

Design and Research of New High-efficiency Seed Removal Roller for Sunflower Seed Remover

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Abstract. Based on the working principle of sunflower seed remover, this paper studies the existing de-seeding of sunflower seed remover in China. Through analysis, it is found that the main reasons for the sunflower seed remover's low efficiency are the low removal rate, high crushing rate and low cleanliness. Based on the analysis, the reason is obtained. With the improvement of sunflower seed removal roller, the problems of low efficiency and high failure rate of seed removal machine were solved. A new type of combined sunflower seed remover was designed, and through the related experiment research proves that this new type of combined sunflower seed remover can improve the work efficiency of the seed remover.

1 Overview of the working principle of sunflower seed remover

Sunflower seed remover is generally composed of frame, feeding device, seeding device, screening device, collecting device, transmission device, shell and others. One of the most important structures is the seed removal device. The seed removal device is mainly composed of a seed removal roller and a concave grid plate. The high-speed operation of the seed removal roller directly applies mechanical force to the sunflower plate, so that the sunflower seeds fall off the sunflower plate. The concave grid is also called an arc grid. The concave grid plate is composed of several semi-circular arc-shaped round steels and its function is to carry the sunflower disk and guide the sunflower disk forward. The tension spring can adjust the distance between the seed removal roller and the concave grid plate, and the distance is generally 30mm.

Figure 1 is a schematic structural diagram of a sunflower seed remover. During work, the sunflower plate is fed from the feed inlet (feeding device) along the tangent direction of the seed removal roller. After the sunflower plate enters the seed removal device, it is brought into the concave grid by the fast-moving seed removal roller. By adjusting the size of the gap between

the seed removal roller and the concave grid plate, and adjusting the kneading or knocking between the seed roller and the concave grid plate, the sunflower seeds are deseeded. The sunflower plate after seed removal runs vertically along the center axis of the seed removal roll under the action of the rotation torque of the seed removal roll, and is discharged from the outlet of the sunflower plate. The removed grain mixture fell into the screening device from the gap of the concave grid plate. The screening device, also known as the wind separator, is the structure for separating sunflower seeds and impurities. The key components of the screening device are the fan and the separation sieve. The smaller impurities in the grain mixture were blown by the fan from the outlet, and the larger impurities fell into the impurity collection device below through the mesh of the separation sieve. The sunflower seeds are stored in the seed-collecting hopper, and finally the seed-deseeding and collection of sunflower seeds are realized.

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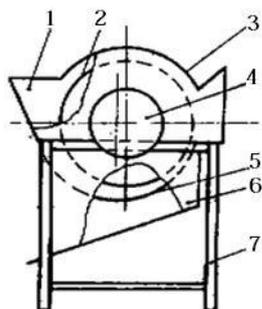


Figure 1. Schematic diagram of sunflower seed remover

1. feed inlet 2. seed removal roller 3. chassis 4. transmission
 5. concave grid 6. seed bucket 7. rack

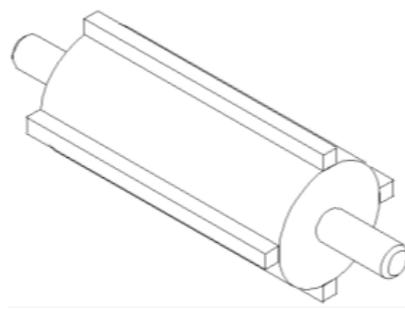


Figure 2. Figure with kneading seed removal roller

The most important structure of the seed removal device is the seed removal roller. The seed removal roller is divided into a kneading sunflower seed removal roller and a percussion sunflower seed removal roller. The surface of the kneading seed removal roller is made of textured rubber material. The working principle is that the sunflower seeds are separated by kneading between the seed removal roller and the curved grid plate. The percussion sunflower seed removal roller is evenly distributed on the surface of the seed removal roller by a plurality of tooth nails. The working principle is that it cooperates with a seeding roller with nail teeth and a concave grid plate with concave plate teeth on the surface. The sunflower disc enters the seed removal device and is knocked and squeezed to achieve the effect of seed removal.

2 Reasons affecting the efficiency of sunflower seed remover

The factors affecting the working efficiency of sunflower seed remover are complex and diverse. In addition to high labor costs and low machine automation, the most important factor is the seed removal efficiency of the seed remover itself. The three factors, such as low deuration rate, high crushing rate, and low cleanliness, directly affect the seeding efficiency of the seed removal device.

2.1. Low removal rate

The removal rate is the ratio of the weight of the extracted sunflower seeds to the total mass of the original sunflower seeds when the sunflower seeds are removed. The removal rate of most sunflower seed removers in China is between 95% and 98%. However, the actual deuration rate of some models of sunflower seed removers is low and cannot reach the standard. Especially for some small and medium seed removers, it is difficult to remove the seeds once, and even two times of seeds are required. Repeated seed removal will seriously reduce the working efficiency of the machine and increase the intensity of human labor.

The characteristic of the kneading seed removal roller is that the intensity is soft and does not harm the

sunflower disk. After the seeds are removed, the sunflower disk is still intact, so the breaking rate of the seed is very low. However, the kneading seed removal roller is easily removed. Sometimes the rubbing type seeding roller needs repeated seeding to achieve a 95% removal rate.

Figure 2 shows a kneading seed removal roller, which is also called a rib seeding roller. This type of straight seed removal roller can achieve seed removal, but it does not have the function of guiding the sunflower disc forward, so the phenomenon that the sunflower disc gets stuck in the drum may occur. In addition, the time for the sunflower tray to stay in the seed removal device is too short and the working time of the seed removal roller is insufficient, which is also the reason for the low removal rate.

2.2. High breaking rate

The breaking rate is also called the damage rate, which refers to the ratio of the weight of the damaged sunflower seeds to the weight of all sunflower seeds after the seed is removed. Sunflower seed fragmentation is a problem that cannot be avoided by all sunflower seeders. In China existing sunflower seed removers, the crushing rate is generally between 2% and 5%. This is a big loss for large-scale farmers. For the seeder, it also reduces the work efficiency from the perspective of the variable.

The percussion seed removal roller achieves seed-removal by hitting the sunflower plate. The removal rate is much higher than the kneading seed removal roller, and there is no problem of repeated seeding. However, due to the strong force of the percussion seed removal roller, the damage to the sunflower disk is extremely great. There is almost no complete sunflower disc after seeding is completed, so the crushing rate of sunflower seeds is high.

Figure 3 is a percussion seed removal roller, which is also called a nail-type seed removal roller. There are two types of percussion seed removal roller: open and closed. Figure (a) is an open-type percussion seed removal roller, and figure (b) is a closed-type percussion seed removal roller. After the sunflower disc is broken by the percussion seed removal roller with tooth nails, the debris of the sunflower disc adds great difficulty to the subsequent screening and reduces the cleanliness of the

seed-removing machine.

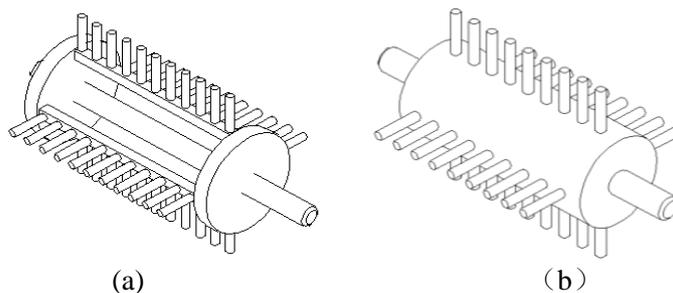


Figure 3. Figure with percussion seed removal roller

2.3. Low cleanliness

The cleanliness refers to the ratio of the mass of sunflower seeds to the total mass of the kernel mixture after deseeding. Both the seeding process and the screening process will affect the cleanliness, especially the percussion seed removal roller. Fragmentation of the sunflower disk during seed removal will lead to increased impurities in the kernel mixture, which will increase the difficulty of screening. Therefore, avoiding sunflower disk fragmentation is an important measure to improve the cleanliness.

3 Strategies of improve the work efficiency of sunflower seed remover

Early sunflower seed remover was only equipped with one kind of seed removal roller, which can only ensure one of the crushing rate and the cleaning rate. The more advanced sunflower seed remover now has a compound seed removal roller structure. A sunflower seed remover is equipped with two types of seed removal roller. First, the sunflower plate is passed through a kneading seed removal roller to peel off most of the relatively easy-to-remove seeds from the sunflower plate. At this

time, only the seeds that are difficult to remove are left on the sunflower plate. Subsequently, the sunflower discs passed the percussion seed removal roller, which not only greatly reduced the crushing rate of sunflower seeds, but also achieved a higher rate of depuration by cracking the seeds. One action achieves two effects.

However, the structure of the seed removal roller of the existing compound sunflower seed remover is two types of seed removal rollers installed side by side, which is called a composite seed removal roller. As shown in Figure 4, the kneading seed removal roller is installed on the side near the feeding inlet. The sunflower plate is first passed through a kneading seed removal roller. The percussion seed removal roller is installed on the exit side, and the sunflower disc is discharged from the outlet through the percussion seed removal roller. The kernel mixture falls into the screening device below for screening. Compared with a single seed removal roller, this composite seed removal roller not only meets the high removal rate, but also guarantees a low crushing rate. However, such a side-by-side structure is prone to malfunctions in which the sunflower plate is stuck between the two seed removal rollers. The problem that the straight seed removal roller cannot guide the sunflower plate forward still exists.

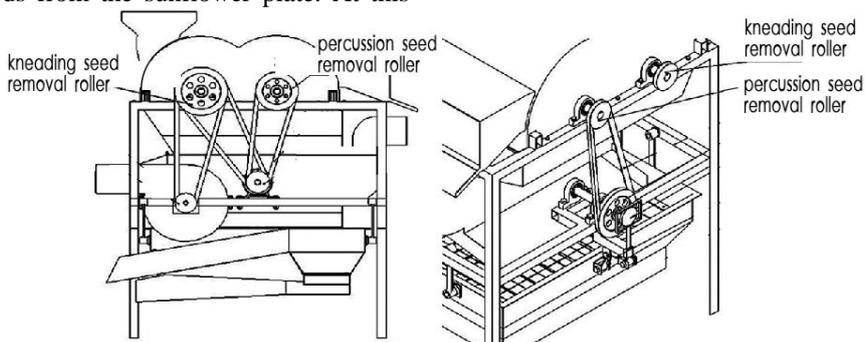


Figure 4. Figure with paralleling compound seed removal roller

The design of the new combined seed removal roller is based on the spiral advance seed removal roller. Figure 5 shows a spiral advance seed removal roller. At present, it is a more advanced type of seed removal roller, which is an improved type of kneading seed removal roller. In addition to its function of seed removal, it can also

transport the de-sunned sunflower discs to the outside of the machine by means of spiral conveyance according to the principle of spiral push.



Figure 5. Figure with spiral advance seed removal roller

The principle of the new combined seed removal roller is to combine the kneading seed removal roller and the percussion seed removal roller on the same seed removal roller. This design will be improved from two aspects: First, on the basis of the spiral advance seed removal roller, the second half will be changed to a tooth nail seed removal roller. And reduce the size of the nails, increase the number of nails, change the "knock" to "comb brush". The purpose is not to break the sunflower plate as much as possible, to improve the cleanliness of the seed remover. Second, increase the total length of the seed removal roller, the purpose is to extend the working time of the sunflower plate in the seed removal device and improve the removal rate.

Figure 6 shows the structure of a new combined seed removal roller. In the initial design, the total length of the seed removal roller was set to 1600mm. The seed removal roller is divided into two parts, the length of the kneading seed removal roller portion is 900 mm and the length of the percussion seed removal roller is 650 mm. The kneading seed removal roller is longer than the percussion seed removal roller, because the new combined seed removal roller is designed based on the principle of kneading and supplementing the impact. Most of the kernels are threshed by rubbing to ensure a low crushing rate. The remaining small part is completed by the percussion seed removal roller to ensure a high removal rate.

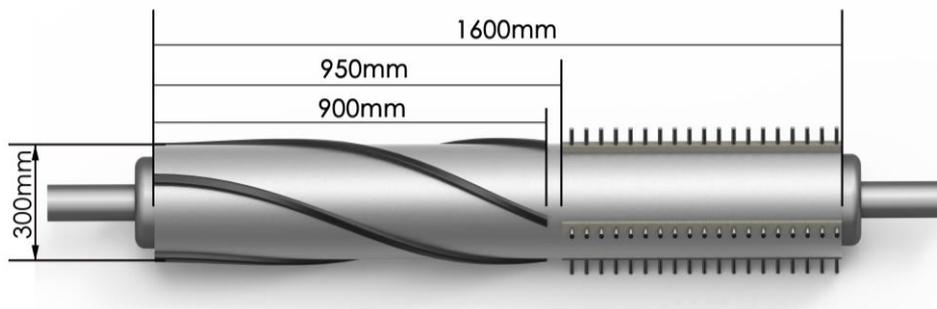


Figure 6. Figure with new combined seed removal roller

Through a comparative experimental study of the performance of the new combined seed removal roller and other seed removal rollers, the data comparison of the three indicators of deputation rate, crushing rate and cleanliness is obtained, as shown in Table 1. In terms of performance, the new combined seed removal roller has significant advantages. The removal rate can reach 97%

in one time and the crushing rate is reduced to less than 1%. The cleanliness is also higher than other seed removal rollers. In addition, during the experiment, there is no phenomenon that the sunflower disc is stuck in the drum, indicating that the new combined seed removal roller solves the problem that the compound seed removal roller is prone to failure.

Table 1. Comparison of primary decontamination rate, breaking rate, and cleanliness

Seed removal roller type	Primary decontamination rate	Breaking rate	Cleanliness
Kneading	85%	1.5%	95%
Percussion	90%	2.5%	90%
Parallel compound	95%	2%	95%
All-in-one compound	97%	≤1%	98%

4 Conclusion

By analyzing the working principle of the existing sunflower seed remover in China, the main reasons for the low efficiency of the sunflower seed remover are: low removal rate, high crushing rate, and low cleanliness. Based on the above reasons, starting from the most important seed removal device, a solution to improve the

work efficiency of the sunflower seed remover was proposed: designing a new combined seed removal roller, which is based on the spiral advance of the deseeding roller. In addition, the kneading seed removal roller and percussion seed removal roller are combined to achieve a high removal rate and a low breakage rate. At the same time, the percussion seed removal roller was improved to a comb-type seed-removing, without breaking the sunflower tray, which effectively improved the

cleanliness of the seed-removing machine. The new combined seed removal roller has the following advantages: first, improve the working efficiency of sunflower seed remover. According to the experimental results, compared with other deseeding rollers, it can indeed improve the removal rate, reduce the crushing rate and improve the cleanliness. Second, reduce the failure rate. The new combined seed removal roller solves the problem that the compound seed removal roller is prone to get stuck in the middle of the two rollers. Third, the structure is simple. Combine the percussion seed removal roller and the kneading seed removal roller on the same seed removal roller. Compared with the compound seed removal roller, the new combined seed removal roller has a simpler structure and is easier to maintain and upkeep.

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