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Spoil Heaps - Influence of Ash and Bulk Weight

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Abstract: Lignite surface mining is, and for a long time will remain, one of the important energy sources within Czech economy. This fact is supported also by the worldwide trend of increase of prices for all fossil fuels, including the prices for oil-based products. However, this mining entails an extensive devastation of the landscape, with significantly negative environmental impacts. Landscape changes consisting of formation of completely new elements, the spoil heaps, is taking place. Forest re-cultivation are one of the renewal methods, which might, in relatively short time, restore the basic functions of the forming ecosystems.

This paper deals with the quality analysis of birch chip obtained in the area of Northern Bohemia (the quarry Lom Barbora). Indices of the quality of the birch chip obtained in this area were the chip ashes content and bulk weight. Based on the experiments, we found the ashes percentage in the birch chip equal to 0.307% and its average bulk weight equal to 352.64 $kg.m^{-3}$.

Keywords: ashes content, bulk weight, spoil heaps, wood chip

INTRODUCTION

The direct re-cultivation of spoil heap substrates is the most usual alternative within the circumstances of Northern Bohemia lignite basin. While re-cultivating heavier spoil materials (sand-loam clay, loam clay, dusty clay), pelic anthropogenic earth is created. In case of lighter materials (sand, caly sand) re-cultivation, also sandy anthropogenic earth is created (Čermák and Ondráček 2006).

The wood species selection shall be carried out after a careful analysis of the location conditions, mainly of the pedologic conditions, based on the environmental requirements for the individual wood species. Due to the heterogenous environment of the spoil heaps (substrates from sandy to heavy loams, tilt and angle of the individual surfaces), no universal scheme can be set up for the range of wood species for the re-cultivation.

The main item of the vegetation is an economically valuable wood species, which is planted in groups. There, such species is completed with suitable range of auxiliary and improving wood species, which participate on the forest soil creation, on target wood species support and are creating long-term vegetation frame (Štýs 1996). While planning the species range for the spoil heaps to be re-cultivated by afforesting, it is necessary to take into account, in first order, the achieving of the defined re-cultivation goals. So, the wood species classification from the point of view of their functionality is important.

Currently, several processes are used for the transformation of biomass to products suitable as energy sources. Each of these processes is specific as far as both its product and the input form of the biomass to be transformed concerns, because the individual processes are applicable only for certain biomass types due to the non-rentability or absolute inappropriateness (Pastorek 2004).

The area of the currently formed spoil heaps located next to Oldřichov village, 5 km W from the town Teplice in Northern Bohemia (originally Barbora lignite mine) is exploited mainly for recreational purposes. The recreational function of the greenery is primary while the wood mass utilization is explicitly secondary issue. The slopes around the water area were afforested with wood species participating in the formation of the recreational environment. One of the wood species in these spoil heaps is the silver birch (Betula pendula). The competing tree species supersede the silver birch, pushing it out to humid or dry acid soil with low content of nutrients, often even pushing it out to the sand. Silver birch prefers light soils. It is frost-resistant (Požgaj et.al. 1997, Gaff 2009, Gaff et.al. 2010). As it seldom grows into dimensions suitable for more valuable processing, the birch wood is marketed mostly as a fibrous wood for both cellulose processing and paper-mill industry. It is sold also as fuel wood.

EXPERIMENTAL

MATERIALS

Wood chip of silver birch (Betula pendula) from Northern Bohemia (area of the former Barbora lignite mine, the quarry Lom Barbora) was utilized for the experiment.

The samples were obtained from branches and from the tree top. They were laid in snow pit inside an impermeable packing (thick-wall PE bag). The wood chip was made using the Linddana chipper TP 160 FTO on third day after the sampling.

The chip samples were laid twice in thick-wall plastic bags and marked with the sample No. and sample name. Afterwards, the samples were transported to labs, where the required experiments were carried out.

METHODOLOGY

We opted to find out the following parameters on the wood mass obtained from the former lignite mine Barbora:

- ***Ashes content***, as the ashes constitute one of the three fuel basic components. The term “ashes“ include the solid unburnt residue of the fuel, which is formed throughout the combustion process. It is a result of reaction of minerals with oxygen. It is composed mostly from the oxides based on the minerals contained in the biomass (K_2O, Na_2O, CaO, MgO, Fe_2O_3, Al_2O_3, SiO_2, P_2O_5). Generally, the ashes content in biomass fuels is much lower than in another types of fuel. This is a guarantee of lower solid particles content in the flue gas. The ashes content in biofuels depends on the proper chemical structure of the biomass individual types as well as on the contamination (by ash-generating elements) of soil, where the biomass was nutrified from while growing. Again, the increased ashes content in biofuels is adverse to their calorific value as it is just the non-burnable residue without energy utility. Moreover, there is further problem related to the ashes, which affects the combustion process: the ash clinkering (sintering) inside the combustion equipment under higher temperatures (Pepich 2010).

- ***Bulk weight***, which defines the loose biomass weight, which occupies the given rated volume. It depends on the poured material, biomass type, moisture, grains size, pouring method, etc. Like the density, this parameter is important for the material transportation. Moreover, the bulk weight is more indicative as far as the energy point of view concerns, becaus based thereon, it is possible to define the fuel quantity, which can be introduced into a combustion chamber with limited capacity. This quantity also depends on the fuel introduction method. Most usually, the fuel is added by loose pouring (Kyjovský 2007).

In order to ***determine the ashes content***, samples of absolutely dry fuel weighing 10 g each were prepared. The annealing dish used to spread the ash thereon was weighed on Radwag scales WPS 510 C both before and after the spreading. The annealing dish was introduced in muffle oven, where the temperature was increased to 500 °C during 60 minutes and held for another 30 minutes. Thereafter, the annealing continued by rising the temperature to 815 ± 10 °C during 60 minutes. Once achieved, this temperature is held for 360 minutes. When the annealing is finished, the dish is removed from the oven and cooled slowly on non-flammable pad. After the cooling, the annealingb dish with the ash is weighed on a scale with 0.001 mg accuracy. The ashes content in the fuel (Ad) for the analysed sample is expressed in mass percentage.

$$\text{Ad} = \frac{m_3 - m_p}{m_2 - m_l} * 100\ (\%) \qquad (1)$$

In order to determine the second parameter (***bulk weight***), five samples have to be prepared. The analysis begins with weighing of empty vessel (m_1) and the determination of volumes to be used (in our case, 51 ± 0.1 liters). Birch chip is poured into the vessel. The maximum cone shall be formed on the top. The full vessel shall be exposed to two impacts in order to induce the settlement of the chip loose particles. The impacts are carried out by the mean of free fall from the height of 150 mm to wooden plate. Subsequently, the created empty rooms in the vessel are filled. An excessive material on the top of the vessel is removed by the mean of balk whose oscillating movement created a level at the vessel top edge. Full vessel mass (m_2) is determined by weighing, and the bulk weight is expressed thereafter:

$$M_{sh} = \frac{m_2 - m_1}{V} \quad (\text{kg.m}^{-3}) \qquad (2)$$

RESULTS

See the Table 1 for the fuel ashes content *Ad* in the analyzed birch sample, expressed in mass percentage.

Table 1 Ashes content

Sample No.	Sample dish mass m_1 [g]	Mass of sample dish plus sample m_2 [g]	Sample mass m_L [g]	Mass of sample dish plus ash m_3 [g]	Ash mass m_p [g]	Ad [%]
1	61.404	76.372	14.968	61.443	0.039	0.261
2	56.792	71.259	14.467	56.843	0.051	0.353
Ashes content average value						**0.307**

The analysis has proven the ashes content in the analyzed sample equal to 0.307 ± 0.322%. This value is in conformity with the average results of another authors.

Table 2 describes the bulk weight of the analyzed birch chip.

Table 2 Bulk weight of birch chip

Sample No.	Sample vessel mass M_1 [g]	Mass of sample vessel plus sample M_2 [g]	Sample mass M_{vz} [g]	Vessel capacity V [dm^3]	Bulk weight M_{sh} [$kg.m^{-3}$]
1	187	2325	2138	6.25	342.08
2	187	2395	2208	6.25	353.28
3	187	2385	2198	6.25	351.68
4	187	2445	2258	6.25	361.28
5	187	2405	2218	6.25	354.88
Bulk weight average value					**352.64**

The evaluation resulting value is 352.640 ± 4.34 $kg.m^{-3}$. Taking into account the sample is of hard frondose wood species, the found value corresponds to the upper limit of typical variance.

CONCLUSION

The wood importance is increasing also due to its utilization for energy-related purposes. The facts have proven that the economic growth is not antagonistic with the environment conservation. All the contrary, there is a conviction that new economy will consist on the environment protection, on new relations between the business and the environment, which are compatible with the ecology. This is supported by efficient legislation, which introduces air quality standards in order to prevent global negative environmental changes.

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Streszczenie: *Hałdy ze zrębków brzozowych – wpływ zawartości popiołu oraz masy.* Niniejsza praca dotyczy analizy jakości zrębek brzozy uzyskanych w obszarze północnych Czech (kamieniołomu Lom Barbora). Wskaźnikami jakości zrębek brzozy uzyskanych w tym obszarze były zawartość popiołu i masa. Opierając się na doświadczeniach, wyznaczono zawartość popiołów w zrębkach brzozy równą 0,307% i jego średnią gęstość nasypową równą 352.64 kg.m-3.