner);
- ✓ Burning hydrogen (Stage 1) H_2 +1 / 2O_2 = H_2O+ Q_H;
- ✓ Combustion of volatiles (Stage 2) CxHyOz + O2 -> xCO_2 + yH_2O+ΔQ;
- ✓ Burning carbon (Stage 3) C + O_2 = CO_2 + Q_C;
- ✓ Combustion of CO and atomic particles (Step 4) CO +1 / 2O_2 = CO_2 + QCO.

Kinematic equation for the reaction speed of a chemical reaction: nA + mB → pC + qD + ΔQ, is a mathematical expression used in chemical kinetics to link the rate of reaction for each reactant concentration 'r' is:

$$r = k(T)[A]^{n'}[B]^{m'} \quad (4)$$

We know that k (T) is the reaction rate coefficient or rate constant, although it is not actually a constant since it includes all the factors (variables) that influence the reaction rate. Of all the variables listed, the temperature is usually the most important.

Exponents n 'and m' are called reaction orders and depend on the reaction mechanism.

By combining the speed equation with a mass balance system (inside) reaction takes place, one can deduce an expression for the rate of change of concentration. For a closed constant volume of expression of such can be in the form:

$$\frac{d[C]}{dt} = k(T)[A]^{n'}[B]^{m'} \quad (5)$$

The reaction rate relative to an enclosed volume and the environment where the reaction takes place is defined as the as the difference (interval) between the number of moles / amount react in a period of time and the interval time. Catullus intervals divide the volume V enclosed or progress of the reaction solution and the stoichiometric coefficient of the participant to respond.

Time interval dt is denoted by and is a very small time interval of seconds.

Variation in the number of moles of a participant corresponding reaction time interval dt is denoted dn[10]. The reaction speed with previous notations, for example to reactant A results:

$$v(A) = \frac{1}{V}\frac{dn}{dt} \quad [6]$$

This formula on theoretical speed of vegetal biomass particle combustion (burning speed carbon) in the burner is:

$$V_s^c = k(T)\left[\frac{O^i}{\frac{1}{a}+\frac{1}{b}+\frac{1}{n_x}}\right]\left[\frac{m}{s}\right] \quad [7]$$

Where k (T) = 0.356 coefficient of plant biomass combustion rate that keeps the overall temperature in the furnace, O^i are the percentage of vegetal biomass concentration [kg/m3]. α_H is the speed of combustion of the molecular hydrogen from biomass [m/s], a-the speed of combustion of volatiles [m/s], b-carbon burning rate [m/s] and n_x is the rate of burning of the carbon monoxide [m/s].

For larger particles, fluidized bed or fixed grill, a heat wave is considered that through all combustible particles, removing all moisture from the biomass.

All processes follow each other very quickly in the furnace immediately after drying biomass pyrolysis, gasification, oxidation and combustion formation of the well itself.

This case thermal analysis is taken into account when it comes to large amounts of biomass and involved numerous thermal gradient.

CONCLUSION

My study shows the best solution in terms of biomass combustion plants of various kinds. The paper describes the operation of biomass energy and biomass waste processing technology. Moreover, the amount of biomass and energy content of the biomass particles and how they affect combustion. The particle dynamics and kinematics in biomass fuel burner and the fuel burning rate equation and also the energy footprint of biomass fuel and the amount of volatile.

Table 2. The main varieties of biomass, elemental composition and calorific value [8, 9]

Biomass sample	**C** [%]	**H** [%]	**O** [%]	**S** [%]	**N** [%]	**K** [%]	**Ca** [%]	**Mg** [%]	**P** [%]	**W** [%]	**A** [%]	**Q**[kJ/kg] (Kcal/kg)
Wood	48-52	6.2-6.4	40-43.5	0.05	0.01-0.03	0.1-0.3	0.1-0.2	0.05-0.1	0.03-0.06	5-40	0.4-0.6	16500-17200
Spruce wood (with bark)	49.8	6.3	43.2	0.03	0.13	0.13	0.7	0.08	0.03	19	0.6	16950-17350
Beech wood (with bark)	47.9	6.2	45.2	0.015	0.22	0.15	0.29	0.04	0.04	15	0.5	16850-17300
Poplar wood	47.5	6.2	44.1	0.085	0.42	0.35	0.5	0.05	0.05	16	0.5	16750-17100
Wood pellets	51	6.3	41.8	0.01-0.002	0.02	0.13	0.7	0.08	0.03	7.7	0.7	17270-18500
Wheat straw	45.6	5.8	42.4	0.082	0.48	1	0.3	0.1	0.1	4.7	0.57	14800-16150
Corn cobs	45.7	5.3	41.7	0.12	0.65	2.9	0.21	0.15	0.45	11.3	1.05	13250-13755
Corn kernel	45.7	5.3	41.7	0.12	0.63	2.3	0.19	0.12	0.4	6.4	0.9	14850-15785
Reed	46	5.9	42	0.25	0.75	4	1.1	0.1	0.1	5.9	0.98	14750
Sunflower stalk	42.5	5.1	39.1	0.15	0.65	5	1.9	0.21	0.2	7.8	0.96	17550-18350
Shells and sunflower seeds	45.2	5	38	0.15	1.15	2.1	1.25	0.15	0.1	7.1	0.83	17550-18350
Lignite coal	53	4.7	23.5	3.43	1.65	-	-	-	-	8.7	1.85	21450

Several characteristics affect the performance of biomass fuel, including the heat value, moisture level, chemical composition, and size and density of the fuel. These characteristics can vary noticeably from fuel to fuel. In addition, natural variations of a given fuel type can be significant. The following table illustrates the main types of biomass heating equipment.

Table 3.

Main types of woody biomass and biomass residues heating equipment or plant are the same thing

<table>
<tr><td>Tip echipament</td><td colspan="2">Caracteristicile principale</td></tr>
<tr><td>Boiler which burns wood waste biomass and biomass waste</td><td rowspan="4">Suitable for heating buildings or even an entire household</td><td>-Chips can be inserted automatically into the furnace.
-Wood waste and biomass waste can be provided from local sources and are cheaper than pellets;
-It is suitable only for powers greater than 25kW.</td></tr>
<tr><td>Bioler that use pellets of all kind of biomass residues</td><td>-Pellets require a lighter handling and storage;
It's available for power ratings greater than 8kW;
-The yield was 80-90%.</td></tr>
<tr><td>Boiler burning wood logs or briquettes of many types</td><td>-Fuel inexpensive and secured from local sources;
-The boiler must be operated manually;
-Requires a storage tank.</td></tr>
<tr><td>Boilers using other types of biomass plant</td><td>Fuel really cheap and secured from local sources;
-The boiler must be operated manually;
-Needs storage tank;
-Available for low power under 15kW.</td></tr>
</table>

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This paper has been reviewed.