Xuan Thiet Nguyen, Gerd Bernhardt and Thomas Herlitzius, Dresden

Influence of Concave Length and Feeding Angle on Separation Capacity in the Multi-cylinder Threshing System

The increase of capability of a tangential threshing unit was investigated at the chair of Agricultural System Engineering of TU Dresden with a two-cylinder threshing unit. In the following the lab test stand and the results on optimizing the feeding angle as well as the effect of concave length on grain separation are presented.

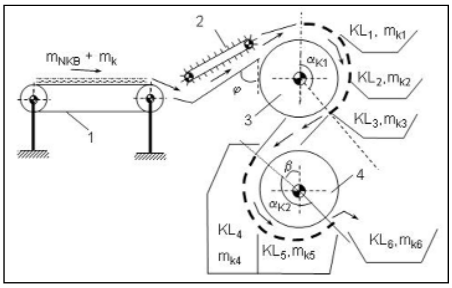

Fig. 1: Test stand design

Dr. - Ing. Xuan Thiet Nguyen is research fellow at the chair of Agricultural Systems Engineering (head: Prof. Dr.-Ing. habil. Th. Herlitzius since 1. Oct. 2007; Prof. em. Dr.-Ing. habil. G. Bernhardt until 30. Sept. 2007), Institute of Processing Machines and Mobile Working Machines at the TU Dresden, 01062 Dresden; e-mail: *ngxthiet@yahoo.com*

Keywords

Combine harvester, threshing unit, multi-drum threshing system

Literature

[1] • *Regge, H.*: Wissenschaftliche Grundlagen des Entkörnens und Korn-Stroh-Trennens von Getreidekulturen mittels Schlagleisten- Dresch- einrichtungen. Habilitation, TU Dresden, 1984

The basic setup of the test stand is shown in *Figure 1*. The unthreshed crop material is prepared on a storage belt 1 and tangentially fed to the rasp bar cylinder 3 and 4 by means of a feeding mechanism 1 and 2. The grain and material other than grain (MOG) separated underneath the concave during the test are collected in classes 1…5 ($m_{k1}…m_{k5}$). The remaining material that is discharged from the second cylinder is post-processed using classical straw walkers to separate grain m_{k6} that is still contained within the MOG (class 6). The feeding angle (φ) is varied in three steps from 50° through 60° to 70°.

The concave clearance at the primary cylinder (DT_1) is defined with the dimensions S_1, S_2, S_3 and S_4. The concave clearance can be modified by changing the length of the connections L_1 through L_5 of the concave support (*Fig. 2*).

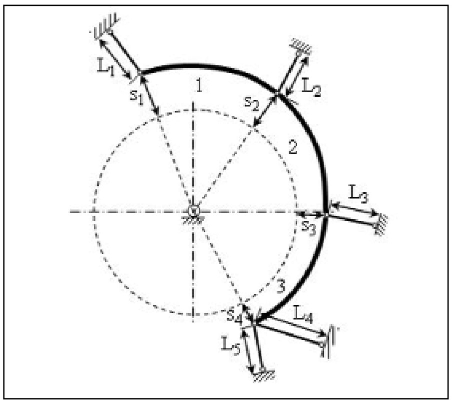

Fig. 2: Layout of primary cylinder and concave

Influence of the concave length

The tests have shown that very little grain is separated at the first class. This is typical behaviour of a tangential threshing unit, since kernels have to be removed from ears first. At the end of the second class approx. 50% of the grain is separated. Less than 5,5% grain is kept in the straw after leaving the second cylinder at a specific MOG feedrate of 9 kg/(s•m) as seen in *Figure 3*.

For the evaluation of the concave length the partial grain separation (S_{pki}) as defined

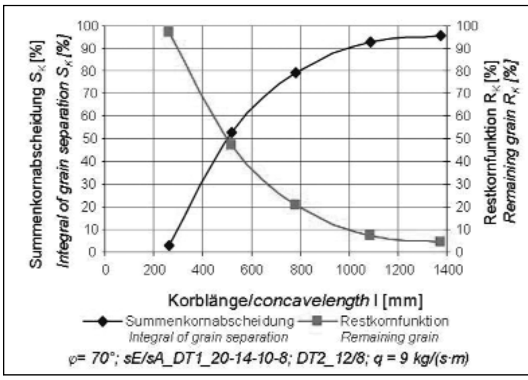

Fig. 3: Integral of grain separation and its inverse function

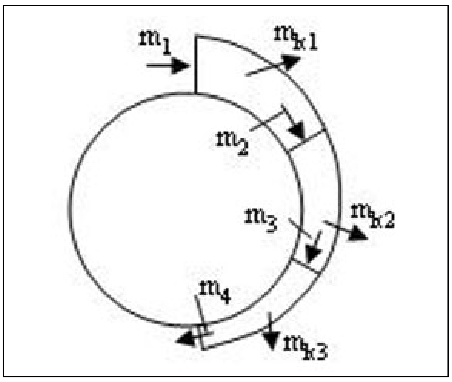

Fig. 4: Definition of the grain masses in the classes 1 to 3

in Eq. (1), *Figure 1* and *Figure 4* was derived out of the measured grain masses gathered at the different classes.

$$S_{Pki} = (m_{ki} / m_i) \cdot 100\% \qquad (1)$$

The partial grain separation as a function of the concave length can be approximated with a parabolic function (*Fig. 5*), which is valid for all test runs done.

The maximum of the partial grain separation occurs from 700 mm to 1200 mm between the end of the first concave and the begin of the second concave, which is corresponding to a concave wrap angle from 115° to 200°. Wrap angles of more than 130° are hardly achievable with conventional tangential threshing cylinders while maintaining a reliable material flow.

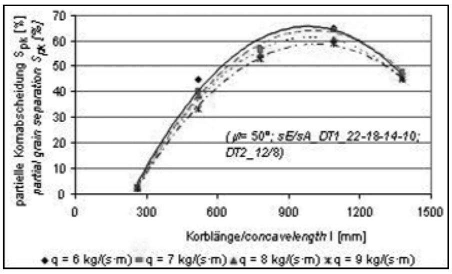

Fig. 5: Partial grain separation as a function of the length of the concave

Influence of the feeding angle

Figure 6 and *Figure 7* show remaining grain that was not separated through the concaves as a function of the specific total feedrate at different feeding angles. The content of grain increases as expected with larger concave clearance and at higher MOG feedrates.

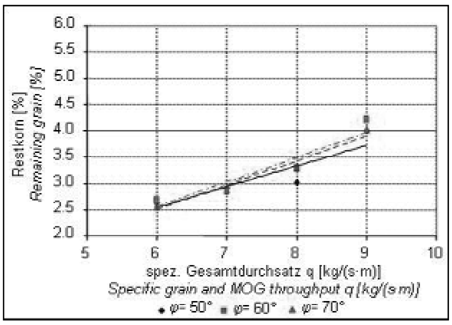

Fig. 6: Remaining grain as a function of specific grain and MOG throughput for different feeding angles with concave clearance sE/sA_DT1_20-14-10- 8; DT2_12/8

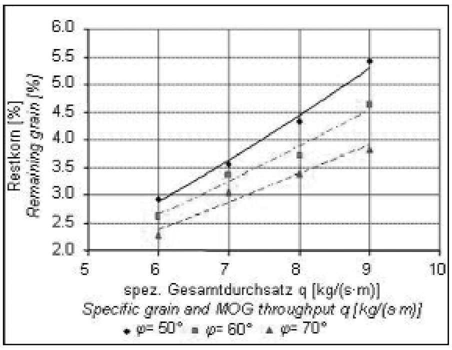

Fig. 7: Remaining grain as a function of specific grain and MOG throughput for different feeding angles with concave clearance sE/sA_DT1_22-18-14-10; DT2_12/8

It becomes clear that feeding angle and concave clearance mutually affect each other. Different feeding angles have low influence at the smallest concave clearance (*Fig. 6*). However, the largest concave clearance causes recognizable differences in grain separation for the individual feeding angles (*Fig. 7*). The feeding angle φ = 70° delivers the highest efficiency, which results in the conclusion that the feeding angle 70° causing nearly tangential feeding is very advantageous. There is still more than 94 % of the grain separated at the concaves with large concave clearance and a specific grain and MOG throughput of 9 kg/(s•m).

MOG separation as a function of the specific MOG throughput is shown in *Figure 8*. Smaller MOG separation is accomplished the more the feeding angle becomes tangential. Less straw damage and MOG creation is a substantial advantage compared to hybrid combines with conventional threshing units.

Figure 9 shows the dependence of the torques of the primary cylinder on the feeding angle for different concave clearances and different specific grain and MOG feedrates. With increasing feeding angle (becoming tangential) the torque of the cylinder decreases. The smallest torque tends to be in all test runs at φ = 70°.

Summary

The new threshing system consists of two tangential rasp-bar cylinders, where the 1st rasp-bar cylinder is tangentially fed from a chain conveyer. Both cylinders are arranged one behind the other in the direction of the material-flow. For this arrangement the following advantages could be proven in lab tests:

- With this threshing system the material is only tangentially accelerated. The crop experiences smaller forces of the rasp bars compared to conventional threshing systems. Broken grain and straw damage decreases.
- The first cylinder accelerates the material flow for the second cylinder, which causes higher grain separation in the second cylinder.
- The dwelling time of the material in the threshing system and the total separation surface of concaves increases compared to a conventional system resulting in an improvement of grain separation.

Based on the tests can be concluded that such a threshing system contributes to the further increases in output, however, the concept of present combines would have to be changed. It is an alternative to the hybrid system, since the specific power demand and the straw damage can be reduced.

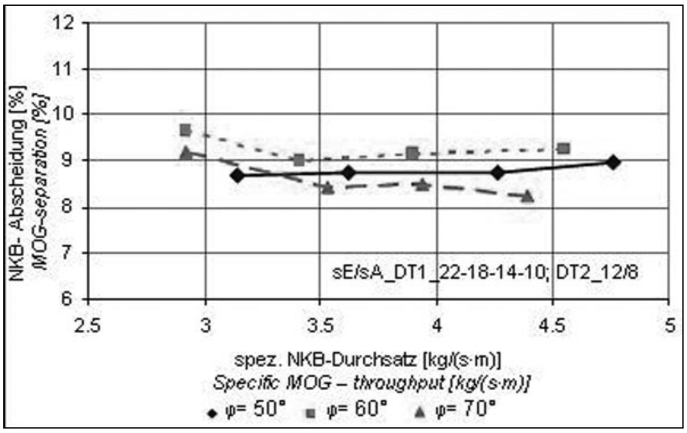

Fig. 8: Specific MOG separation at the primary cylinder as a function of specific MOG throughput

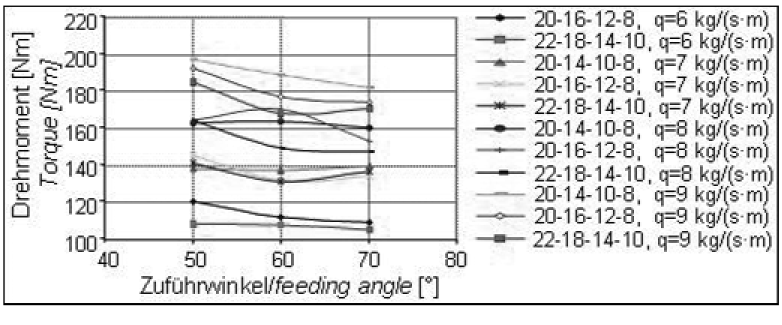

Fig. 9: Torque of the primary cylinder for different feeding angles at different concave clearances and specific grain and MOG throughput