Böttinger, Stefan and Timofeev, Andrey

Conveying and pre-separation on the grain pan of combine harvesters

The grain pan of combine harvesters has to ensure under all working and harvesting conditions a reliable conveying of the grain mixture to the cleaning unit. Additionally, a pre-separation of the grain mixture on the oscillating conveyor will help making the cleaning easier. On a recently developed test rig the influences of the geometrical and kinematical parameters on conveying and pre-separation can be examined.

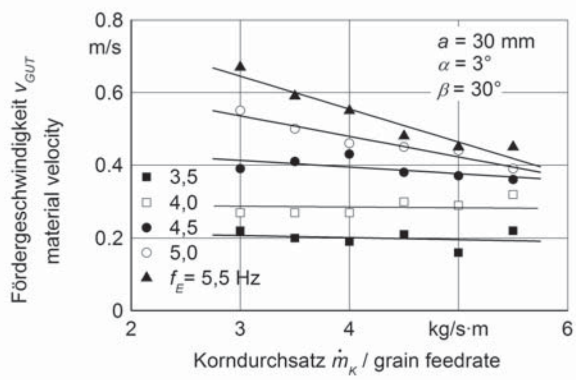
Keywords
Combine harvester, grain pan, separation

Abstract
Landtechnik 65 (2010), no. 5, pp. 380-382, 5 figures, 1 reference

In combine harvesters a mixture of grain and MOG (material other then grain) is separated by the threshing and separation system. The grain pan conveys this material to the cleaning unit. This process of the oscillating conveyor has to occur reliable under all harvest and working conditions. Additionally, a pre-separation of the material has to relieve the cleaning unit also at high throughputs and with bigger portions of MOG by rotating separation systems. At the already in detail presented test rig the geometrical and kinematical parameters of a grain pan can be varied in a wide range and the influence on the conveying and the pre-separation can be examined [1].

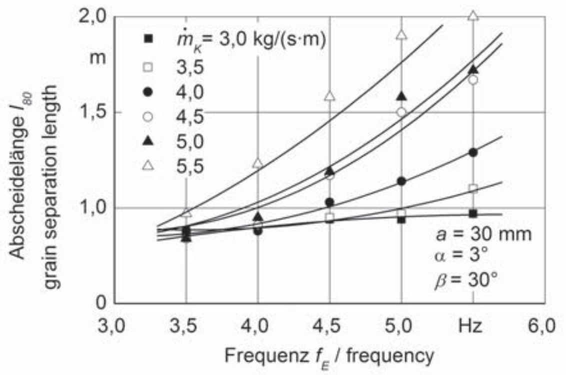
High-speed video recordings of the tests enable to analyse the motion of the material in vertical and horizontal direction and to estimate the thickness and the loosening of the material layer. The visual measurements of the material velocity are also checked with these recordings. The quality of the pre-separation is estimated by a cleaning unit located behind the grain pan. For this the cleaning losses are determined and the course of the separation is estimated by the amounts of grain in four collecting boxes over the sieve length. One important value is the

Fig. 1



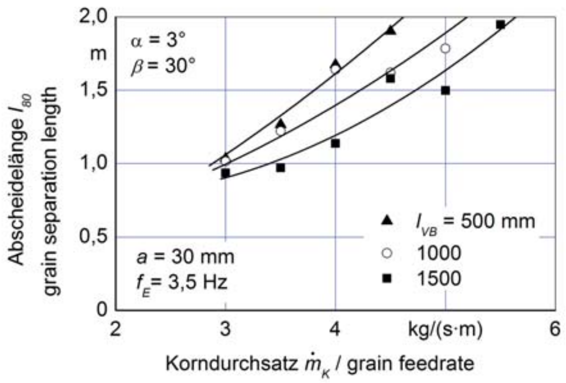
Effect of grain feedrate on the material velocity at different frequencies

Fig. 2



Effect of grain feedrate on the grain separation length in dependence on the frequency

Fig. 3



Effect of the length of the grain separation pan on the grain separation length

separation length l_{80}, the sieve length where 80 % of the feeded grain is separated.

Research results

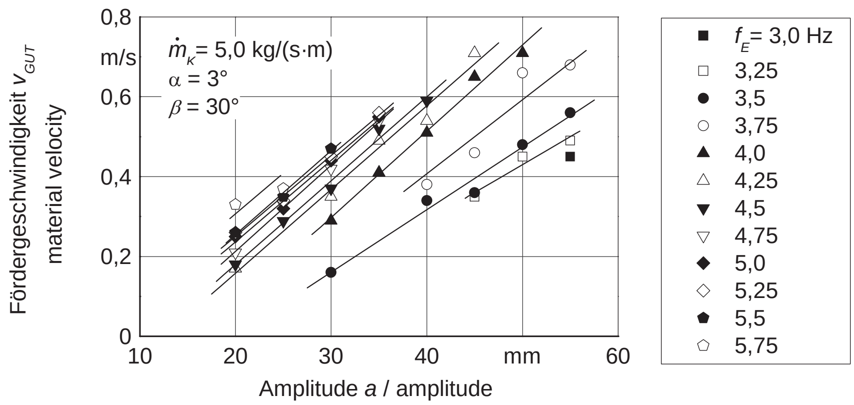
The influence of the layering of the material on the grain pan and also of the frequency and the amplitude of the oscillating conveyor are presented in the already published test results [1]. In additional tests the influence of the geometrical and the kinematical parameters were analysed in detail.

Influence of thickness of the material layer on velocity and separation: The thickness of the material layer on the grain pan depends on throughput and on the material velocity. The velocity itself is also influenced from the layer thickness. A mechanical excitation of the material layer is induced by the oscillating movement of the grain pan. Due to the damping of the material layer this movement is not transferred to the whole layer and the velocity decreases. With increasing frequency of the excitation the influence of the throughput on the material velocity also increase, **figure 1**. In the used configuration of the grain pan a throwing of the material starts from a frequency of f_E = 4–4,5 Hz. The loosening of the material layer increases and their elasticity obstructs the transfer of the mechanical excitation.

With increasing height of the material layer not only the necessary time for the pre-separation but also the separation process itself is impeded by the limited excitation of the top layers. Due to this the separation length l_{80} increases strongly with increasing throughput, **figure 2**. If the material layer on the grain pan is completely pre-separated, then its velocity is nearly independent from the throughput. The mechanical excitation is transferred nearly without any damping to the layer of kernels directly on the grain pan. These grain kernels are carrying the MOG layer during the further conveying.

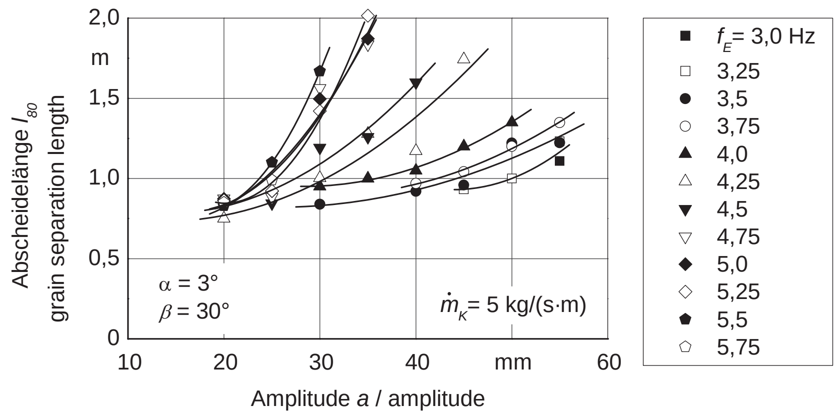
- Influence of the length of the grain pan: The length of the grain pan and due to that, the longer time period of the material on it, has a key role for the pre-separation.

Fig. 4



Material velocity in dependence on the amplitude

Fig. 5



Grain separation length in dependence on amplitude

Up to a grain feedrate of $\dot{m}_K$ = 3 kg/(s • m) the separation length l_{80} remains nearly constant with different lengths of the grain pan and with the chosen parameters of the test stand. Only with further increasing grain throughput the separation length l_{80} increases with shorter length of the grain pan, **figure 3**. If the grain feedrate increases from $\dot{m}_K$ = 3 kg/(s • m) to 4,5 kg/(s • m), an extension of the grain pan from l_{VB} = 500 mm to 1 500 mm leads to a decrease of the separation length l_{80} of up to 50 %.

- Influence of amplitude and frequency: The amplitude a and the frequency f_E of the oscillating conveyor have a strong influence on the material velocity and the separation. With increasing amplitude the material velocity increases linear, **figure 4**. With the usual basic adjustments of grain pans in combine harvesters and an amplitude of for example a = 30 mm the material velocity is in the range of v_{GUT} = 0,35–0,5 m/s. The according frequencies are in a range of f_E = 4–5,5 Hz. In comparison to that the separation length l_{80} increases at all frequencies with increasing amplitude more than proportional, **figure 5**. For a detailed analysis of the influences of amplitude and frequencies combinations of them with similar material velocities were used. This results in the finding, that for combinations with bigger amplitudes clearly shorter separation lengths are achieved. By longer swinging amplitude the throwing height increases and the loosening of the material layer is better. Additionally the impact velocity of the particles on the grain pan is higher. Especially with higher grain feedrates or rather higher material layers these two effects are positive for the separation.

Summary

The performance of a cleaning unit in a combine harvester can be significantly increased by the pre-separation of the material on the grain pan. At a test rig in laboratory the geometrical and kinematical parameters of a grain pan and their influence on the conveying and the pre-separation were examined. Especially with higher throughputs and so with bigger heights of the material layer, the mechanical excitation of the top of the layer is impeded. A better pre-separation is achieved by bigger amplitudes and smaller frequencies of the oscillation.

Literature

[1] Timofeev, A.; Wacker, P.; Böttinger, S. (2007): Untersuchungen am Vorbereitungsboden von Mähdreschern. Landtechnik 62 (2) , S. 90–91

Authors

Prof. Dr.-Ing. Stefan Böttinger is head of the chair Fundamentals of Agricultural Engineering at the Institute of Agricultural Engineering of the University of Hohenheim, E-Mail: boettinger@uni-hohenheim.de

Dipl.-Ing. Andrey Timofeev was as DAAD scholar Research Associate at this Institute and is today plant manager at the company Liebherr in Dzerzhinsk, Russia.