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THE PROCESS OF OBTAINING ENERGY FROM BIOMASS IN THE GASIFICATION PROCESS

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Abstract: *The article presents an innovative solution for a modern system for gasification of biomass and production of electric power. Motivation to develop this installation were European Union directives related to waste management and supporting activities for reducing problems related to the "Low emission". Demonstration installation was performed as part of the project. Demonstrator + under the title "Developing and testing on a demonstration scale an innovative, compact module for the production of power from biomass" called "EKOMPAKT". The article presents the process of gasification used in the project and describes the concept and operation scheme of the device.*

Keywords: *Biomass, Gasification process, Light mobility installation*

INTRODUCTION

The process of gasification of biomass has been studied and analyzed for many years. There are currently many technical solutions in the process of biomass gasification. Most of the professional equipment is large stationary installations, capable of processing large amounts of biomass, acting alone or in cogeneration with systems based on fossil fuels. These systems, which have the status of "EKO", are ecologically only theoretical because they are based on the processing of biomass supplied to the gasification site with systems based on fossil fuels. In addition, the rising costs of these extraction and the cost of transporting them result in increasingly inexpensive waste processing and less environmental waste.

Motivation to develop a demonstration plant for gasification of biomass is a noticeable and increasingly prominent issue in the European Union's structures related to waste management, renewable energy supporting the development of distributed sources of electricity (including renewable energy sources) and supporting activities significantly reducing problems related to the so-"Low emission". Consequently, the assumptions of the project have assumed the main assumptions for the current local and strategic needs of the directions set out in the EU directives. These directives are: Directive 2008/50 / EC on air quality and cleaner air for Europe; Directive 2008/98 / EC on waste and repealing certain directives; Directive 2009/28 / EC on the promotion of the use of energy from renewable sources,

- Utilization of waste at their place of origin and hence a significant reduction of waste disposal costs by reducing the need for waste transport to waste treatment plants and thereby significantly reducing "low emissions" (particles smaller than 10μm)
- Consumption of energy (heat and electricity) produced from biomass at the place of its production and hence reduction of costs of purchasing power from the central power grid, reduction of transmission charges, reduction of CO_2 emissions, additional revenue from the sale of electricity and heat,
- The consumption of heat in the immediate vicinity of its production by inserting it into the local heating network, or by direct supplying, for example, utilities, significantly affects the local reduction of "low emissions"
- The possibility of connecting the system to the main power energy grid and thus obtaining additional revenue from the sale of generated electricity.

Demonstration installation was performed as part of the project Demonstrator + - "Developing and testing on a demonstration scale an innovative, compact module for the production of power from biomass" called “EKOMPAKT”. Project co-financed by the European Union from the European Regional Development Fund, Project implemented in cooperation with the Faculty of Mechanical Engineering of the Wroclaw University of Technology. As part of the project, it is assumed that, on the basis of the experience gathered, it will be designed and tested in complete simulations and then built innovative, compact and mobile module for converting biomass (especially waste) into the power energy. In this context, it will be possible to completely recycle the heat generated, with the aim of eliminating the conversion of "waste into the waste" At the same time, it provides a great opportunity for individual modifications of the installation.

GASIFICATION PROCESS OF BIOMASS

According to (Basu P., 2010) gasification is a process in which solid or liquid raw materials are converted into more useful and convenient gas fuel. The resulting gas is used to generate of power energy. Gasification, unlike combustion, involves the formation of chemical bonds in gaseous products to produce the power energy, while burning involves destroying these bonds to produce energy. The gasification process adds hydrogen and collects carbon from the raw material thus creating a gas with a higher hydrogen to coal ratio.

Typical gasification processes include the parts:

- desiccation
- thermal decomposition or pyrolysis
- partial combustion gases, vapors and decolourizing coal
- gasification of products decay

Gasification requires a factor gasification to change the structure of the gas to be converted into gas or liquid the gasifying factor reacts with coal and hydrocoal to transform it into low molecular weight gases such as CO or H2, therefore the gasification factor is essential for gasification. Oxygen, steam and air are the most common. Oxygen is a very popular gasifier, although it is primarily used during the combustion stage. It can be applied to the gasifier in pure form or in the form of air (confuse of oxygen and nitrogen). The three-component scheme (Fig. 1) present the pathways for the formation of different combustion products depending on the amount of hydrogen carbon and oxygen in the fuel and depending on the gasification factor used. If pure oxygen is used as the gasification agent, the conversion path is shifted towards the corner with oxygen (right bottom corner in Fig. 1). Then the combustion products contain CO for a small amount of oxygen and CO_2 for more oxygen. When the amount of oxygen exceeds a certain (stoichiometric) value, the process changes from gasification to combustion, and consequently gas is produced instead of gas. In this case, neither the combustion gases nor the combustion products have a significant calorific value when cooled. Providing more oxygen leads to a reduction in the amount of hydrogen and an increase in the amount of carbon compounds - ie CO and CO_2, as the gasification product. If air is used instead of oxygen, the nitrogen atom significantly weakens the calorific value of gasification products. Instead of oxygen, steam is used as the gasifying agent, then the gasification path in Fig. 1 will move to the hydrogen corner. Gasification products then contain more hydrogen per unit of carbon. Sometimes, indirect reaction products (ie, CO, H_2) also help in the coal gasification process (Basu P., 2010), (Zhang W., 2010), (Catallo WJ. & Shupe TF. & Eberhardt TL. 2008)

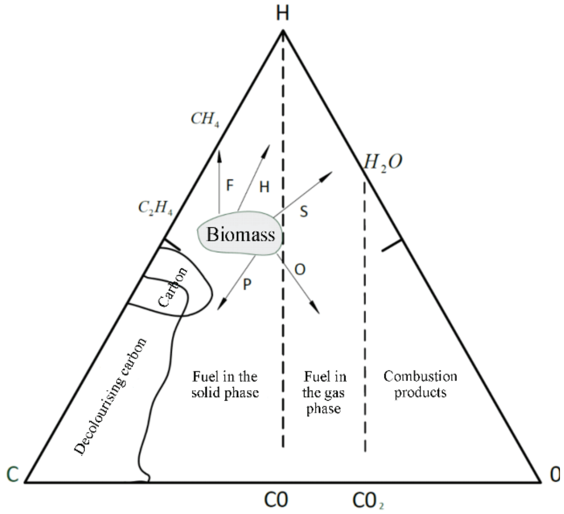

Fig. 1. Scheme of C-H-O process gasification products [1];
H- Hydrogen, S - Steam; O - oxygen; P - Free pyrolysis; F - Rapid pyrolysis

The choice of the gasification factor is therefore of paramount importance in the gasification process because it represents the calorific value of the gas obtained after the process. The estimated gas calorific value of the gas depending on the gasification factor is given in Table 1 (Basu P., 2010), (Zhang W., 2010).

Table 1. Calorific value of gaseous products depending on the gasification factor (Basu P., 2010) (Zhang W., 2010)

№	Gasification factor	Calorific value $MJ/_{nm^3}$
1	Air	4-7
2	Steam	10-18
3	Oxygen	12-28

The typical gasification process follows the steps below. The diagram of biomass gasification is shown in Fig. 2. The basic process of gasification of biomass assumes preheating (drying of biomass) followed by thermal degradation or pyrolysis. Pyrolysis products (ie gas, solid and liquid) react with each other and with the gasification agent to form gasification products. In most gasification machines available in the industry, the heat energy required for drying biomass, pyrolysis and endothermic reactions is derived from the exothermic combustion reactions produced in the gasifier machines (Basu P., 2010), (Sun Y-I. & Yoon SJ. & Kim YK. & Lee J-G. 2011).

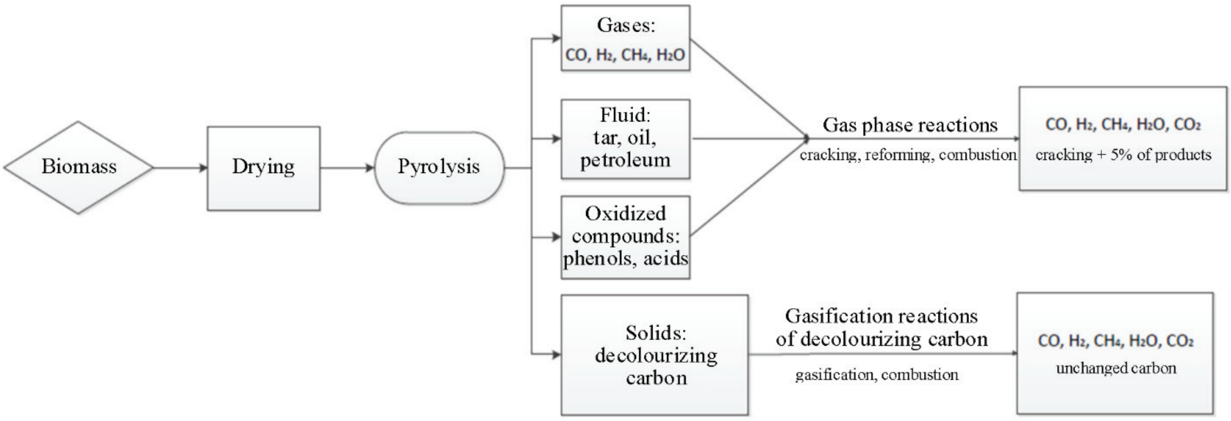

Fig. 2. Biomass gasification scheme (Basu P., 2010).

Typical installation of gasification includes a gas generator reactor and its auxiliary equipment, consisting of the parts:

- biomass handling system
- biomass feeding system
- gas cleaning system
- cinder and particulate removal system.

CONCEPT OF GASIFICATION MACHINE

The "EKOMPAKT" machines performed within the project Demonstrator+ is a device designed to process biomass in the amount of 300kg/h and consists of the modules (Fig. 3):

- biomass preparation module: shredder and intermediate tank (I)
- reactor module (II)
- gas cleaning module: cyclones, catalyst (III)
- gas conditioning module (IV)
- generator module (V)

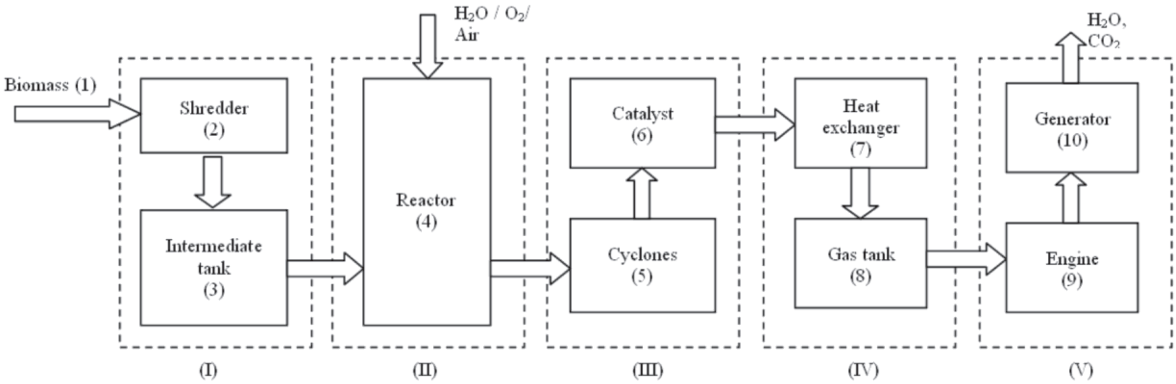

Fig. 3. Idea of "EKOMPAKT" gasification machine

Separate parts of the installation are built in 20-foot containers, which allows easy expansion of the system by multiplication of individual modules. Demonstration installation allows verification and optimal selection of the gasification process for the given fuel type by means of the possibility of checking the gasification process downstream and upstream, and also with recovery and without recovery of heat from the exhaust. Demonstration installation allows to verify and optimum gasification process for a particular type of fuel by checking the simultaneous and counter-current gasification process as well as with recovery and without heat recovery from exhaust and non-recovery. Such a real-time verification of the process gives great security to obtain and develop optimal gasification parameters for a given fuel and achieve optimum financial benefits from this process. Commercial installations that are currently in a very advanced design stage will also be equipped with a remote monitoring system and a remote monitoring system. Information about the level of emissions can be made available to individual institutions and local governments, giving them the opportunity to apply for the "EKO" status, ie. environmentally friendly.

SCHEME OF OPERATION

The biomass by transport system (1) is transported to the shredder (2), which processing the biomass to produce a material up to 3x3x3 cm in size (Fig. 3). This size of material allows for a smooth gasification process.

From the shredder (2) the fuel is transported to the intermediate tank (3), where it is premixed to pre-homogenize the fuel, which also has a significant effect on the smooth gasification process. In this tank, the fuel can be pre-heated to increase the efficiency of the gasification process and additionally dried to obtain an optimum level of fuel humidity.

From the tank (3) the fuel is transported to the reactor (4), where the gasification process occurs. Depending on the type of fuel, additional carrier gases H_2O or O_2 or air are added to the reactor. Mineral compounds remaining after gasification are removed from the gasifier outside the installation. Syngas from the reactor (4), due to the possibility of contamination with solid particles, is transported to the cyclones system (5), where it is cleansed.

From cyclones (5), the syngas is transported to a catalyst (6), which is used to interception of the particles that have not been trapped in cyclones and shorten the hydrocarbon chains to a level that will remain gas when the temperature of the syngas decreases. Syngas from cyclones (6) are transported to a heat exchanger (7) in which the gas is shocked cooled to prevent re-forming of long hydrocarbon chains that remain liquid or tar at ambient temperature.

From the heat exchanger (7), the gas is transported to the set of tanks (8), in addition it is mixed, in order to homogenize its chemical composition, to ensure stable operation of the internal combustion engine (9). Internal combustion engine powered by Syngas drives the generator (10) that generates power electricity. The installation is described as a self-sufficient installation, which, when activated and powered by biomass, generates heat and power electricity for its own use and sale.

Fig. 4. Real construction of gasification machine "EKOMPAKT"

The presented idea of operation was used in the final stage to build a real machines. On figure 4 shown the construction of the machine, whose the first initialization is planned in the next month.

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CONCLUSION

Demonstration gasification machine "EKOMPAKT", through to its container construction, is a mobile device and easily scalable. This is consistent with the development strategy defined by the European Union directive, It also responds to local and social needs related to waste reduction and low emission reduction. In addition, the gasification machine "EKOMPAKT" device reduces the cost of the enterprises involved in waste disposal and also reduces the costs associated with the purchase of energy. For local governments, as well as entrepreneurs, the "EKOMPAKT" installation is a demonstration of the policy of conducting business in an environmentally friendly way.

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