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Chaff feeding concept for laboratory tests of combine harvester cleaning units

Further development of combine cleaning units on a test rig requires feeding systems to supply a cleaning mixture of material other than grain (MOG) as well as grain. One essential demand is the constant charging of the test rig with cleaning material to describe the stationary operating point of the cleaning unit. The University of Hohenheim in cooperation with CLAAS Selbstfahrende Erntemaschinen GmbH developed and produced a feeding system for the cleaning unit test rig which permits a more efficient use of time capacity and reduces the manpower requirement to run the system.

Keywords
MOG-dosage, cleaning unit, laboratory examination, combine harvester, feeding system

Abstract
Landtechnik 65 (2010), no. 5, pp. 376-379, 6 figures, 6 references

The feeding system for laboratory tests of combine harvester cleaning units is mostly realised using feeding belts. The mixtures of grain and MOG are placed on a constant length of the belt to get separated. Several theories regarding the positioning of the grain mixture components on the belt offers a variety of solutions: from putting the components alternating and in layers to even use a stochastic mixture. The University of Hohenheim uses the placing in two or three layers. Similar to the composition of the grain mixture of Damm, Freye put the grain mixture on chaff, and the chaff on short straw, the chaff consisting mostly in husk [1; 2]. Dahany placed in two layers. The grain was distributed on a chaff mixture consisting in husk, beard and short straw [3]. Due to the mechanical stress during the test, the MOG had to be replaced partly. Manually, the new part of the MOG was placed below and the used part was put above. In the positioning on the belt, the weight distribution of the portions was constant per m and homogenised on the transitions. After that, a cell wheel dosing device was feeding the grain onto the MOG.

The throughput variation can be realised in modifying the quantity of the material (thickness of layers) or the belt velocity [3]. To limit the influence of the wall friction when running tests with small working widths of the belt and high throughputs, the length of the belt has been extended from 4 to 14 m, the velocity increased and so the thickness of layers has been reduced [4]. This approach of an automatic feeding for combine cleaning units is not a new one. Grobler already used a device consisting in screw feeders, paddle elevators and silo storage for his examinations on the planetary drum selector. But the adjustment was hardly reproducible [5]. The dosage system of the Technical University of Dresden consists in a feeder belt with a congruent unrollable dosage belt to position the grain in layers on the belt. The grain is transported into the test rig using a slide to avoid mixing [6]. Conventional feeding with belts requires a relatively high preparation time compared to the actual measuring time in order to guarantee a high reproducibility.

Requirements

The use of an automated dosage system should increase the productivity of laboratory tests, offering a higher number of test series per day (**figure 1**). Based on the measuring time of 6 s for one stationary test series determined by Grobler and Baumgarten, the provided throughput of the grain mixture should show a constant number for at least 10 s [5; 6]. For an analysis close to reality of the whole combine harvester cleaning system, it should be possible to feed separately the preseparation pan (PSP) and the return pan (RP) with different amount of material as well as adjustable grain to MOG ratio in order to examine the transportation from the PSP to the RP and its influence on the performance of separation. The grain throughput should be between 0.2 kg/(s • m) and 8.44 kg/(s • m) and the MOG throughput between 0.16 kg/(s • m) and 1.96 kg/(s • m). Mechanical wear of the testing material should be avoided as far as possible. The reproducibility should be at least equal to the one of tests with feeding belts, i.e. stay within the limits of +/- 3,5 %.

Design of the MOG/grain feeding device

The design of the MOG dosage system is shown in a kinematic diagram in **figure 2**. The MOG quantity for the PSP and the RP is dosed from a container by an emptying device. This device consists in a scraper at the container bottom and a bucket elevator for continuous emptying. Another conveying device is fixed to the container top. It ensures a continuous stripping of the buckets just before discharging onto an oscillating conveyor and holds the material back in the container. The MOG is moved counter clockwise to achieve a stationary state. This state is maintained as long as the function of the conveying device is ensured. Therefore a certain content of material in the container is necessary to ensure a constant feeding of MOG. The bucket elevator discharges the MOG in portions onto an oscillating conveyor, which distributes them evenly.

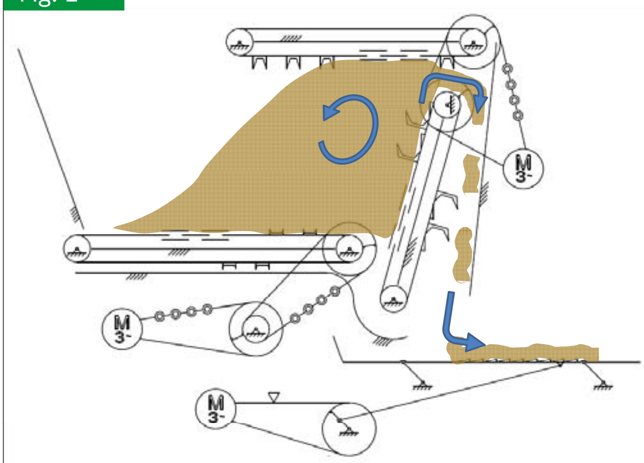
Evenly distributed, the MOG flow is split by an adjustable plate to be transferred by augers to the PSP and the RP respectively. The two grain dosage systems are equipped with conventional cell wheels, conveying the grain dose to the corresponding auger of the PSP and RP. The grain is unloaded from above onto the MOG flow. The augers ensure the mixing and the transport of the MOG and the grain fractions. This mixture of grain and MOG is brought to the PSP and the RP in the test rig by using cell wheels with funnels. **Figure 3** shows the top view of the entire test rig of combine harvester cleaning units.

The dosing unit as well as the following cleaning test rig is controlled by a SPC (stored program control). The turn-on and turn-off times of each feeder part are phased to minimize lead times and test material quantities.

Fig. 1

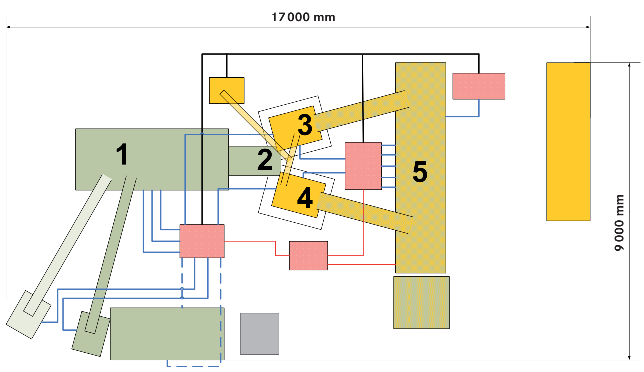
Test rig of MOG-feeding system.

Fig. 2



Kinematic diagram of MOG-feeding system

Fig. 3



Ground plan of test rig for cleaning units (1 MOG-feeding system, 2 oscillating conveyor with splitter, 3/4 grain dosage and auger preparation floor, 5 Test rig of cleaning unit)

Calibration

While testing, the MOG dosage system must guarantee a constant throughput for up to 10 s. The transient phases can be faded out on the test rig. A platform weighing cell was used to calibrate the MOG dosage system. It is positioned right after the oscillating conveyer. The filling of the MOG dosing unit was reset to the starting point after each measurement. The used MOG was fed back to the dosage system with a ratio of 1 to 3 of new MOG and used MOG. The MOG flow was measured for 40 seconds including 5 seconds of entering and leaving phase each. The oscillating conveyer was run empty after each measurement.

The data were analysed statistically. The analysis is based on 20 tests per throughput point of MOG. The MOG throughput was obtained by differentiating the increasing mass during measuring time and then averaged over the 20 tests. The measured data were triggered considering a 5 s entering phase. **Figure 4** shows the MOG throughput with constant MOG fill of 100 kg over time for two measuring points.

The analysis of the measurement data for calibration showed dynamic effects (**figure 5**). The amplitude diminishing is due to the influence of the sinking height of drop on the mass impulse of the MOG portion while weighing, as well as the effect of the increasing damping on the already taken MOG quantity With a FFT an initiation frequency of the oscillating conveyor of 5,6 Hz and an output frequency depending on the throughput of the bucket system could be proven.

These small rhythmically alternating throughputs are further smoothed thanks to the buffer action of the following feeding elements as the auger and the cell wheel and can therefore not be measured when feeding the PSP and the RP. **Figure 6** shows the calibration characteristics of the MOG dosage system for a constant 100 kg MOG fill. The standard deviations are +/- 5 % of the setting value.

Conclusions

The performance reliability as well as the homogeneity of the MOG throughput provided by the new MOG dosage system has been proved allowing now its application. After a satisfying check of the grain/MOG mixture for the PSP and the RP that was done after the two augers, the described MOG dosage system will be used in future tests of combine harvester cleaning units.

Literature

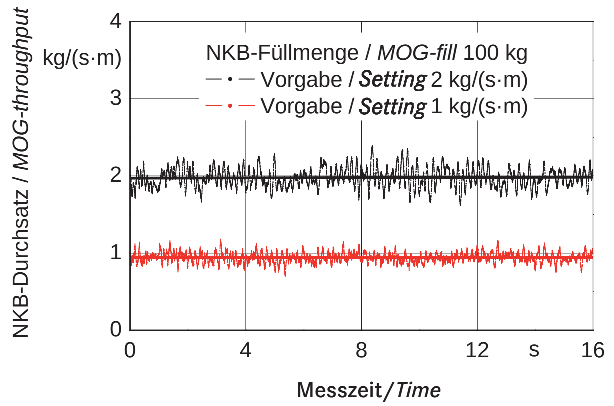
[1] Damm, J. (1972): Der Sortiervorgang beim luftdurchströmten Schwingsieb. Dissertation, Technische Hochschule Stuttgart, Fortschrittberichte der VDI-Zeitschriften Reihe 3, Nr. 37

[2] Freye, T. (1980): Untersuchungen zur Trennung von Korn-Spreu-Gemischen durch die Reinigungsanlage des Mähdreschers. Dissertation, Universität Hohenheim, Forschungsbericht Agrartechnik Nr. 47

[3] Dahany A. (1994): Verbesserung der Leistungsfähigkeit luftdurchströmter Schwingsiebe bei der Korn-Spreu-Trennung im Mähdrescher durch Optimierung der Luftverteilung. Dissertation, Universität Hohenheim, Forschungsbericht Agrartechnik Nr. 245

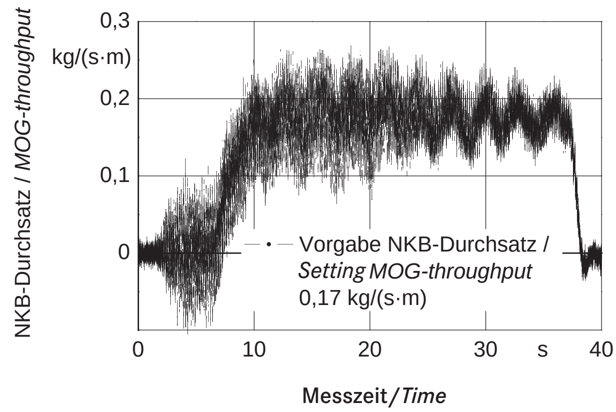
[4] Zhao, Y. (2002): Einfluß mechanischer und pneumatischer Parameter auf die Leistungsfähigkeit von Reinigungsanlagen im Mähdrescher. Dissertation, Universität Hohenheim, Forschungsbericht Agrartechnik Nr. 287

Fig. 4



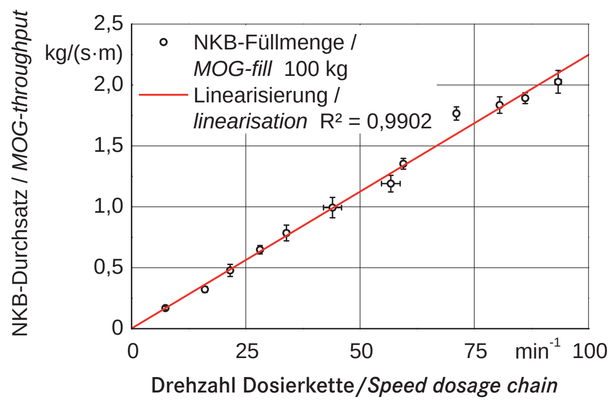
Verification of constant MOG-throughput

Fig. 5



Dynamic effects on MOG-feeding

Fig. 6



Calibration curve of MOG-feeding system

[5] Grobler, H. W. (1987): Untersuchungen zur Korn-Stroh-Trennung mit überlagerten Beschleunigungen im Planetentrommelsortierer. Dissertation, Universität Stuttgart, Forschungsbericht Agrartechnik Nr. 140
[6] Baumgarten, J. (1988): Theoretisch experimentelle Untersuchungen zur Optimierung des Trennprozesses in einer Kaskadenreinigungseinrichtung eines Mähdreschers. Dissertation, Technische Universität Dresden

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Dipl.-Ing. Waldemar Schulz und **Dr.-Ing. Joachim Baumgarten** are staff members of CLAAS Selbstfahrende Erntemaschinen GmbH Harsewinkel.

Acknowledgement

The Institute of Agricultural Engineering of the University of Hohenheim thanks his cooperating partner, the Department Advanced Engineering of CLAAS Selbstfahrende Erntemaschinen GmbH, Harsewinkel, for the support in construction and financing of the test rig.