Mineral and moisture extraction by mechanical dehydration of ensiled Miscanthus in the energy-from-wet-biomass chain

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Introduction

The moisture content at which herbaceous biomass crops, used for energy production, are harvested can vary between 10% and 80%, depending on local conditions and harvest time. Low moisture contents can be reached in winter or spring time when delayed harvest systems are applied. During the drying period minerals are transported to the root system and dry matter is lost by leaves and stem parts which fall on the ground from where they can be recovered only partly. During collecting the biomass becomes polluted by sand or clay. So early harvest combines higher yields, higher mineral contents, lower moisture contents and lower harvest costs because of a longer available harvest period. The high moisture content gives low efficiency at conversion and higher transport costs. The high mineral content, especially for nitrogen, chlorine, potassium and sulphur, gives lower ash melting point as well as high corrosion and emissions.

Conservation of the high moisture content biomass can be done by drying the material or ensiling (by anaerobic sealing). Ensiling has many advantages: no weather risks, simple logistics (long harvest period, storage close to the harvest site and no long distance transport concentrated at harvest time), low energy costs (no drying) and low dry matter loss. [1] A large part of the moisture, including minerals, can be removed by mechanical dehydration just before or after transport of the biomass to the conversion plant. When done before, the liquid can be collected and applied for agricultural use without much transport. The liquid contains extracted minerals and organic acids from ensiling. It can be recycled to the fields as liquid manure. If it is mixed with animal manure the ammonia emission will be decreased at application. The density of the product will also be higher after expression, in this way reducing the transport costs.

The biomass can be both produced at a farm (Miscanthus, reed canary grass, switchgrass, triticale canola, hemp, etc) and gathered in nature (wetlands, protected nature area and road side vegetation). When crops like winter barley, winter rye, and winter canola are harvested just before maturity (no field drying) a second crop like corn, sunflower and hemp can be planted, harvested in wet condition and ensiled on the same field [2]. Miscanthus and grass can also be ensiled easily [3]. Many materials can be harvested, stored and pre-processed in this way for energy production. In order to quantify the advantages and disadvantages in such production chains data are needed of the various crops harvested at various harvest moments. As a part of a research program on Miscanthus these measurements were performed in 1999 in The Netherlands.

Objective

Objective of the research was to quantify the relationship between mechanical expression of moisture and minerals and the required pressure, using two compression systems, at two harvest moments of Miscanthus.

Method

Miscanthus was chopped and sealed in bales wrapped in plastic as well as sealed in 30 litre containers in November 1997 and January 1998. Samples were taken in March 1999 and expressed (in two repetitions) by means of a piston press with a perforated press chamber at the pressure range of 0 to 60 bar in 5 steps. Also a screw press was applied. The content of moisture, N, P, K and Cl was determined before and after dehydration. The moisture and mineral contents of the same crop harvested in November, January, February and March were also determined

Results
Results with the Miscanthus harvested in November showed that the moisture content decreased roughly linearly from 55% to 45% using the piston press at a pressure increasing from 0 to 60 bar. With the screw press a moisture content of 37 % was reached. This means that with the piston press at 60 bar 35% and with the screw press 44% of the original moisture was removed. Together with the moisture also 35% of the original N and P, 47% of the K and 56% of the Cl was removed when using the piston press. The screw press removed 35% N, 44% P, 56%K and 62% Cl of the original amount.

Since the moisture content in January was 38%, only 8% of the original moisture could be removed. Even then about 10-13% of the original minerals were removed. No experiments with the screw press could be done with this material.

The change of contents as a result of the harvest time from November through March is given in table 1. The results show that in that specific year the dry matter content increases foremost from November till February. During the same period there is the major decrease in content (in % of weight) of N, P and K, while the decrease of Cl is very small.

Table 1. The content (in % of weight) of several minerals and dry matter of Miscanthus as harvested in different months of 1997 - 1998.

Material / Month	November	January	February	March
N	0.44	0.46	0.26	0.26
P	0.07	0.06	0.04	0.04
K	1.14	1.19	0.95	0.79
Cl	0.70	0.67	0.75	0.61
Dry matter	41.9	64.4	85.2	81.8

Conclusion
It can be concluded that a high portion of the original moisture and about the same portion of N and P can be removed while even higher contents of K and Cl are removed. These last two minerals were even removed to a larger extent as the decrease in the field from November to March. The moisture content reached makes conversion in some type of gassifiers possible.

References
[1] W. Huisman
Harvesting and Storage of Perennial Rhizamatous Grasses.
Proceedings of the 1st World Conference and Exhibition on Biomass for Energy and Industry, June5-9, 2000, Sevilla, Spain. In press

[2] Stülpnagel R, Heinz A, Kaltschmitt M, Scheffer K. Annual crops from agriculture for energy generation; Comparison of different provision chains with respect to environmental and economic aspects. Proceedings of the 1st World Conference and Exhibition on Biomass for Energy and Industry, June5-9, 2000, Sevilla, Spain. In press

[3] Huisman W. and W.J. Kortleve
Mechanisation of crop establishment, harvest and post harvest conservation of Miscanthus Sinensis Giganteus.
Industrial crops and products, 2, 1994 289-297.