

ANALYSIS OF THE ASH QUANTITY DURING BEECH WOOD COMBUSTION¹NESTOROVSKI Lj., ²NACEVSKI M., ¹TRAJKOV P., ¹TRAJANOV Z., ³DANILOVIC M.¹*Ss. Cyril and Methodius University in Skopje, Faculty of Forestry in Skopje, Skopje, Macedonia*²*Ss. Cyril and Methodius University in Skopje, Faculty of Design and Technology of Furniture and Interior in Skopje, Skopje, Macedonia*³*University of Belgrade Faculty of Forestry, Belgrade, Serbia**Corresponding author e-mail address: nestorovski@sf.ukim.edu.mk*

ABSTRACT: The subject of investigation in this paper is the ash residue during combustion of the beech wood that is one of the most common forest species in Republic of Macedonia, and one of the most usable as fire wood in the households. The purpose of this investigation was to establish the amount of ash, as one of the biggest problems during energy production with forest biomass. The material for this investigation is collected from two different regions of the State, in order to eliminate or to emphasise the influence of the stand conditions. The results from the investigation show that during the beech wood combustion the wood is producing less ash than wood with bark, and the bark is producing highest amounts of ash.

Keywords: biomass, ash, residue, alternative energy

1 INTRODUCTION

The availability of energy is becoming a major issue, and the demand for energy is growing every day. Concerning that fact, as well as the fact that the reserves of fossil fuels, such as oil coal and natural gas are limited, the world is turning towards discovering and using alternative, environmentally friendly, and renewable energy resources.

One of these resources is biomass from forests. Wood has been used as energy source since the early days. While in Western Europe the use of firewood decreased in favour of fossil fuels, large parts of the human population in South-Eastern Europe (SEE) still depend on wood as energy source. In the wake of Kyoto Protocol the use of renewable resources for energy production has become a major issue in climate change mitigation (IPCC, 2007). Forest biomass plays a major role in the EU energy action plan (2020), as well as in most national policies in Europe. This interest in increased utilization of forest biomass resources raised questions on the potentials and limitations of forest ecosystems to produce biomass in a sustainable way. The importance of forests as a major source of global biodiversity has become well known during the recent decade. Not only as a source for utilization of wood and other non-wood products, but also for providing a multitude of other ecosystem services and functions.

2 OBJECTIVE OF THE INVESTIGATION

Forests contribute a substantial share of the energetic balance in Republic of Macedonia, where a significant share of the population is heating with firewood or other biomass source (75% of the heating energy is coming from firewood). The analysis of the World Bank predicts that the Balkan region is, or will be very soon, in a position where the energy availability will be restricted due to the lack of investments in the energy sector (World Bank Report, 2004) [6].

The objective of this paper is to estimate the potential residue in the form of ash, during wood combustion for energy purposes, as one of the major obstacles, and main deposition problem, and contribute to a more rational discussion about prospects and problems of forest biomass as a source of energy.

Republic of Macedonia is the south-eastern European developing country with low level of energy resources and lack of capacities for energy production. It has no natural gas and fossil fuel resources, and has limited lignite reserves. Its total annual energy production is around 122.000 TJ, and the total annual energy consumption is around 218.000 TJ. 56% of the needs are covered from domestic sources, and 44% of the needs are satisfied importing expensive energies. The main energy production is from coal (around 70.000 TJ), than from oil (around 40.000 TJ) and Forestry biomass (around 7.000 TJ).

About 85% of the electricity production is concentrated in two lignite fired thermal power plants (TPP), and the rest is covered by the hydro power plants. The system's electricity generating capacity is around 7.500 GW/year [7].

The goal of this investigation is to estimate the quantity of ash residue during wood combustion of Beech (*Fagus moesiaca*), from different parts of the wood, to establish if there is a difference in ash deposit between wood and bark, and emphasize the problem with its deposition or possible usage for other purposes.

3 APPROACH

Forests in Republic of Macedonia are mostly coppice, with low quality and very diverse in species. The first task was to establish two different stands of beech (*Fagus moesiaca*) in the Country, in order to eliminate eventual stand and ecological condition influence on the results. Samples were collected from different parts of the trees (1,3m, 5,3m, branches, bark and small branches) in order to investigate eventual differences in the ash production.

Collected samples were then brought in the laboratory, where the ash deposit in absolute dry condition was established for pure wood, mixed wood and bark and pure bark, and statistically processed.

4 RESULTS**4.1 Ash residue from Mavrovo stand**

There were 34 samples taken from the beech from Mavrovo stand. On 12 of them, the ash residue was analyzed on pure wood (wood without bark), on 14 of them the ash deposit was analyzed on wood with bark (approximately as their percentile share in the wood

volume), and on 8 of them the ash residue was analyzed on pure bark. Results of the analysis show that the most ash residue is produced during the combustion of bark, and the less ash residue is produced during pure wood combustion (Figure 1).

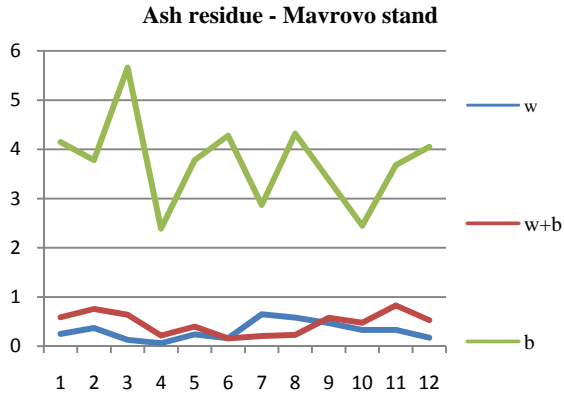


Figure 1: Ash residue from Mavrovo stand

The ash residue from pure wood from Mavrovo stand was in the outskirts between 0,06% and 0,65% of the burned volume, averaging $0,31166 \pm 0,05251$, with standard deviation of $0,181901 \pm 0,03713$ and variation of $0,033088 \pm 0,006754$.

The ash residue from wood and bark from Mavrovo stand was in the outskirts between 0,16% and 0,76%, averaging $0,452857 \pm 0,056641$, with standard deviation of $0,21193 \pm 0,040051$, and variation of $0,044914 \pm 0,008488$.

The ash residue from bark from Mavrovo stand was in the outskirts between 2,39% and 5,66%, averaging $3,90375 \pm 0,34976$, with standard deviation of $0,98927 \pm 0,247318$ and variation of $0,978655 \pm 0,244664$.

4.2 Ash residue from Ohrid stand

There were 21 samples taken from the beech from Ohrid stand. On 8 of them, the ash residue was analyzed on pure wood (wood without bark), on 8 of them the ash deposit was analyzed on wood with bark (approximately as their percentile share in the wood volume), and on 5 of them the ash residue was analyzed on pure bark. Results of the analysis show that the most ash residue is produced during the combustion of bark, and the less ash residue is produced during pure wood combustion (Figure 2).

The ash residue from pure wood from Ohrid stand was in the outskirts between 0,04% and 0,14% of the burned volume, averaging $0,01025 \pm 0,010815$, with standard deviation of $0,030589 \pm 0,007647$ and variation of $0,000936 \pm 0,000234$.

The ash residue from wood and bark from Ohrid stand was in the outskirts between 0,11% and 0,26%, averaging $0,1975 \pm 0,034161$, with standard deviation of $0,096622 \pm 0,024155$, and variation of $0,044914 \pm 0,008488$.

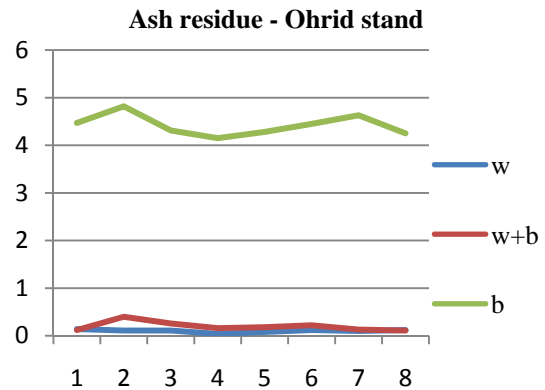


Figure 2: Ash residue from Ohrid stand

The ash residue from bark from Ohrid stand was in the outskirts between 4,15% and 4,82%, averaging $4,406 \pm 0,115352$, with standard deviation of $0,257934 \pm 0,081566$ and variation of $0,06653 \pm 0,021039$.

The results also show that there is no significant statistical difference in ash deposition during combustion of pure wood and wood with bark in both stands and between the stands, but that there is statistically significant difference during bark combustion.

4.3 Ash residue for the beech as species

Since there were no statistically significant differences in ash deposition during combustion of beech wood between the two stands, we will present the average ash deposition for the beech as species (Figure 3).

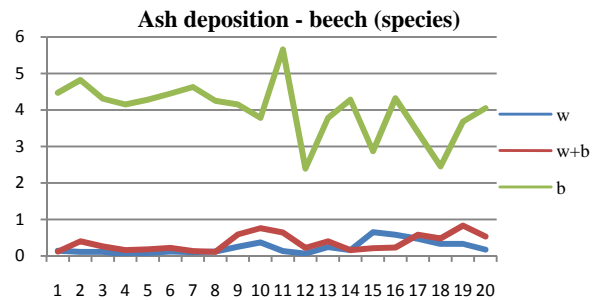


Figure 3: Ash deposition for the beech as species

The average ash residue of pure wood from both stands was in the outskirts between 0,04% and 0,65% of the burned volume, averaging $0,228 \pm 0,03909$, with standard deviation of $0,1748 \pm 0,02764$ and variation of $0,030055 \pm 0,004831$.

The ash residue from wood and bark from both stands was in the outskirts between 0,11% and 0,76%, averaging $0,360 \pm 0,05461$, with standard deviation of $0,2162 \pm 0,03259$, and variation of $0,0467 \pm 0,0070$.

The ash residue from bark from both stands was in the outskirts between 2,39% and 5,66%, averaging $4,0969 \pm 0,2249$, with standard deviation of $0,8110 \pm 0,1591$ and variation of $0,6577 \pm 0,1290$.

As it is presented in the Figure 3, there is no significant statistical difference while burning wood or wood with bark ($T=2,41413$), but there is statistically

significant difference while burning only bark (T=14,886).

5 CONCLUSION

According to the results from this investigation the following conclusions can be drawn:

- There are no statistically significant differences in ash deposition during combustion of beech wood from different stands, so we can conclude that the stand conditions don't influence the amount of ash deposition;
- There are no statistically significant differences in ash deposition while burning wood with or without bark in normal natural ratio.
- There is statistically significant difference while burning only bark, and this condition gave more ash than burning wood.

6 REFERENCES

- [1] Laponche, B., Jamet, B, Colombier, M., Attali, S.: Energy efficiency for a sustainable world, ICE editions, Paris,1997.
- [2] van der Hem,A.B., Hoogsteen, R., Wetzels, F.J.B.: Energy and environment in Macedonian industry, PSO programme, Skopje, 2000.
- [3] Lj. Nestorovski, Comparative Analysis of the energetic potential of forests as an renewable resources and the possibilities for its utilization in Republic of Macedonia, Skopje 2004
- [4] F. Chiani, C. Corradi, L. Perugini, V.Rappuoli, R. Valentini, E.Angelova, Lj. Nestorovski,: Biomass Availability in the Territory of Republic of Macedonia, 2010;
- [5] Nacevski M.,Vasilevski K.: Influence of the age of annual tree ring on the amount of ash from the Black pine (*P. nigra*) wood from artificial stands, Skopje 1993;
- [6] Nacevski M., Nestorovski Lj., Iliev B., Trajanov Z.: Quality analysis of the wood from domestic and foreign tree species, Skopje 2002.
- [7] FYR Macedonia energy policy paper, World Bank, July 23, 2004
- [8] Energy Balance 2009, Ministry of economy, 2009
- [9] Second National Communication of R Macedonia under UNFCCC, 2008

