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Current Status Of Research On Cleaning And Homogenising Devices For Longitudinal Flow Combine Harvesters

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Abstract:
In the process of rapid improvement of corn mechanized harvesting level, it is found that longitudinal axial flow threshing exists the problem of uneven distribution of discharged material on the sieve surface, and short clearing time of discharged material at the rear of the drum leading to large entrainment loss, in view of the problem, firstly, we explored the research of domestic and foreign researchers in improving the effect of uniform distribution of discharged material and found that many scholars at home and abroad have carried out research on the technology of uniform distribution of discharged material, which indicates that uneven distribution of discharged material of longitudinal axial flow drum is the bottleneck of the current development of discharged material technology. This shows that uneven distribution is the bottleneck that restricts the development of longitudinal flow scavenging technology. Therefore, this paper reviews the research progress of domestic and foreign grain combine harvester cleaning and spreading technology and devices from the aspects of cleaning and spreading device structure and material movement, and analyses and elaborates on the development trend of combine harvester cleaning and spreading device, in order to further improve the working performance, operational efficiency and adaptability of combine harvester cleaning and spreading device in China.

Key word: *Sorting device, uniform device,Longitudinal flow combine harvesters, sum up*

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I. Introduction

Maize is a key food crop all over the world, and maize in China is grown in a wide range of areas and varieties [1]. Relevant statistics show that in 2023, the sown area of maize in China will be 0.45 billion hectares, and the total output will be 280 million tonnes, with a year-on-year increase of 96 kg/ha per unit area [2].During the "14th Five-Year Plan" period, China's agricultural mechanization made important progress, especially the corn combine harvester began to be applied on a large scale, which had a far-reaching impact on improving the efficiency of agricultural production and the development of agricultural modernization. With the improvement of agricultural machinery and agronomy, corn production has been increasing year by year; corn harvesting has been transformed into large-scale production and mechanical harvesting, and at the same time, large-feeding combine harvesters have also begun to be widely used[3]. According to the "14th Five-Year Plan" National Agricultural Mechanisation Development Plan, "accelerating the development of large-scale high-efficiency

combine harvesters" and "improving the ability of independent research and development of agricultural machinery and equipment, and supporting high-end intelligence "has been elevated to the height of the national strategy, so it is important to research on this combine harvester, in line with the requirements of the national policy, but also the inevitable choice of the development of agricultural modernization [4].

The advantages of longitudinal flow combine harvester are long stroke, large separation area, high productivity, strong applicability, etc., and thus its share in the market is increasing[5].

With the increased demand for large-feeding grain harvesting equipment in production, the longitudinal flow drum, as a core component of large-feeding harvester that reduces threshing intensity, prolongs threshing time, and ensures the quality of operation, is affected by its layout and rotational speed, resulting in a serious inequality in the load distribution in the direction of the width of the clearing sieve screen surface, which shows "two sides are high, and the middle is low ", in this case, the clearing pressure of each region is obviously different, and the traditional clearing vibrating screen in the operation process can not achieve the effect of uniform distribution of particles, thus varying degrees of aggravation of the clearing vibrating screen screen load, which seriously affects the operational performance of the clearing system; coupled with the longitudinal axial flow of the threshing end of the threshing out of the seeds, the distance between the light impurities too close to the discharge outlet, resulting in an increase in the clearing loss [6], which is the main reason for the increase of the clearing loss. The increase in cleaning loss.

Obviously, it is of great practical significance to study the technologies that can improve the homogeneous distribution of large feeding capacity scavenging screen surface, reduce the load of scavenging vibrating screen and improve the loss of scavenging screen scattering tailing to become the key of longitudinal axial flow grain harvester.

II. Current Status Of Research On Scavenging And Homogenising Devices

The key component of the combine harvester is the scavenging device, and the main index for evaluating its performance is the scavenging quality. In order to meet the performance requirements of the combine harvester, it is necessary to carry out research on the improvement of the scavenging device, and at present, there are many studies related to this, mainly involving the study of lateral homogeneous distribution of discharged material, the structure of the blower and the optimization of the working parameters, etc., and the following is a description of the relevant information of these researches.

Research status of foreign clearing and homogenising devices

The German company CLAAS® [7,8]developed 3D and 4D scavenging technologies to meet the requirements of combined harvester effect scavenging performance, and the following figure shows its structural composition. The former set up 3D cleaning vibrating screen, in the process of operation, according to the slope of the ground, the attitude of the vibrating screen can be adjusted in real-time, so as to control its level with the ground; the latter additional drum baffle and sweeper, the combination of the 4D cleaning device. The rotational speed of the drum baffle can be adjusted according to the amount of discharged material during operation, so as to improve the cleaning performance.

Fig. 1 CLAAS TUCANO Series 3D Cleaning Device

Fig. 2 CLAAS AVERO Series 4D Cleaning Device

The American company Gleaner®[9]developed a high-performance threshing and separation system, shown in Figure 3, with single screw push churns on both sides, through which a homogeneous distribution of the material is achieved, thus controlling the uniform fall of the material onto the screen surface.

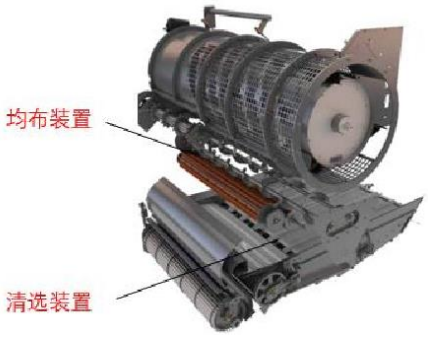

Fig. 3 Gleaner S8 Cleaning Device

Fig. 4 CASE Cleaning Device

CASE® company[10]developed a new type of scavenging device, as shown in Figure 4, which consists of churning discs, cross-flow fans, pre-scavenging plate, in the processing of the material from the concave plate into the churning discs, followed by certain churning conditions into the scavenging chamber, so that the scavenging efficiency after treatment is greatly improved, and can be highly efficient scavenging under the conditions of the large feeding volume.

Research status of domestic scavenging and homogenising device

In 2008, Jiangxi Agricultural University, Xu Jing et al[11] in order to improve cleaning efficiency, developed a high-performance grain transverse cleaning vibrating screen, Figure 5 shows its structural composition, the analysis can be seen in which the drop mouth of the transverse amplitude is larger, so as to promote the material extension of the screen surface transversely on the uniform distribution.

In 2008, Chen Ni et al[12] developed a high-performance wind sieve cleaning device, in the operation of the reasonable taper conditions can be obtained under the 2. 5m-s-1 transverse wind speed, the lateral uniformity of the particles of the performance of a significant improvement in the clearing of the impurity rate of not more than 0.64%.

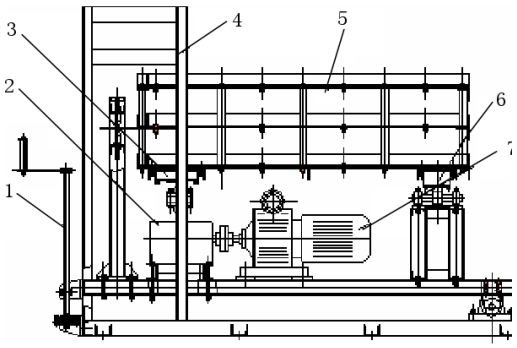

Fig. 5 Transverse Vibration Plane Cleaning Sieve

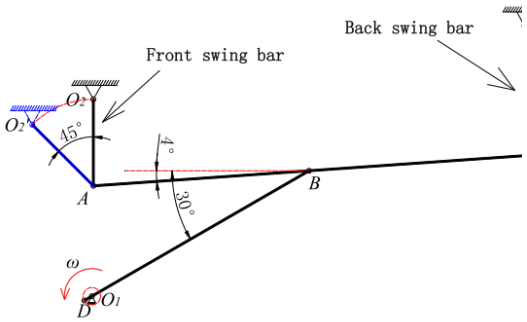

Fig. 6 Variable Amplitude Cleaning Sieve

In 2015, Ma Zheng et al [13] from Jiangsu University developed a linkage-type variable amplitude mechanism, as shown in Fig. 6, and the test results showed that it could effectively solve the problems related to uneven distribution of dislodged material as well as material accumulation during operation.

In 2016, Zhang Min et al [14] from Nanjing Agricultural Mechanization Research Institute of the Ministry of Agriculture developed a high-performance double-drum wind-screening test platform, which analysed the variation of the cleaning loss rate and the seed impurity rate under different working parameter conditions through the response surface methodology, and the optimal parameter combinations were given based on the results obtained to provide support to improve its operational performance.

In 2016, Tong Shuguang et al [15]specifically discussed the problem of inhomogeneous airflow field of traditional single-duct centrifugal fan, specifically analysed the reasons for its generation, and then put forward the fan structure improvement scheme, and then carried out the numerical simulation of the mixed airflow field through the computational fluid dynamics method, and then optimized the working parameters of the scavenging after the processing of the obtained results, and finally compared the results of the simulation and analysis with the measured results, to validate the value of its application. value is verified.

In 2017, Li Yang et al [16]specifically analysed the changes in the airflow field inside the scavenging device under different conditions of feeding volume in the research process, and then detected the changes in the airflow field under each feeding volume condition based on anemometer, and the results found that the airflow velocity decreased to a certain extent after increasing the feeding volume, and curve fitting was performed on the trend of the vibrating screen airflow velocity.

At present, most of the foreign combine harvester are installed with the dislodged material uniform distribution device, in the process of operation can be adjusted according to the working conditions of the appropriate dislodged material related parameters, in order to achieve the optimal dislodging and clearing effect. Some foreign Russian scholars also for threshing separation device and cleaning device joint research, so that in the conditions of large feeding volume can also be efficient processing. However, these uniform device also exists a certain scope of application, for wheat, soybean and other crops, the application of good results, but the domestic corn combine harvester with this research and application reports are relatively lack of.

III. Conclusion

In summary, although the previous researchers have recognised that longitudinal flow threshing has the problems of uneven distribution of rejects on the cleaning screen surface and large cleaning loss, and have also carried out various explorations on the methods to improve the load equalisation, however, few studies have

been carried out on the problems such as clogging of vibrating screen caused by uneven rejects in large-feeding combine harvesters. Therefore, as the development and promotion of large-feeding grain harvesters centred on longitudinal flow threshing is accelerated in China, it is crucial to strengthen the research on the load distribution technology of discharged material screen surface based on longitudinal flow threshing to crack the bottleneck problem.