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Foliage compression

Every autumn large amounts of fallen leaves have to be collected from parks, roads and private and public areas. From parks in the city of Brunswick alone this „harvest“ represents ~ 400 t per year. To reduce transport effort and make the whole system from collection to transporting the leaves more efficient, a test stand for foliage compaction went into operation last autumn at the Institute for Agricultural Machinery and Fluid Technology. With the help of this stand, which works according to the radial pressure baling principle, characteristic parameters were determined for foliage compression.

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Keywords

Compaction technology, foliage

Leaf collection machinery used so far in community work are small, lightweight and manoeuvrable so that they can work around obstacles efficiently and cause as little ground compaction as possible. These machines have limited uptake capacity however so that they have to be emptied relatively often at an intermediate dump. This is not only uneconomical but also leads to excess driving over the ground which can increase compaction. More compacted loads of leaves would have a positive effect in both cases.

The machinery for this aim should still be small, lightweight and manoeuvrable produced either as pulled or mounted models with power source the existing community tractors. Noise level should be low.

Test stand

Since autumn 2001 a stationary test stand for compression of leaves into round bales has existed at the Institute. The radial pressure compression baling principle was selected for compressing the collected leaves. Compared with the normal pressure baling system this gave a smoother action and produced lower power demand peaks. The baler has a top loading fixed chamber (*fig. 1*). The bale chamber features an endless surrounding belt to avoid broken leaf loss during operation. Even at the beginning of the baling process this has a round form with 40 cm diameter and 60 cm breadth. This small size was deliberately selected so that the amount of leaves required for the trials could be kept low. Leaves are delivered into the baler over a conveyor belt with infinitely variable speed adjustment. Through variation of the leaf depth on the belt and its speed different throughputs can be achieved.

Following a very fast start to the rotation of the introduced leaves the bale thus formed is compressed through addition of further leaves. The process depends on a forced intake of the leaves into the chamber and this is achieved by the revolving belting.

During the tests the power requirement and speed were measured by a torque measurement boss und rpm sensor respectively. Additionally, the forces acting on the ejection flap was measured at both bale chamber sides via expansion measuring strips integrated in the closing mechanism. The speed

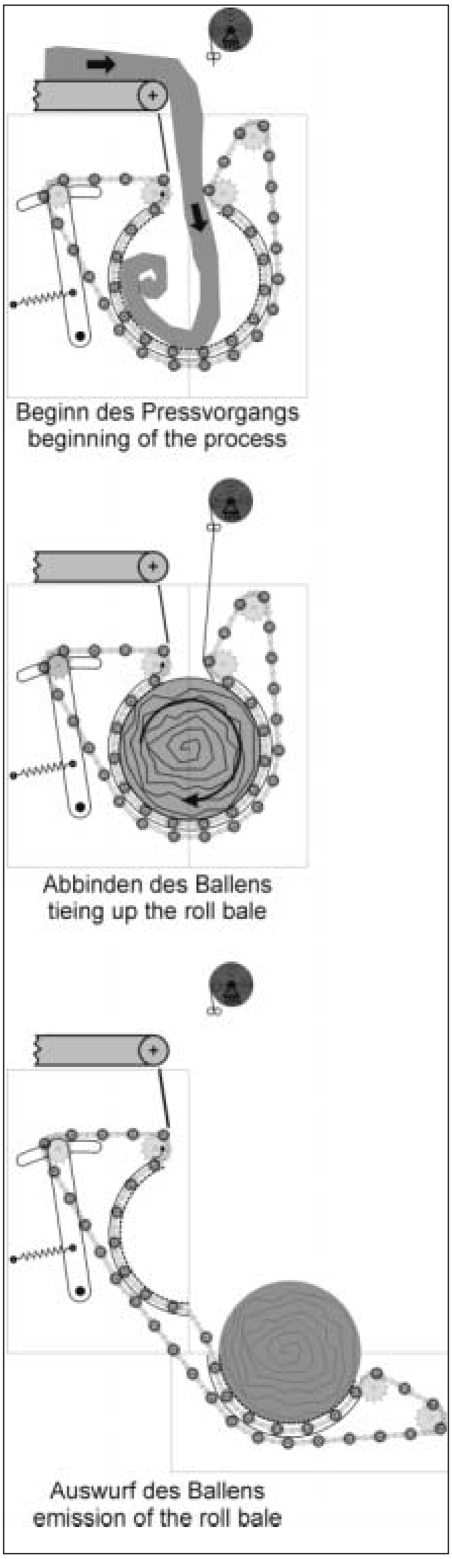

Fig. 1: Sketch of the press chamber

of the revolving belt is steplessly adjustable. Leaf moisture content was determined in a drying oven. At the end of each trial the bale was weighed for determining density.

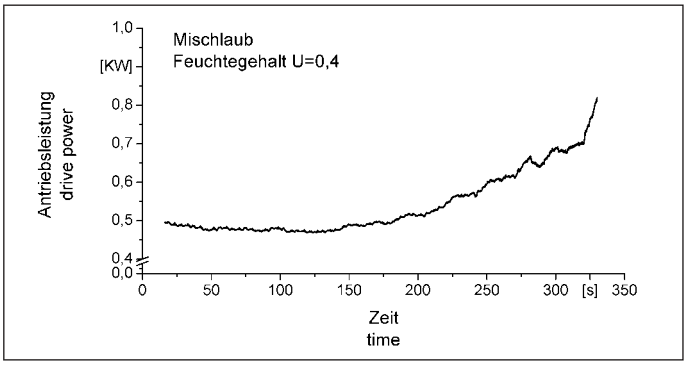

Fig. 3: Flow of drive power during one compaction process

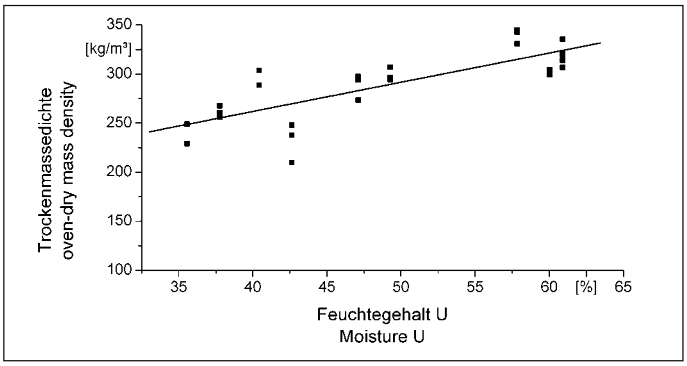

Fig. 4: Dry matter density of mixed foliage round bales at different moisture contents

Results

First trials with the above described leaf baler were carried out in autumn 2001. Different types of leaves of various moisture contents were baled. The leaf intake functioned well and a perfect bale start was possible with wet or with dry leaves. The structured surface of the belts running in the bale chamber pulled the material into the chamber perfectly without blockages occurring in the intake funnel. The bales could be kept in rotation under all conditions during the entire compaction process. Figure 2 illustrates a bale of dry beech leaves.

This had a weight of 35 kg, a moisture content of U=0.3 and a volume of 0.09 m^3. The resulting density was 390 kg/m^3 with a dry matter density of 273 kg/m^3. With this moisture content 35 kg of uncompressed foliage would have an approximate density of 30 kg/m^3. Trials so far have featured leaves from chestnut, maple, beech and a mixture of different kinds. In *figures 3 and 4* the results from the trials with mixed leaves are presented. *Figure 3* shows the power requirement of the baler during a trial with mixed foliage with U=0.4 moisture content. Clearly shown is that the power requirement stays approximately the same for a long period and then substantially rises at the end of the baling process. In comparison to the maximum requirement at the end of the process, the baler had a relatively large idling power requirement. This high value was due to the construction of the implement and has been reduced for 2002.

Figure 4 shows the dry matter density of mixed foliage bales with different moisture contents. It can clearly be seen that the dry matter density rises with increasing moisture content. This means that the higher the moisture content of the leaves the more leaves can be pressed into the compressed bale. There are two possible reasons for this. One is that the bending resistance of leaves changes with different moisture content so that leaves can present more resistance or less to the process. The second ground has to do with the way in which the bale making process is completed in the chamber. In the trials the baling process was always stopped at a predetermined power requirement, not by the usual method which reacts to the pressure on the rear flap. Because of technical and constructive grounds it was not possible to fit the latter system on the test stand last year. Power demand was not only from the baling action but, very importantly, stemmed from requirements to overcome friction of the bale on the solid side walls of the chamber. This friction also changed in line with the moisture content of the leaves in the chamber. This meant that the higher dry matter density with higher moisture content could be through reduced bending resistance of the foliage or through less frictional resistance of the bales against the chamber side walls, or a mix of both.

Outlook

A stop in the bale formation with the leaf baler reconstructed for autumn 2002 will be through the conventional method of predetermined pressure on the rear flap. Additionally the baler will be will be extended to include a possibility of measuring the sidewall friction. Thus it will be possible to better evaluate the process during the baling action and to order individual effects to their respective causes. Further reflections within the framework of the foliage compaction project include finding possibilities for the integration of the developed leaf baler into the leaf collection operation Thoughts are also being given to suitable binding material for the bales with regard to later composting or use in energy production.

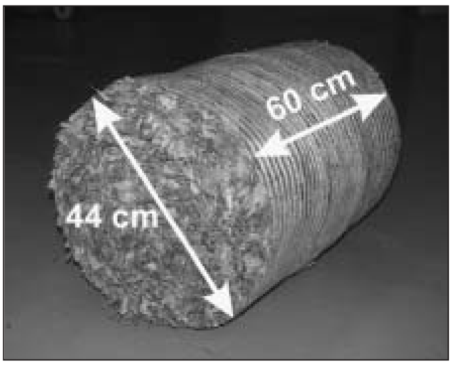

Fig. 2: Beech foliage compacted into a round bale