STUDY ON THE REDUCTION OF POLLUTING EMISSIONS THROUGH COMBUSTION BIOMASS IN THE THERMAL BOILERS

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ABSTRACT. This paper presents a case study on reducing pollutant emissions by burning biomass in power thermal boilers. There are presented the main types of biomass and their technical characteristics. There is presented a proposal for the production of electricity through combustion of coal and biomass.

KEY WORDS: Energy slurry, elephant grass, wood waste, CO_2 emissions

1. INTRODUCTION

In the Strategy for the Recovery of Renewable Energy Sources in Romania, approved by HG1535/2003, it is mentioned that biomass has:

- Annual energy potential of $318x10^6$ GJ
- Energy equivalent: 7,59 thousand t_{ep}

For 1 MWh produced and delivered by the electricity producers 2 green certificates are granted. Electricity suppliers are required to purchase a number of green certificates a year. At present, the technical energy potential of biomass is about 519000 TJ.

For vegetal biomass, the energy potential in 2030 will be:

- Technical : 418000 TJ/an
- Economic: 290000 thousand t_{ep} /an

The biomass potential in Romania consists of:

- Wood waste
- Residues from forestry and firewood
- Agricultural waste

The forest fund occupies 4 billion ha worldwide. Romania ranks 8th in the world with a forest fund of about 6.5 million hectares.

At the level of Gorj county the degree of afforestation is 44%:

- Surface area of the forest fund: 247 thousand ha
- Area of the county: 560 thousand ha

The situation on tree species in Gorj county is:

- Softwood: 70 thousand ha
- Hardwood: 177 thousand ha

The situation regarding the forestry property in Gorj County is:

- Public property administered by Romsilva: 147 thousand ha
- Private property of legal persons: 51 thousand ha
- Private property of physical persons: 46 thousand ha

Of the amount of timber approved for exploitation in Gorj County (720 thousand cubic meters) the amount of wood waste less than 5 cm in diameter is 35 thousand cubic meters.

From the secondary processing of wood material in Gorj County (325 thousand cubic meters) a quantity of sawdust of 46 thousand cubic meters and a quantity of 130 thousand cubic meters of other wastes can be turned into sawdust.

The culture of Miscanthus giganteus, also known as the elephant grass, can grow up to 3.5 m per season and can be exploited for 15-20 years. The annual yield of dry mass per hectare per year is 25 tones. This plant can be used for the production of electrical and thermal power in thermal power plants. The CO_2 emitted during combustion is equal to the amount of CO_2 used by the plant during vegetation and thus there is no greenhouse gas emissions. The minimum

temperature required to enter the vegetation cycle is 6 ^{0} C.
The energy poplar has a short vegetation period with rapid growth. The energy poplar is used to produce biomass and to reduce groundwater pollution.
Energy sludge can leverage land in the slope by fixing the soil and improving its quality. Energy sludge biomass is a neutral carbon fuel and participates in reducing global warming. Production varies between 24-70t/ha in the first 3 years after planting.

2. EXPERIMENTAL RESULTS

Figure 1 shows the steam boiler diagram of a 330 MW energy group.

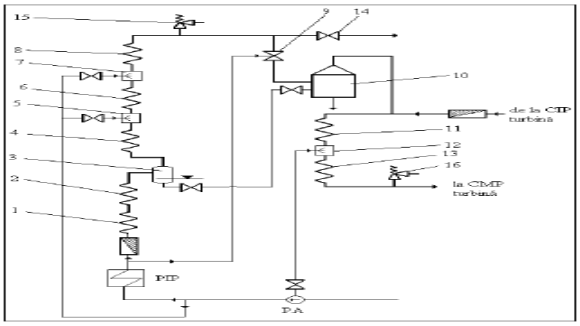

Fig. 1.

Table 1

No	Wooden material	Heat power (Kcal/Kg)	Combustion temperature in boiler furnace (^{0} C)
1.	Hard essence with humidity 25%	3210	1390 (excess air 1,5)
2.	Hard essence with humidity 35%	2780	1170 (excess air 1,8)
3.	Hard essence with humidity 55%	1930	1040 (excess air 1,8)

Table 1 presents the technical characteristics for combustion of wood waste in the boiler core.
Table 2 shows the calorific values for biomass types that can be used to produce electricity.

Table 2

No	Biomass type	Heat power (Kcal/Kg)
1.	Miscanthus	3900
2.	Energy sluice	4900
3.	Power Plop	4900
4.	Grain straw	3700

1 kg of energy willow or energy poplar is equivalent to 2.5 kg of coal.
1 kg of Miscanthus is equivalent to 2 kg of coal.
1 kg of grain straw is equivalent to 2 kg of coal.
Table 3 shows the initial ash deformation temperature for biomass burning.

Table 3

No	Biomass type	Initial ash deformation temperature (^{0} C)
1.	Miscanthus	960
2.	Energy willow	1070
3.	Power poplar	730 - 1000

The percentage of biomass introduced into the boiler is 10%, representing about 21 t/h of biomass.
The coal dust preparation system at the 1035 t / h boiler is made up of 6 hammer fan mills.

In the coal mills, combustion gases are introduced with a temperature of about 850^o C for the coal drying.
The used boilers are with slots.
Table 4 shows the biomass combustion possibilities with coal dust for the 330 MW steam generator. The possibilities of changes in the steam boiler installation are also presented.

Table 4

No	Biomass input mode	Installation changes
1.	In the air channels beneath the coal burners	No
2.	In coal burners	Yes
3.	In additional biomass burners	Yes

The biomass plant in the plant contains:
- Biomass storage
- Biomass processing system
- Insertion system in the steam boiler

The biomass storage contains:
- Concrete platform
- Automobile ramps for biomass unloading
- Forklifts for stacking and stacking of the baits
- Bundle conveyor belt to de-dusting cyclone
- De-dusting cyclone
- Air blowers

The biomass processing system contains:
- Concrete platform
- Biomass transport strips
- Machine for baits disruption
- Biomass chopping system
- Biomass drying system
- Mills for biomass milling
- Boiler biomass pneumatic transport system

The biomass introduction system in the steam boiler contains:
- Stands for pneumatic transport of biomass

3. CONCLUSIONS

Replacing a quantity of coal with biomass contributes to reducing the pollutant emissions of the steam boiler because:
- biomass has lower emission factors than coal
- biomass has higher calorific value than coal
- replacing coal with biomass has the effect of reducing CO_2 emissions into the atmosphere
- the biomass dust collected during the transport and grinding process is introduced into the biomass combustion circuit.

By burning 1 kg of biomass (Miscanthus, energy willow, grain straw) a volume of combustion gases of 6 Nmc is produced.
Table 5 shows the pollutant emission values for combined combustion of coal and biomass.
It is noticed that the values of emissions decrease in the case of combined combustion of coal and biomass. Emissions of dust fall within the limits allowed by environmental legislation.

Table 5

No.	Pollutant	Emissions of coal without biomass (mg/Nm^3)	Emissions of coal burning with biomass (mg/Nm^3)	Maximum admissible values (mg/Nm^3)
1.	SO_2	380	374	200
2.	NO_x	470	462	200
3.	Dusts	18,2	13	20

REFERENCES

[1] Schiopu Emil Catalin**;** Popescu Luminita Georgeta; Popa Roxana Gabriela, *DETERMINATION OF POWDER IMISSIONS DEPOSITED FROM ROVINARI AREA WHICH COME FROM THE ACTIVITIES OF DEPOSING THE COAL AND PREVENTION MEASURE***,** 14th International Multidisciplinary Scientific Geoconference, ISBN: 978-619-7105-17-9, ISSN: 1314-2704, 2014.

[2] Popescu, C. Racoceanu, C., *Improve the efficiency of power plants under environmental protection*, Publishing House Sitech, 2006.

[3] Racoceanu C., Popescu C., *Assessment of pollutant emissions from burning of lignite in power CTE*, Publishing House Sitech, Craiova, 2006.

[4] Annex 6, Technical Documentation on ash generation and storage at the Turceni Energy Complex, project LIFE+ Environment Policy and Governance 2010, Life 10/ENV/RO/729 - New building materials by eco-sustainable recycling of industrial wastes.

[5] HG1535/2003

[6] Racoceanu Cristinel**,** Hațiegan Cornel, *POLLUTION EMISSIONS RESULTING FROM COAL BURNING,* Annals of the „Constantin Brancusi" University of Targu Jiu, Engineering Series, No. 1/2018, pag. 57 -61 , ISSN 1842 – 4856.

[7] Racoceanu Cristinel, *ENERGY BALANCE MEASUREMENTS FOR AUXILIARY INSTALLATIONS OF LARGE POWER ENERGY GROUPS,* Annals of the „Constantin Brancusi" University of Targu Jiu, Engineering Series, No. 2/2017, pag. 27 -31 , ISSN 1842 – 4856.

[8] Anghelescu Lucica, Cazalbaşu Ramona, Abagiu Traian, *Using the power plant ash as raw material in the manufacture of construction lightweight concretes,* Proceedings of the International Conference "Sustainable Energy Use and Management", Academica Brancusi Publishing House, Târgu-Jiu, Romania, ISBN: 978-973-144-647-9, pag. 226-232, 20 mai 2014.

[9] Popescu Cristinel - *Aspects regarding the diagnostication of the medium voltage afferent to the collector bars of the power supply system of own service consumers of an energy group with the power of 330 MW*. Annals of the „Constantin Brâncuși University of Târgu Jiu, Engineering Series, No. 2/2017,pp.92-95.

[10] Penka Zlateva, Adriana Foanene - *Energy conversion efficiencies*, Analele Universitatii „Constantin Brancusi" din Tg Jiu, Seria Inginerie, Nr.2/2017, Tg Jiu, Romania,ISSN 1842-4856, pag.57-62.

[11] Mihai Cruceru, Bruno Valentim, Białecka Barbara, Cristina Freire, Juan Lazaro Martinez[5] Georgeta Predeanu, Nicola Wagner, Claudia Santos, Traian Abagi[1], Lucica Anghelescu, *PRE-CONCENTRATION TECHNIQUES FOR RESIDUAL COAL FROM BOTTOM ASH. PART 1 - METHODOLOGY AND PROCEDURES,* Annals of the „Constantin Brancusi" University of Targu Jiu, Engineering Series, No. 2/2017, ISSN 1842 – 4856.

[12] Mihai Cruceru, Bruno Valentim, Lucica Anghelescu, Białecka Barbara, Cristina Freire, Juan Lazaro Martinez, Georgeta Predeanu, Nicola Wagner, Claudia Santos, Traian Abagiu, *PRE-CONCENTRATION TECHNIQUES FOR RESIDUAL COAL FROM BOTTOM ASH. PART 2 – RESULTS AND DISCUSSION***,** Annals of the „Constantin Brancusi" University of Targu Jiu, Engineering Series, No. 2/2017, ISSN 1842 – 4856.