Experimental Research Concerning the Cleaning System of Various Cereals Harvesting Combines

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Abstract. The separation of seeds from the heap is effected thanks to the vibration of the flat sieves. The efficiency of the cleaning process of the sieves from the cleaning system depends on the following factors: the inclination of the sieves, the sieves size and mainly of the character of the relative movements of the seeds on the sieve, respectively the cinematic regime of the sieves.

This paper presents a comparative study regarding the different types of cereals harvesting combines with a view to work techniques.

Keywords: flat sieves, sliding regimes, kinematics index, fuel consumption.

INTRODUCTION

The operation of separation of seeds from the layer on the sieves of cereals harvesting combines takes place due to both the stratification process of the material in its components differentiated according to density and to its sieving state on the separation area induced by the sieve movement (Scripnic and Babiciu, 1979).

The material sieving state on the oscillating plane sieve surface, without taking into account the air current directed below the sieve, depends on the physical and mechanical features of the material to separate, on the ratio between the seed volume and the volume of the other components in the pile, as well as on the constructive and functional parameters of the cleaning system (Ilea, 2001).

Academic studies show that an efficient separation of the seeds in the pile on the sieve takes place when the material has reached a sieving state defined by relative movement, in both directions, on the sieving surface, with a tendency to detachment and a movement resulted from the movement towards the end opposed to the material feeding end (Letoşnev, 1959).

The forces that act on the particles on the surface of the cleaning system sieves and that can induce the material a certain sieving state are inertial forces (Brîndeu et al., 2002).

In order to check the results obtained through academic studies, we organized trials within which we determined the time and movement rate of the material on the surface of the oscillating sieve surface, the degree of separation of the components of the mixture undergoing conditioning, and sieve productivity, depending on the kinematics parameters of the cleaning system movement, i.e. the number of revolutions of the motor shaft of the operating mechanism, on the amplitude and frequency of oscillations (Brîndeu et al., 1998).

To obtain some conclusive results, trials were carried out under working conditions on self-propelled cereal harvesting combines.

All determinations were effected at different inclinations of oscillating sieves and different rotative speed of the driving shaft. In all variants of work, the tests were performed in more repetitions, the results presented in this paper being the average of these repetitions.
MATERIALS AND METHODS

Trials on cereal harvesting combines were carried out under working conditions, upon wheat harvesting, on a lot of 4 self-propelled combines of the Didactic Station in Timișoara. The 4 types of combines on which we made measurements and determinations were as follows:

- the C-14 combine: 105 HP engine, working width – 5 m;
- the CLAAS-98SL MAXI combine: 160 HP engine, working width – 5 m;
- the MDW-525 STS combine: 268 HP engine, working width – 7 m;
- the John Deere-Hydro 4-1174 S combine: 150 HP engine, working width – 7 m.

The 4 combines harvested in the same working formation and under identical working conditions with identical technological adjustments. The operating mechanisms of the sieves of the connecting rod – crank system induces them a plane-parallel movement.

The kinematics scheme of the cleaning system is presented in Fig. 1.

![Fig. 1 – Cleaning system:](image)

1 – oscillating carrier; 2 – batter; 3 – upper sieve; 4 – lower sieve; 5 – prolongation of the upper sieve; 6 – spike grill; 7 – radial ventilator; 8 – helix grain carrier; 9 – sloping plane; 10 - helix spike carrier.

In each combine we measured the parameters of the cleaning system, i.e.: the number of revolutions of the motor shaft operating the cleaning system, crank radium, length of the connecting rod, size of the sieves, sloping angle of the sieves, oscillation direction angle, and air current direction angle.

In order to determinate the hourly working capacity (t/h), we took into account the real time it took to fill the bin with seeds, the bin volume, and the hectolitre volume of the harvested wheat (780 kg/m³). In each combine, we made 4 timings of the real bin filling time and we took into account the arithmetical mean of the timings in the determination of the hourly working capacity.

RESULTS AND DISCUSSION

The separations of seeds from the heap on the sieves of the cleaning systems takes place thanks to the phenomenon of material stratification in its components what are separated according to the density, as well thanks to the sieving state of the material on the
separation surface, produced by the sieve motion. Technical parameters of the cleaning system, in the 4 combines are centralised in Tab. 1.

Tab. 1

Technical parameters of the cereal harvesting combine cleaning system

<table>
<thead>
<tr>
<th>No.</th>
<th>PARAMETER</th>
<th>Combine C-14</th>
<th>Combine CLAAS-98SL</th>
<th>Combine MDW-525 STS</th>
<th>Combine J. Deere-1174 S</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Number of revolutions of the shaft [r.p.m.]</td>
<td>300</td>
<td>370</td>
<td>240</td>
<td>270</td>
</tr>
<tr>
<td>2</td>
<td>Angle speed [sec⁻¹]</td>
<td>31.4</td>
<td>38.7</td>
<td>25.0</td>
<td>28.3</td>
</tr>
<tr>
<td>3</td>
<td>Crank radius [mm]</td>
<td>35</td>
<td>40</td>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td>4</td>
<td>Length of the connecting rod [mm]</td>
<td>470</td>
<td>430</td>
<td>850</td>
<td>430</td>
</tr>
<tr>
<td>5</td>
<td>Length of oscillating branches [mm]</td>
<td>110</td>
<td>180</td>
<td>230</td>
<td>160</td>
</tr>
<tr>
<td>6</td>
<td>Sieve sloping angle [grade]</td>
<td>4°</td>
<td>7°</td>
<td>6°</td>
<td>7°</td>
</tr>
<tr>
<td>7</td>
<td>Oscillation direction angle [grade]</td>
<td>16°</td>
<td>30°</td>
<td>3°</td>
<td>23°</td>
</tr>
<tr>
<td>8</td>
<td>Air current direction angle [grade]</td>
<td>24°</td>
<td>35°</td>
<td>26°</td>
<td>30°</td>
</tr>
<tr>
<td>9</td>
<td>Kinematics index k</td>
<td>3.5</td>
<td>6.1</td>
<td>1.8</td>
<td>2.6</td>
</tr>
<tr>
<td>10</td>
<td>Sieve length [mm]</td>
<td>1500</td>
<td>1760</td>
<td>1850</td>
<td>1760</td>
</tr>
<tr>
<td>11</td>
<td>Sieve width [mm]</td>
<td>960</td>
<td>1200</td>
<td>1500</td>
<td>1350</td>
</tr>
<tr>
<td>12</td>
<td>Total sieve area [m²]</td>
<td>2.9</td>
<td>4.25</td>
<td>5.4</td>
<td>4.8</td>
</tr>
<tr>
<td>13</td>
<td>Bin volume [m³]</td>
<td>3.5</td>
<td>6.2</td>
<td>10.5</td>
<td>7.5</td>
</tr>
<tr>
<td>14</td>
<td>Mean hourly productivity [t/h]</td>
<td>4.5</td>
<td>8.7</td>
<td>17.4</td>
<td>12.5</td>
</tr>
<tr>
<td>15</td>
<td>Hourly fuel consumption [kg/h]</td>
<td>18</td>
<td>28</td>
<td>47</td>
<td>26</td>
</tr>
<tr>
<td>16</td>
<td>Fuel consumption per wheat t [kg/t]</td>
<td>3.75</td>
<td>3.2</td>
<td>2.7</td>
<td>2.1</td>
</tr>
</tbody>
</table>

CONCLUSIONS

On the ground of the data centralised in Table 1, of the trial measurements and determinations on the 4 self-propelled combines, we think we can draw the following conclusions:

- mean hourly productivity is proportional to the separation area, to the operating engine power, i.e. to the feeding flow;
- fuel consumption per t of cereals decreases with hourly increase.

Despite all this, there are important differences between the 4 combines from the point of view of hourly productivity in relation to sieve separation area. Thus, in the MDW-525 STS, CLAAS-98SL, and John Deere-1174S combines, compared to the C-14 combine, productivity per sieve separation area is almost the double of that in the C-14 combine. Lower hourly productivity of the C-14 combine compared to that of the other combines can be
explained by the fact that this combine uses a classical threshing device, classical sieve clearing systems, and classical ventilator.

The threshing devices of the MDW-525 STS, CLAAS-98SL, and John Deere-1174S combines have forced feeding and their working process influences directly the process of separation – cleaning as well as the dynamics of the separation – cleaning activity. Because the feeding flow of the thresher devices and the percentage of grains separated from their spikes are larger in these combines compared to those in the classical combines, the percentage of spikes not threshed decreases and the grain percentage in the pile reaching the sieves increases. Another characteristic explaining the increase of the productivity of these combines consists in the pre-separation of the husks and of the light particles by the air current produced by the ventilator even before the pile reaches the upper sieve of the cleaning system. Increasing in this way the percentage of grains in the pile, hourly sieving productivity increases for the same sieve area unlike the classical systems.

REFERENCES