Scientific Papers. Series E. Land Reclamation, Earth Observation & Surveying, Environmental Engineering. Vol. VI, 2017
Print ISSN 2285-6064, CD-ROM ISSN 2285-6072, Online ISSN 2393-5138, ISSN-L 2285-6064

ENVIRONMENTAL AND TECHNOLOGICAL ASPECTS OF USE OF RESIDUES FROM TOBACCO PRODUCTION AS HEATING FUEL

Dimitar KEHAYOV, Georgi KOMITOV

Agricultural University of Plovdiv, 12 Mendeleev Blvd., Plovdiv, Bulgaria

Corresponding author email: gkomitov@abv.bg

Abstract

The heating of residential and industrial buildings is necessary for their normal function in the winter period of the year (these are the months from October to April).
To meet its energy needs in many countries are planning a more rational use of energy and the development of renewed energy sources (RES) to replace part of the fossil fuels. The biomass is organic matter of biological origin, which can be used as an energy source.
Tobacco is grown in weak soils (mountain and semi-mountain areas) and in non-irrigated conditions. Statistically is not specified the mass of tobacco stems, as well as its energy potential. After retraction of the foliage, the stems remain on the field until next year. The stems of the tobacco plantations are proving to be a serious energy source, because the calorific value and the quantities and qualities of this biomass remain unexplored.
The article presents the possibilities of using the residue from tobacco production as an energy source for heating.

Key words*: bioenergy, biomass, tobacco waste*

INTRODUCTION

Globally, there is an energy crisis with distinct highs and lows, which compels all countries to seek lasting solutions in terms of energy balance. To meet their energy needs, many countries are planning a more rational use of energy and the development of renewed energy sources (RES) to replace part of the fossil fuels (*www.abea-bg.org/files/Biomass_pravna%20ramka.pdf; Georgiev, 2010; Georgiev, 2013))*. To the energy from RES refer: biomass, hydro, geothermal, solar and wind energy and liquid biofuels (Figure 1).

Biomass is organic matter from biological origin, which can be used as an energy source (Failoni, 2006). It can be from:

- Plant origin – in the form of wood waste (from wood logging and woodworking) or in the form of solid agricultural waste;
- Animal origin – biogas from mature or sewage sludge;
- Municipal solid waste, including methane from landfills.

According to Figure 1 the largest share of use there is biomass. Its potential is enormous and is still not fully known. Bulgarians forests occupy about 34% of country, and 48% are agricultural areas. Around 33% of our population lives in rural areas.

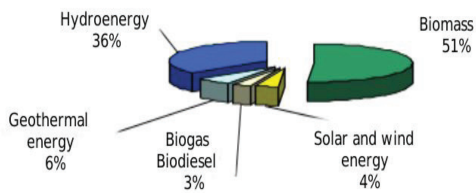

Figure 1. Distribution of renewed energy sources

The residual biomass can be classified as:

- Wood biomass – these are unusable material from wood logging (twigs, bark, etc.), residue from wood working (bran, scobs, utter, etc.) and waste from the paper industry (scobs, paper waste, etc.). The calorific value of the dry wood is approximately 4300 kcal/kg, while the air-dry about (1500-1700) kcal/kg. The quantity cinder is only about (1-1.5) % (Zahariev, 2015).
- Solid agricultural biomass – mainly straw, corn stalks, sunflower stalks and flakes, tobacco stalks, clipping from orchards and vineyards. Studies show that about 30% of

Scientific Papers. Series E. Land Reclamation, Earth Observation & Surveying, Environmental Engineering. Vol. VI, 2017
Print ISSN 2285-6064, CD-ROM ISSN 2285-6072, Online ISSN 2393-5138, ISSN-L 2285-6064

the straw quantity, 65% of the corn stalks and around 80% of the other solid agricultural biomass can be used for energy purposes (Al-Rifai, 2004; Georgiev, 2010).

Annual solid agricultural biomass is estimated at 800,000 t. Tobacco stems prove to be a serious energy source from agricultural biomass. Calorific value, quantities and qualities of this biomass remain unexplored and untapped - early spring under cultivation of fields, as cutting the remaining stems and leaving in the soil.

WORKING METHODS

To determine the quantity of residual biomass of unit area, arbitrarily converged 200 plants from proving ground, for each mass is determined. Measurement of the tobacco stalks mass is carried out with electronic scale "DENVER INSTRUMENT", model "PK202" with range up to 200 g and accuracy 0,01 g. After their reporting the received data are processed and determine the average mass of one wet plant. Next operation is drying of the stems into a stove to absolutely dry condition and weighted. The received results are processed and obtained the average value of mass from absolute dry plant.
The humidity is determined by equation 1:

$$W = \frac{M_F - M_D}{M_B}.100\,\% \qquad (1)$$

where:
M_F - average value for freshly harvested plant mass, g;
M_D - the mass of absolutely dry plant, g.

The quantity of biomass from tobacco stems at 1 ha is defined by equation 2:

$$Q_B = i.M_F \text{ [kg]} \qquad (2)$$

where:
i - number of planted tobacco plants in 1 ha.

Total residual biomass in the cultivation of small-leaved tobacco in Bulgaria for the year is derived from equation 3:

$$Q_T = Q_B.A \text{ [kg]}, \qquad (3)$$

where:
A - total areas cultivated with tobacco.

For the determination of the energy potential of tobacco stems it is used stand calorimeter "CALORIMETER KL 11" of company "Micado", shown in Figure 2. Biomass is put in specially designated camera for this purpose and the result-calorific value of tobacco residues is read directly on the display in [kJ].
For the determination of cinder content, the content of carbon dioxide CO_2, carbon monoxide CO and silicates in the exhaust gases and the hard residue after burning of tobacco stems was developed laboratory stand. The stand copies standard solid fuel heater. It is mounted probe to capture exhaust gases.

Figure 2. "CALORIMETER KL 11" - general view

The analysis of samples from exhaust probe is performed with gas-chromatograph for determination of their composition. Before the beginning of each attempt, it is weighted the quantity of tobacco residues, then placed in the combustion chamber. After complete combustion the cinder is examined for the presence of silicates. Measure the amount of cinder after burning. Measurements of the weighting of the tobacco residues and cinder after burning is measured with "Mettler Toledo", model "AB104-S" with range up to 110 g and accuracy 0.0001g. Percentage the cinder PP is determined by equation 4:

$$PP = \frac{M_P}{M_O}.100 \qquad (4)$$

where:
M_P - the mass of cinder, g;
M_O - mass of burnt tobacco residues, g.

RESULTS AND DISCUSSIONS

The average value of the mass from moist tobacco stem is 47.17 g, and at absolute dry state respectively is 25.4 g.
Using dependence 1 humidity is obtained approximately 46%. The quantity of dry biomass from tobacco stems from 1 ha with according to dependence 2 and the results referred above is 304.8 kg in the 12,000 planted plants. Over the past (2-3) years small-leaved tobacco in Bulgaria is cultivated on around 138,000 ha. Using equation 3 for the total quantity of absolutely dry tobacco results approximately 42,000 t. The results of the experiments for the determination of the calorific value, cinder content, the presence of silicates in cinder, content of carbon monoxide and dioxide are listed in the table 1.

Table 1. Experimental results

Calorific value [kJ/kg]	18,332
Silicates [%]	2.94
Cinder content [%]	3.16
Content of CO_2 [mg/m^3]	3.24
Content of CO [mg/m^3]	0.31
Energy [kWh/kg]	5.09
Calorific heat [kcal/kg]	4,378

It is seen that content of the cinder after the complete burning of tobacco stems is 3.16%. According to European certification EN-B this value must be less than 3.5% for pellets and between 0.3 and 6% for the chipped wood. In both cases, the obtained result meets to European requirements indicates that the tobacco waste is an appropriate power source.
The presence of silicates in burning leads to deposits on the grids of the combustion chamber and reduce the air flow through them. In this case is disrupted the burning process.
This can cause the halt of the combustion installation. This disadvantage is reduced using removable grid, which are periodically washed with water. Content of the silicates in the hard waste after combustion of tobacco stems, is 2.94%.
It is higher than that of certain solid wastes from agricultural production, such as sunflower -1.1% and lower than that of straw from wheat- up to 52%. For comparison, the rate of burning wood silicates is about 4.7%.
In this study the contents of the silicates in the cinder allows burning of tobacco residues in standard heating systems.
In terms of carbon dioxide and carbon monoxide there is no clear picture of the limit values. They depend both on the fuel that is used also by the device in which combustion takes place, working conditions, etc.
The limit concentration of CO in the ambient air (which does not directly or indirectly affect, adversely affect the present and future generations, not lowers efficiency, not worse self-esteem and sanitary and household living conditions) is 3 mg/m^3. From the data in the table 1 it is apparent that the burning of residues from tobacco plants it results that the quantity of units CO is much less than the permissible.
The calorific value of the residues from agricultural production is less than that of the different types of wood with 20 to 30%. In some literary sources data show that straw, stalks of corn, vine sticks and oil cake have a calorific value 4,100 kcal/kg. This is equal of 4.77 kWh/kg energy.
Studied by us tobacco residues is having energy 5.09 kWh/kg or 4,378 kcal/kg, which is comparable to the literature data.

CONCLUSIONS

The results of the four tracked indicators give grounds to assert that tobacco residues (stems, leaves and particles on them) may be used as heating fuel.
Due to the contents of a small quantity of silicates in the cinder there is no danger from clogging the grids in the combustion chambers and suspension of the combustion process due to a lack of oxygen.

REFERENCES

Zahariev I.,Kehayov D., 2015. Results from research of rose stems burning. University of Ruse Proceedings, vol. 54, book 1.1, Ruse, 123-125.

Failoni, 2006. Renewable energy sources. Trakia University, Stara Zagora.

www.abea-bg.org/files/Biomass_pravna%20ramka.pdf

Al-Rifai, H., Y. Enakiev, B. Borisov, S. Mitev, 2004. Research on practical opportunities for utilization of plant lefts of the corn industry. EE&AE Proceeding 2004, Ruse, 658-665.

Georgiev, V., N. Markov, G. Kostadinov, L. Asenov, I. Ivanov, G. Kapashikov, Y. Enakiev, 2010. Fuel-technical specifications of straw from cereals. Agricultural Journal, vol. 1, Sofia, 32-35.

Georgiev, V., G. Kapashikov, L. Ivanov, I. Mortev, Y. Enakiev, 2013. Investigation of sunflower stems and heads combustion in chipped biomass combustion.