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Storage Characteristics of Wood Chips in Stacks

Since firewood is harvested and used at different times, storing larger amounts of wood chips becomes mandatory. Storage in buildings would result in high storage costs. The investigations presented indicate that the quality of the stored material is considerably affected by temperature development and by the drying progress in the bulk store. Coarsely chopped wood chips (> 80 mm edge length) reduce dry matter losses and mould formation.

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Keywords

Storage, wood chips, dry mass losses

The contribution of biomass for power supply in Europe rose according to data of the International Energy Agency (IEA) in the last years from 45 to 50.2 million t crude oil units. This means an increase by 1.1 million units per year. In the coming years annually 8 million t biomass for the energy market must be made available, so that for the period of 2000 to 2010 the aimed increase of biomass is reached up to 135 million t crude oil units [1]. The increasing need of biomass for heating and power generation will accelerate the cultivation of energy crops. In particular energy cultures with a duration of several years such as poplars and willows have advantages, due to comparatively small production costs, low emissions during cultivation and energy conversion and a high accumulation ability of heavy metal. Additionally proven emission-minimized burning technologies are available for the fuel wood. However enforcing breeding and the development of economical and more reliable technologies for the harvest and storage of the wood are necessary as well as for field recultivation of the area surfaces [2].

To attain the necessary scientific-technologic advance in the field of energy wood storage for biomass power stations, experimental investigations for the selection of a suitable storage procedure were carried out in Mecklenburg-Western Pomerania.

Material and methods

The storage of wood chips took place outdoors on a concreted surface. The harvested crop was tipped by a transport vehicle and pushed together and stacked by tractors with front shovel to stacks. In one part of the stack (*Table 1*) a potato ventilation technology still available was used.

Although with use of axial blowers in wood chip stacks, as a result of high pressure loss, the air perfusion and thus the drying success was expected to be small, this technique was applied to prevent a strong self-heating of the stacks.

Important investigation questions were
- the self-heating of the wood chips in the stacks
- the drying process and drying success
- the dry matter losses and
- the growth of fungi.

Experiment results

The quality of the stored material is determined considerably by the temperature development in the stack and the drying success. *Figure 1* shows the temperature gradient in the stacks, which were equipped with temperature measuring technique after the DATA-Logger-system.

The result is typical for the storage of finely chopped, moist biogenous materials and corresponds with results from literature as well as with other own storage investigations with wood chips. The rapid heating shortly after storing is caused by the aerobic metabolic processes of micro-organisms on the stack particles and on living plant cells. At first all mesophilic organisms are usually active with rising temperatures, which are replaced with further temperature rising by thermophilic organisms. The heating process at the high level persists for about 4 to 6 weeks and decreases thereafter likewise relatively rapidly to a level somewhat above

Table 1: Description of tested wood chip stacks

Stack	Date of storage	Date of taking out	Stored amount [t] Poplars	Stored amount [t] Willows	Ventilation ducted ventilat.
1	3. 2. 2000	22. 6. 2000	109		yes
2	3. 2. 2000	22. 6. 2000	106		yes
3	9. 2. 2000	22. 6. 2000		77	no
4	9. 2. 2000	22. 6. 2000		46	no

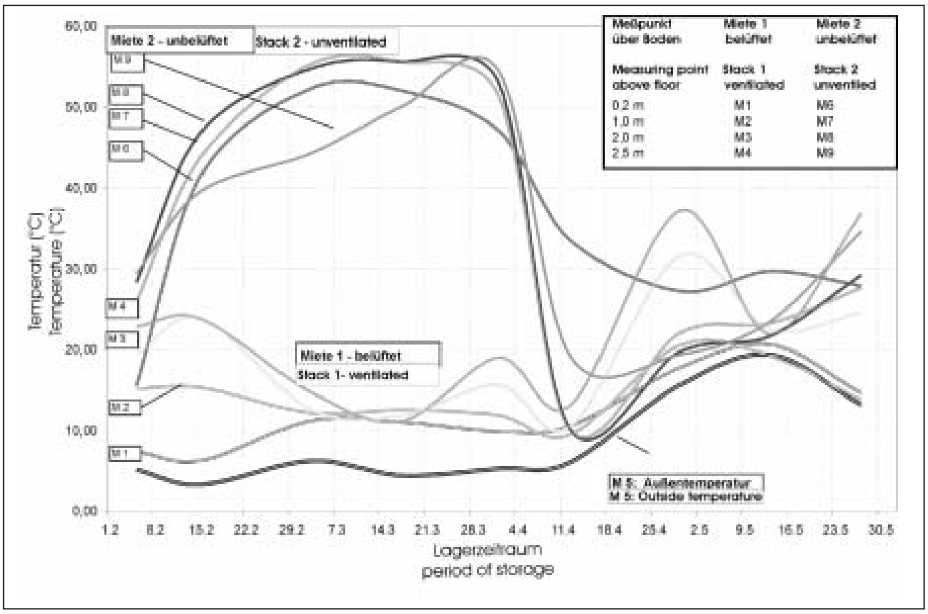

Fig. 1: Temperature pattern of wood chip stacks (stack 1 ventilated, stack 2 unventilated)

the ambient temperature. The cause for the temperature decrease is caused from the thermophilic organisms, which die-off at temperatures around 60 °C. A strong self-heating could be avoided by a forced ventilation in stack 1. As evident from *Table 2*, a certain drying process of the wood chips during the storage took place, too.

The success of drying in the stack without ventilation system is caused particularly by self-heating. Thereby a free convection current develops in the stack body, because of varying densities between the air in the wood chip stack and the ambient air. However, by the fine structure of the wood chips this process was strongly slowed down and so was the drying success small, too. In the ventilated stack a drying process took place, if the supplied ambient air had an appropriate drying potential. These conditions prevail usually outside of the winter months from April on. As the high current resistance, only a low current rate through the stack and only a small drying process could be obtained. The residual water content of w ≤ 35 % w.b. required by the power station was not achieved after the process step of preliminary drying. In both cases (with and without ventilation system) the water residual content (w) was about from 44 to 46 % w.b.

Afterwards there are spaces mainly at the bottom of the stack and underneath the surface (sweating head), where no drying process took place and even during the storage, the material became more moist. In the ventilated stack there was no substantially different result, which shows that in the case of ventilation channels - located in the center at the bottom of the stack - the applied axial air fans were hardly suitable for the drying of fine wood chips. As evident from *Table 2* likewise, high dry matter losses up to 30 % appeared during storage of the wood chips. These are due to the intensive microbial activity both of bacterial and of fungicideal organisms, which is comparable with the biological mineralising process of a rot. A significant difference between ventilated and not-ventilated stacks was not constituted thereby.

Conclusion

The wood chips (length 25 to 30 mm), which were stored outdoors in stacks heated up due to micro-biological activities in the stack very rapidly to approximately 50 to 60 °C. The high temperature level lasted for approximately 4 to 6 weeks and decreased after that relatively rapidly again to a somewhat higher value than the ambient temperature. The storage was accompanied by high dry substance losses. In about four and a half month of storage there was a dry substance loss between 20 and 30 %. The losses are comparable with the dry matter dismantling in the biological mineralizing process. In addition a strong fungus growth could be observed in the stacks. The drying success was relatively small with a water content lowering from 56,60 % w.b. (at beginning of the storage) to 43 to 46 % w.b. at removal from the stack. The residual water content of w≤ 35 % w.b., required by the power station could not be attained in one stack. Between the stacks with forced ventilation system and the no-ventilated stacks there were no significant differences concerning the drying success and the storage quality. However the applied axial air flow fans were hardly effective due to the high current resistance of the finely chopped wood chips.

It is not necessary to equip the stacks with forced ventilation because the danger of the self-ignition of the stacks can be almost excluded.

In a future procedure of the harvest and supply of fast-growing tree species in short rotation coarse wood chips with an edge length ≥ 80 mm should be processed by the harvest technology. Such wood chips are to be stored outdoors the sky in stacks without problems and a loss of quality.

By applying waste heat of a power station for secondary drying the quality of the wood chips could be improved for the following burning by an increase of the heat value.

Table 2: Drying result and dry matter loss during storage of wood chips

Stack	Wood Type	w_a [%]	w_e [%]	∆w [%]	∆DM [%]
1^1 (ventilated)	Poplars	56.57	44,55	-12.02	-30.31
2^1 (unventilated)	Poplars	56.57	43,46	-13.11	-20.62
3^2 (ventilated)	Willows	56.66	46,71	-9.95	-20.36

^{1} Storage date 3. 2. 2000 Removal date 22. 6. 2000
^{2} Storage date 9. 2. 2000 Removal date 22. 6. 2000
w_a = Water content before drying w_e = Water content after drying

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