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JUSTIFICATION OF CONSTRUCTION OF INSTALLATION FOR THERMAL DECOMPOSITION OF BIOMASS

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Abstract

An important part of the overall technical base of the modern greenhouse is the heating system. Choosing the most efficient - both technical and cost-effective, both of the thermal energy source and the heat carrier, is one of the most important factors that a greenhouse can successfully fulfill its purpose. The heating system should be selected in such a way that, as soon as possible, the large investment needed to build large-scale greenhouse production is recovered. The article will propose a possible technical solution for greenhouse heating, focusing on modern tools and systems as well as basic approaches for increasing the energy efficiency of the production made in the facility

Key words*: greenhouse, heating, heating system for greenhouses.*

INTRODUCTION

For heated greenhouses production is close to industrial: high yields of good quality resulting from modern cultivation technologies; regular deliveries not dependent on the season of the year. This provides access to buyers with a significant share and lasting position on the market with fresh vegetables. Achieving these strategic goals requires high investment costs. By literary data (Ivanov et al., 2015) - 100 thousand euros per hectare of greenhouse area. For the conditions of Bulgaria, where greenhouse production is characterized by the existence of free - built but not working greenhouse complexes, a variant for reconstruction and modernization is possible. These costs can be recovered as quickly as possible only through the maximum possible production at competitive prices. In order to minimize the cost of the activity in order to reduce the cost of production, it is necessary to carry out thorough economic analyses of each item.

Despite the wide variety of existing greenhouse heating methods, every individual case of investment intention for greenhouse production needs to be approached strictly individually. Given the large share of the cost of maintaining the microclimate in the heated greenhouses - 55-60% according to (Ivanov et al., 2015) of the total costs, apart from the selection of the heating method, the energy carrier should be strictly observed. It should be at the lowest possible price and combined with the most efficient heating technology to lead to minimal costs for providing the microclimate. On the other hand, the energy carrier must also guarantee relative "autonomy" to the consumer, "Independence" from the prices of other existing energy carriers. The aim is, in the case of a sharp rise in fuel and electricity prices, that there is not a corresponding one in the cost and hence in the price of the greenhouse production produced.

The membership of our country in United Europe imposes restrictions on the use of solid fuels - wood and coal. Directive 2009/125 / EC of 21 October 2009 laying down requirements for the reduction of ambient air pollution by fine particles, carbon monoxide (CO) and nitrogen oxides (NOx) emitted during the combustion process. European Commission Regulation 2015/1185 of 24 April 2015 laying down the rules for the implementation of that Directive. According to these two European normative documents of 1 January 2022, a change in the requirements for the heating systems used and the ban on solid fuels is expected.

In Bulgaria, which is poor in natural fossil fuels, the question of the energy efficiency of each production is of utmost importance. Achieving "energy independence" allows for strategies to develop some economic activity without taking into account the growth of energy prices. This provision of energy at "acceptable" prices makes it possible to produce lower-priced products which guarantee their availability at competitive prices.

A great advantage in this respect is provided by renewable energy sources (RES). Biomass, as one of them, is a significant resource contributing to the overall energy consumption in Bulgaria.

Biomass is created from the living matter of Earth as a result of its vital activity and includes all organic matter.

The continuous generation of biomass on Earth characterizes it as RES. The conversion of biomass energy stored in plant biomass into fuel resembles its mode of formation. Expressed by chemical formulas, the process can generally be written: (Benev A., 2008, http://www.shtrakov.net/RET/Lect_09.pdf)

$$CO2 + 2\,H2O \overset{light}{\underset{heat}{\Longleftrightarrow}} [(CH2O) + H2O] + O2$$

Expressed in this way - the right reaction expresses photosynthesis, in which biomass - [(CH2O) + H2O] is formed and oxygen (O2) is released.

Reverse - the oxidation of the biomass is accompanied by the release of heat. The exothermic nature of the interaction of biomass with oxygen (oxidation) characterizes it as a fuel. The heat generated during this process is the released solar energy that plant biomass generates during photosynthesis and stored in chemical form. The amount of carbon dioxide (CO2) released by combustion of biomass is as much as is necessary to obtain it through photosynthesis (Panzhava et al., 2002; Effective use of biomass, 2010). Therefore, its use as a fuel does not pollute the natural environment with additional damages and it is also called "green energy" (Nazmeev et al., 2001; Moses et al., 2006).

According to (Hayes, 1987; Benev et al, 1994; Benev, 2008) the net amount of energy is in the range of about 8 MJ/kg for green wood, about 20 MJ / kg for dried plant products, 40 MJ/kg for fats, natural oils and oilseed esters, 55 MJ/ kg for methane. For comparison, these fossil fuels are 27 MJ/kg and 46 MJ/kg, respectively for coal and oil. The energy derived from these fuels is also called "brown" because its use always leads to the release of additional polluting materials. Biomass is the resource that is most easy to use and whose resource is yet to develop (Zaharinov et al., 2014). More than 80 high-calorie technologies have been developed in the application of thermal, biological or chemical treatment, in some of the developments being fully equivalent to diesel oil and even better (Jhon et al, 2008; Balat, 2009).

The relative shares of the different biomass fuels are presented in Figure 1.

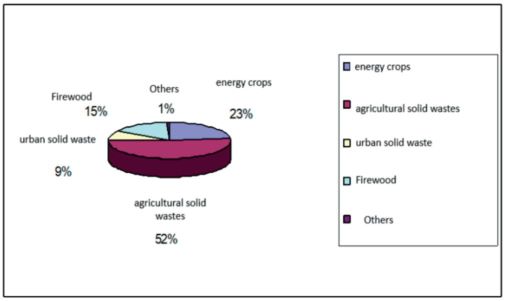

Figure 1. Relative percentages of the various fuels from biomass in Bulgaria
Source: Legal framework for the use of biomass in the countries of the European Union and Republic of Bulgaria, 2005

From the exhibition it is clear that there is a large amount of unused plant and forest residues in Bulgaria. Their use by developing techniques and technologies for harvesting, harvesting and storing them is a challenge for modern society. Using this energy resource will improve the energy independence of both the individual company and our entire country.

In 2020, with full absorption of the biomass energy potential presented in the program, its share will reach 8.5% in gross domestic consumption. About 38% of spent biomass in 2020 is expected to be used to generate electricity and heat, amounting to about 837,000 tons net equivalent. About 70% of the biomass and about 30% of electricity production will be used for this heat production. The share of biomass in final energy consumption will reach 10.7% in 2020, was 8% (National Long-Term
Program to Promote the Use of Biomass for 2008-2020, 2008).

MATERIALS AND METHODS

To explore autonomous technology for the processing of plant residues and low quality wood for heating greenhouses.

The subject of the study is a technology for the use of different types of biomass (plant residues and low-quality wood) as a raw material for heating energy when heating greenhouses.

The means of the study is an installation for the thermal decomposition of plant residues and low quality wood for the purpose of heating the heat carrier.

RESULTS AND DISCUSSIONS

1. Experimental thermal expansion process module.

In Figure 2 is a schematic diagram of an installation of industrial furnaces with periodic action for the thermal decomposition of solid biomass without access of air - retorts. The individual nodes and components of the installation are labelled in order to get an idea of their device - Figure 2.

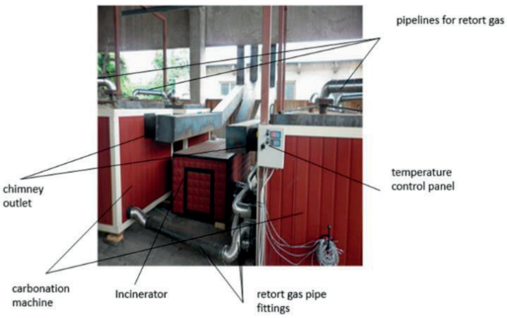

Figure 2. Thermal decomposition plant for biomass

2. Device

The installation consists of: two machines for carbonization (low temperature pyrolysis); insufflator; piping and flue system; control dashboard. Underneath each of the machines an electronic scale is installed. For the interaction between the individual elements of the installation - the thermal decomposition machines of solid biomass and the incinerator, a pipeline installation is used for circulating the thermal decomposition of the biomass gases (Figure 3). A pipe connection exists both between the two machines and between them and the injector. Exhaust gases are used to discharge into the atmosphere through the flue gas chimney. Manipulation, through a change in temperature, of the working processes occurring in low-temperature pyrolysis biomass of solid biomass is using a control panel. Each of the machines consists of a furnace, two chambers for decomposition of solid biomass - returns with a hermetic lid, a system of pipes for the transfer of the gases obtained during the process and for the remainder of their combustion - the smoke. The cameras can also be positioned sequentially depending on the work area.

In this type of equipment, solid biomass is placed in the rhetoric that are heated from outside by hot gases resulting from the thermal decomposition of solid biomass (pyrolysis gases). Retractors are metal containers in the shape of a parallelepiped. They are made of 2 mm thick sheet steel.

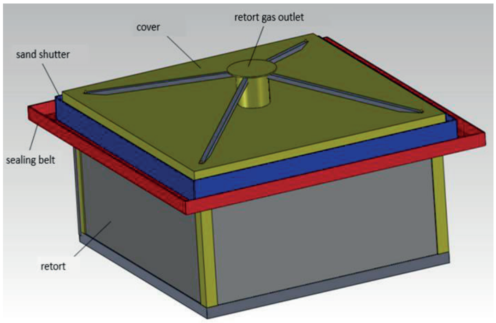

Figure 3. The heat from a thermal decomposition plant for biomass

The rattles are placed in a housing of fireproof insulation. For a tight fit between the machine body and the retort, a sealing belt is used. There is a pressurized biomass filling lid that connects to the body of the retort via a sand block. The steam-gas mixture formed in the thermal decomposition process of the solid biomass is passed through a hole located low at the back of the retort. Then this mixture through a three-way distributor is made: in its first position, to the chimney for discharge into the atmosphere; in the second - for heating the biomass in the next chamber; the third gas-gas mixture goes to the injector.

The incinerator burns the gases obtained from the machines as a result of the thermal decomposition of the solid biomass. The heat generated by this burning is used to heat water in the heat exchanger of the incinerator. From here, the heated water is directed to heating the greenhouse through a pipeline installation.

With the control panel, the temperature in the rhetoric is controlled during the process - the thermal airless decomposition (low temperature pyrolysis) of solid biomass. From the numerical value of the temperature depends the flow of the pyrolysis gases, which in turn determines the output required for the operation of the greenhouse heating system. The pipelines for the separated pyrolysis gases and for the residues from their combustion (smoke) make the connection between the individual elements of the system and that of the environment. To measure the amount of gas emitted during the process of pyrolysis of solid biomass, an electronic balance is used at the base of each machine. The plant is capable of operating in several technological modes, which correspond to the actual heating requirements for greenhouses. In addition, depending on the area of the greenhouse facility and the corresponding heating power, the installation may be composed of a corresponding number of modules.

3. Power management of the installation

The thermal power of the plant is controlled by two circuits:

1. Power of pyrolysis chambers. It is achieved by controlling the separated combustion gases from the retorts by the weighing method;
2. Heat exchanger power. This is achieved by measuring the temperature in the greenhouse or the difference in the temperatures of the outgoing and the water entering the heat exchanger.

For power management of pyrolysis chambers, a system for measuring the mass of exhaust gases is installed in the system.

Figure 4. System for monitoring and setting of modes management of the pyrolysis installation

The management of the separated mass upon biomass heating is carried out by controlling the temperature in the pyrolysis chambers. The temperature is measured with four thermocouples.

Figure 5. Temperature measurement system in the pyrolysis installation's rhetoric

CONCLUSIONS

A constructive concept of a biomass combustion plant is proposed.
An installation for greenhouse heating is synthesized by combustion.
The gasification plant under investigation is in compliance with the national energy efficiency programs and the use of renewable energy sources.
The proposed greenhouse heating technology, in addition to using "green energy", also uses the maximum capacity of biofuel - it has a significantly higher efficiency than its direct incineration.

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