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# Aspects of slope compensation in combine cleaning systems

*Additional lateral oscillation in combine cleaning systems theoretically increases cleaning capacity but also has a slope compensation effect. This and its dependencies could be calculated from motion trajectories within the harvested material mattress.*

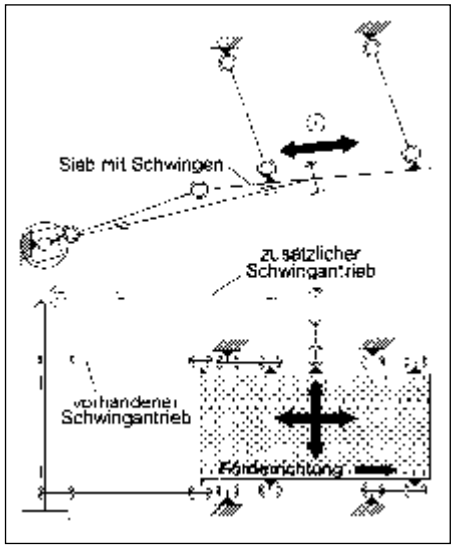


*Fig. 1: Structure of modified cleaning system*

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**Keywords**

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As theoretically shown in [1], performance capacity compared with conventional cleaning can be increased in a modified cleaning system with added lateral oscillation. This is possible because the added cross-oscillation increases the material's length of travel and speed through the system without influencing other separation system parameters. Additionally it allows slope compensation with laterally-angled combines under certain conditions. The modified cleaning system and the influence of some parameters on slope compensation are explained below.

### Construction and action of the modified cleaning system

The modified cleaning system design is largely the same as a conventional cleaning system with the former comprising two oscillating sieves with cyclone effect, positioned one above the other and loaded with the cleaning mix by oscillating conveyor. The existing single axis oscillation is, however, additionally overlaid with an oscillation vertical to it at sieve level (*fig. 1*).The additional oscillation is characterised by the amplitude $a_Z$ and the agitation frequency. The oscillation relationship SV is defined as

*Oversight 1: Used parameter values*

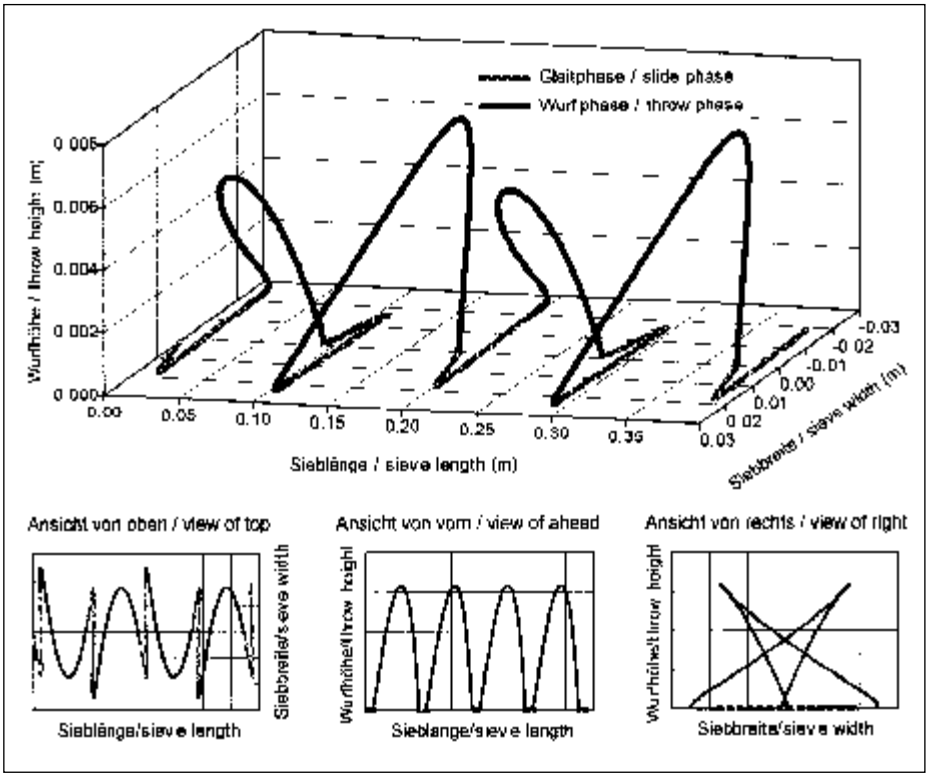


*Fig. 2: Motion trajectory relative to sieve with SV = 1.5*

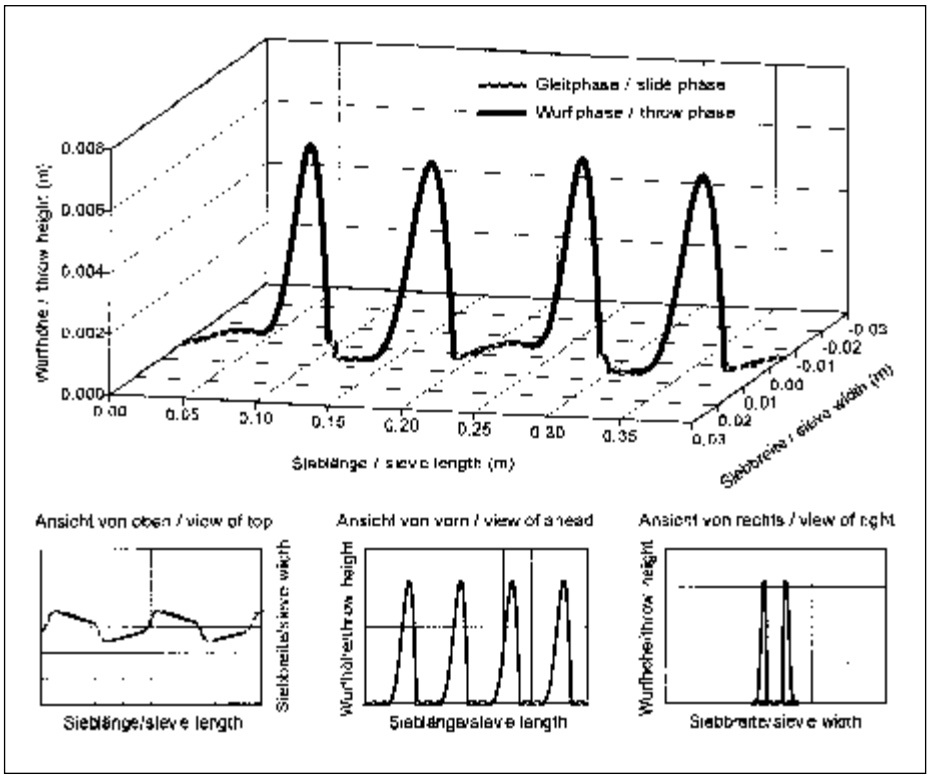


*Fig. 3: Motion trajectory in a room with SV = 1.5*

quotient of the agitator frequency of additional and existing oscillation.

### Movement trajectories with the modified cleaning system

For calculating the movement trajectories and all other parameters the parameter values from *oversight 1* were applied, where not otherwise indicated. With a non-integer oscillation ratio a symmetrical lateral trajectory of the mix on the sieve occured. There occurred, however, no conveyance of the mix laterally to the actual conveyance direction. *Figure 2* shows the movement trajectory relative to the sieve and *figure 3* the movement trajectory in space for an oscillation ratio SV= 1.5.

If the oscillation ratio was integer there occurred an asymmetric lateral movement of the mattress whereby the mix is also moved laterally and can thus be distributed more evenly over the sieve during lateral-slope threshing. Through adjustment of the phase-offset between existing and additional oscillations, the extent of lateral movement to the actual direction of travel can be influenced where the oscillation ratio is integer. As is shown in *figure 4* using the example of the oscillation ratio SV = 1 it is also possible with a certain phase-offset to eliminate the lateral conveyance for combining on the level. A measurement of the lateral conveyance is the lateral conveyance angle.

### Influence of oscillation ratio on slope compensation

The lateral conveyance is dependent on the oscillation ratio (*fig. 5*). The maximum lateral conveyance angle peaks at an oscillation relationship of SV = 1 and then reduces with the increasing of the oscillation ratio. The phase-offset to be set between existing and additional oscillation for no lateral conveyance, is also different for the investigated oscillation ratios. With maximum slope compensation, an oscillation ratio of SV=1 is therefore required.

### Influence of oscillation amplitude $a_Z$ on slope compensation

Increasing oscillation amplitude $a_Z$ of the additional oscillations leads to a strongly degressive increasing of maximum lateral conveyance angle (*fig. 6*). From the theoretical observation in [1] an area of $a_Z = 20...30$ with an oscillation ration SV=1 can be deduced for the achievment of an optimum separation process. This area is also to be aimed for in relationship to slope compensation in that a further increase of the oscillation amplitude $a_Z$ leads to no notable rise in maximum lateral conveyance angle and the forces on constructional parts rise proportionally with increasing oscillation amplitude.

### Influence of pitch slope on slope compensation

A combine pitch slope to the horizontal with downward travel is termed positive and upward travel negative. In that the conveyance speed of the cleaning mix depends on the

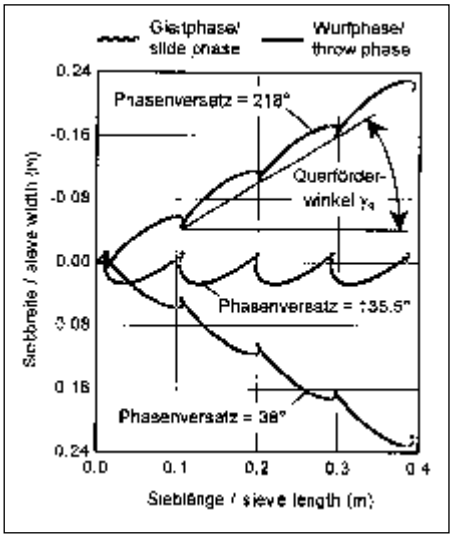


*Fig. 4: Motion trajectories relative to sieve by SV = 1*

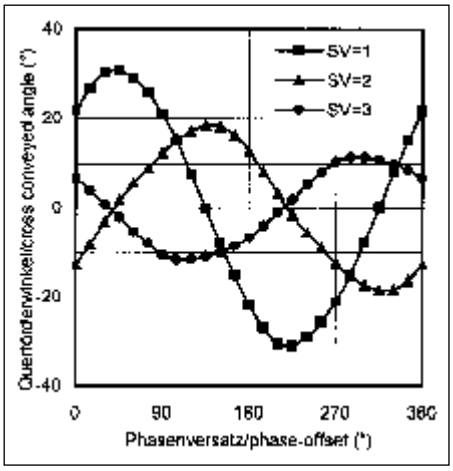


*Fig. 5: Influence of oscillating ratio*

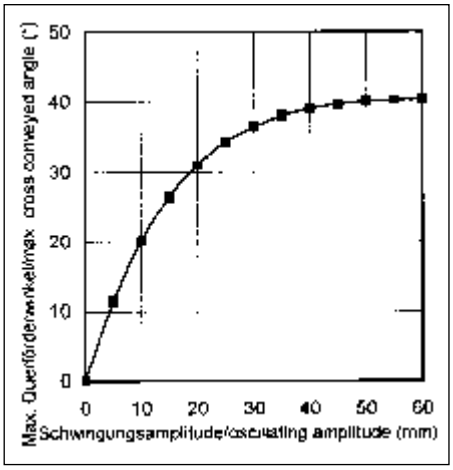


*Fig. 6: Influence of oscillating amplitude $a_z$*

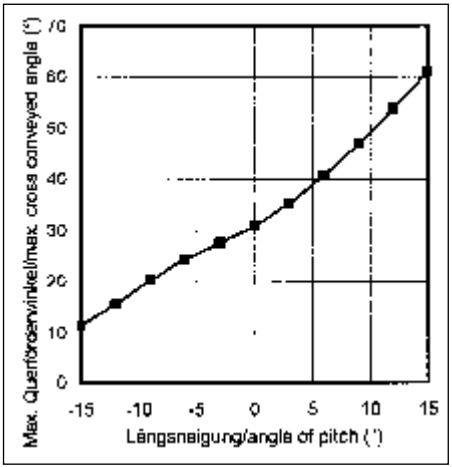


*Fig. 7: Angle of pitch influence of max. cross conveying angle*

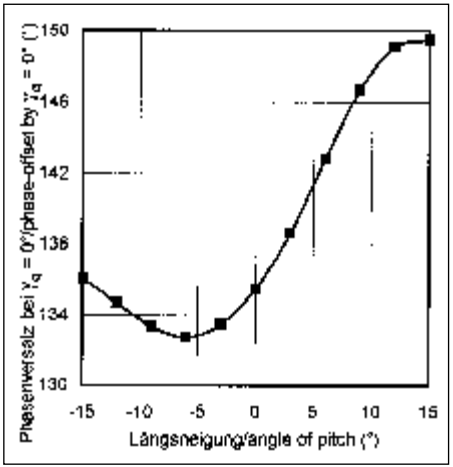


*Fig. 8: Angle of pitch influence of phase-offset by cross conveyed angle $\gamma_q = 0°$*

pitch, the maximum lateral conveyance angle rises with increasing degree of pitch (*fig. 7*). The pitch angle has also an influence of the adjustment of the phase-offset between actual and additional oscillation with which no lateral conveyance takes place (*fig. 8*). To stop cross conveying on combines which are not on side slopes or to match the cross conveyance to the actual slope angle, a suitable control for the phase-offset between actual and additional oscillation is necessary. This can be based on the grain separation divisions over the breadth of the sieve.

### Summary

Separation improves if to the existing oscillation an additional vertical cross-oscillation is added at sieve level. Additionally, integer oscillation ratio slope compensation is possible. The slope compensation is controllable through adjustment of the phase-offset between actual and additional oscillations and peaks at an oscillation ratio of SV=1. The oscillation amplitude $a_Z$ of the additional oscillation should lie in an area of $a_Z$ = 20...30 mm. In that the slope compensation is also dependent on the combine pitch, control for the adjustment of the phase-offset between actual and additional oscillation is necessary.

## Literature

[1] *Hübner, R.*: Leistungssteigerung der Mähdrescherreinigung durch eine zusätzliche Querschwingung. Vortrag VDI-MEG-Tagung Landtechnik 2000, VDI-Verlag, Düsseldorf, 2000