Improving the efficiency of separating machines equipped with flat oscillating sieves

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Abstract. The article deals with the separating machines equipped with flat sieves with various types of holes used for cleaning from impurities and sorting into fractions by size. It is noted that the main disadvantage of these machines is that in the process of their operation, the openings of the sieves are clogged by the separation products, which leads to a decrease in the separation efficiency, as well as a decrease in the productivity of the machines. It is mentioned that the most acute problem of cleaning the openings of sieves is when separating tree seeds. It is possible to increase the efficiency of the separating machines by using cleaning mechanisms that allow the seeds stuck in the holes to be pushed out when the machines are operating. A mechanism for cleaning the holes of sieves is proposed, equipped with cylindrical working bodies on which gears are mounted that are engaged with toothed rails. In the course of experimental studies on the treatment of tree seeds, the dependences of the completeness of the separation of the separated fraction on the specific load of the sieve, as well as on the speed of rotation of the drive shaft of the cleaning mechanism, were obtained. It is established that with an increase in the rotation frequency of the crank shaft of the cleaning mechanism, the completeness of the separation increases. It is determined that the greatest increase in the completeness of separation from 76.0% to 85.8% is observed when used in the design of the cleaning mechanism of gears with a diameter of 30 mm. It is established that the use of a mechanism for cleaning the holes of sieves, equipped with cylindrical working bodies, allows to increase the efficiency of the process of separating tree seeds.

1. Introduction
For cleaning from impurities and separation by size of seeds of various agricultural and forestry crops, machines are used with the equipped flat oscillating sieves. Machines of this design have one common significant drawback, which is that in the process of their operation, the holes of the sieves are clogged with separation products. As a result of clogging of the holes, the efficiency of the separation process decreases, as well as a decrease in the productivity of the machine.

This drawback can be eliminated by using mechanisms for cleaning the openings of the sieves. However, the currently existing cleaning mechanisms do not always allow achieving the desired result. This is due to the fact that often for different cultivated crops it is also necessary to individually select the type of cleaning device, the material of its working bodies, as well as the constructive and kinematic parameters of the machine.

The most widespread problem of removing the separation products stuck in the openings of the sieves is when cleaning from impurities and sorting tree seeds into size fractions. The seeds of trees,
particular, of coniferous species, are held in the openings of the screens by significant forces of adhesion, which significantly complicates the process of removing them from the holes by traditionally used cleaning mechanisms. In addition, the seeds are characterized by a high degree of damage, which also leaves its mark on the choice of working bodies and operating parameters of the separating machines.

Since, as previous studies have shown, the currently existing mechanization tools do not effectively carry out the technological process of sorting forest seeds on flat oscillating sieves, it is necessary to find a technical solution that would improve the efficiency of this process.

2. Research purpose
The purpose of the research was to determine the efficiency of separating machine that processes seeds of coniferous trees, the design of which uses a hole cleaning mechanism with active cylindrical working bodies.

3. Research methods
The works of scientists [1-6], devoted to the processing of seeds of various crops have been studied. Most researchers note that the choice of constructive and kinematic parameters of machines is made depending on the type of material being processed [7-9].

In the course of research, a mechanism for cleaning the holes of sieves with active working bodies was developed (figure 1).

![Figure 1. Mechanism of cleaning the holes of sieves](image)

1 – working body; 2 – gear; 3 – rack.

A distinctive feature of mechanism is the use of active cylindrical working bodies, which, besides the reciprocating movement under the sieve, also rotate. The rotation of the working bodies is ensured not due to their contact with the sieve, but due to the use of gearing. Gears are placed on the working bodies of the mechanism, which are in mesh with racks fixed on the sieve mill.

The studies were carried out on an experimental setup that simulates the operation of a separating machine equipped with a flat oscillating sieve with round holes. Scots pine seeds were used as separation material. Previously, the seeds were depleted and had a moisture content of 8-10%. The type of working bodies of the cleaning mechanism is brushes; quantity of 3, the material is nylon. The separation efficiency was assessed by the completeness of the separation of the processed material through-flow fractions on the sieve.
4. Research results
As a result of the experimental studies, the dependences of the completeness of the separation of the separated fraction on the specific load of the sieve, as well as on the rotational speed of the drive shaft for various parameters of the cleaning mechanism were obtained (figure 2, 3, 4, 5).

Figure 2 Dependences of the completeness of the separation of the through-flow fraction on the specific load of the sieve when the diameter of the gears of the cleaning mechanism is equal to 45 mm.

Figure 3 Dependences of the completeness of the separation of the through-flow fraction on the specific load of the sieve with the diameter of the gears of the cleaning mechanism equal to 60 mm.

Figure 4 Dependences of the completeness of the separation of the through-flow fraction on the rotation frequency of the mechanism crank shaft at a specific load of the sieve of 0.6 kg/h dm².
Figure 5  Dependences of the completeness of the separation of the through-flow fraction on the rotation frequency of the mechanism crank shaft at a specific load of the sieve of 0.8 kg / h dm²

The research results show, that other things being equal, with an increase in the specific load of the sieve from 0.6 kg / h dm² to 1.4 kg / h dm², the completeness of the release decreases. However, with an increase in the rotation frequency of the crank shaft of the cleaning mechanism drive in the interval from 10 min⁻¹ to 30 min⁻¹, an increase in the completeness of the separation of through-flow fractions occurs. Since the greatest increase in the selection completeness from 76.0% to 85.8% is observed when using gears with a diameter of 30 mm, it can be established that a decrease in the diameter of the gears installed on the working bodies also leads to an increase in the completeness of the selection, and hence the efficiency of separation.

5. Conclusion
Studies have shown that the use of a sieve hole cleaning mechanism equipped with cylindrical working bodies can improve the efficiency of the process of separating tree seeds. The data obtained from the research can be used in the design stages of new or modernization of existing various separating machines equipped with flat oscillating sieves.

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