Scholar Publishing Group
Academic Journal of Agricultural Sciences
https://doi.org/ 10.38007/AJAS.2021.020406
ISSN 2789-8415 Vol. 2, Issue 4: 68-80

Diagnosis of Performance Degradation of Combined Rotor of Agricultural Tractor in Maize Planting

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Keywords: Agricultural Tractor, Combination Rotor, Performance Degradation, Corn Planting, Diagnostic Studies

Abstract: The purpose of this paper is to study the diagnosis of performance degradation of the combined rotor of agricultural tractor in maize planting. Based on corn fields farm tractors combination performance of the rotor as the research object, select 5 farms in guizhou city, each farm choose 5 tractors, doing experiments on the sample first, mathematical statistical analysis were used to detect the corn planting farm tractors in the total length of the rotor, roulette section length, length of shaft parts, wheel diameter, rotating shaft part diameter, diameter of these composite rotor bar each physical parameter; The variation law of bending frequency of the first 3 orders with time was analyzed by statistical method. And a single variable method is used to compare the experimental and simulation results of bending frequencies at different moments. The experimental data show that the bending frequency of the first 3 orders of the combined rotor increases with the change of time. There is little difference between the performance degradation trajectory of the model and the simulation results, which to some extent verifies the correctness of the research theory and method of performance degradation of the combined rotor caused by disk creep. The experimental study shows that with the increase of time, the disc creep will cause the performance degradation of the combined rotor. The higher the speed and the more the number of pull rods are, the faster the degradation rate of the combined rotor will be. The performance degradation diagnosis study increases the speed by 84.34% to observe the degradation degree of the combined rotor to reduce the tractor failure problem.

1. Introduction

Tractor in corn planting is a kind of mobile agricultural power machinery, which can tow, suspend and drive various agricultural machinery, and can complete a variety of operations such as ploughing, harrowing, sowing, harvesting, cultivating and transportation in corn planting. Based on this, we need to strengthen the diagnosis of the degradation of the combined rotor performance of agricultural tractors in corn planting by farmers, ensure that the correct methods and technologies are used to carry out maintenance and repair of agricultural tractors, and improve the quality and efficiency of operations. After a certain period of use of agricultural tractors in corn planting, due to changes in operation, friction, vibration, and load, it is inevitable to loosen the connections of various parts, wear, corrosion, fatigue, aging, and clogging of debris. The technical status of tractors has changed. In order to prevent accidents, it is necessary to master the diagnosis of the degradation of the rotor performance of agricultural tractors in corn planting.

The structure of agricultural tractor combined rotor motors mainly includes magnetic barrier reluctance motors, permanent magnet auxiliary reluctance motors, and permanent magnet switched magnetic chain motors. All combined motors have the advantages of a single motor, so they have attracted widespread attention from scholars at home and abroad. Combined rotors are the core components of agricultural tractors. According to incomplete statistics from Siemens, about 58% of various accidents or failures in agricultural tractors come from tie rod combined rotors. At present, there are very few studies on the performance degradation of agricultural tractor combined rotors. Therefore, by studying the cause of detuning and the mechanism of performance degradation of the combined rotor couplings of agricultural tractors, and finding out the evolution law of the faults, it has great research value and practical significance for improving the reliability of agricultural tractor systems. According to statistics, currently more than 70% of the failures of machines and structures are mainly caused by fatigue cracks. In recent years, there have been many researches on cracked rotors. The stiffness matrix of the cracked rotor, the slenderness ratio and other factors on the stiffness of the cracked rotor have been derived by using the combined rotor to consider the bending moment at the crack [1-2]. The stiffness of a rotating shaft with cracks in the direction of 3 coordinate axes under 6 forces and moments is analyzed, and the 6th-order stiffness matrix of the rotating shaft with cracks is derived. The fatigue crack growth of the rotor is studied.

Savta PA considers that the degradation of the combined rotor performance is one of the main factors affecting the comfort of agricultural tractor operators [3]. For the past 20 years, car quality and consumer perceptions and needs have been an increasingly important part of the automotive engineering process. This subject is related to the research on the performance of tractor combined rotors. The design and analysis of the steering system plays an important role in determining the source of the problem. The results show that the main causes of the degradation of the combined rotor performance are engine imbalance, steering system resonance, low damping, and road / field induced vibration. A steering vibration study of different tractor types was conducted, and a tractor in need of improvement was identified. Through a detailed analysis of a certain tractor, it was found that the resonance of the steering system with the engine excitation is the root cause of excessive vibration. In order to reduce the vibration caused by resonance, various methods have been considered, such as moving the natural frequency away from the second-order engine frequency and increasing the damping coefficient to reduce the vibration amplitude at resonance. The concept of axial shock absorbers is used for vibration reduction. In the Matlab SIMULINK environment, the two-degree-of-freedom model with base excitation is analyzed. The key is: steering wheel, vibration, damper, frequency, resonance, and amplitude. Mousavi S F believes that fault diagnosis of agricultural tractors must be carried out in a timely manner. In order to complete agricultural operations in a timely manner and optimize the accuracy and integrity of the system, correct monitoring and fault diagnosis of rotating components is required [4].

The purpose of this paper is to study the performance degradation diagnosis of agricultural tractor combination rotors in corn planting, which is of great significance for ensuring the long-term safe operation of agricultural tractor combination rotors. In this paper, the rotor performance of agricultural tractor combination rotors in corn planting fields is taken as the research object. Five farms were selected in Guizhou City, and five tractors were selected for experiments on each farm. The samples were first analyzed by mathematical statistics to determine the total rotor length, The physical parameters of the combined rotor such as the length of the roulette part, the length of the shaft part, the diameter of the roulette part, the diameter of the shaft part, and the diameter of the tie rod; the statistical analysis of the first three orders of the bending frequency with time using the statistical method; Comparison of the experimental and simulation results of the bending method at different moments with the variable method.

2. Proposed Method

2.1. The Connotation of the Combined Rotor

2.1.1. Combined Rotor Finite Element Model

According to the type and amount of installation, the combined rotor has different number of pull rods and wheel series, and the combined rotor of a dongqi agricultural tractor is studied [5-7]. The composite rotor is composed of compressor segment and turbine segment. The turbine segment is of high temperature and easy to creep. The influence of high-temperature creep is generally considered in the turbine segment when performance degradation analysis of the composite rotor is carried out. There are more wheel series in compressor segment, and the pull rod is longer. Due to the large alternating stress in the process of starting and stopping, fatigue cracks are easy to occur. Most of the energy loss of agricultural tractors is caused by the performance degradation of the compressor segment of the combined rotor.

The existence of interdisc contact interface is the biggest difference between composite rotor and integral rotor. The existence of contact interface causes the local stiffness of composite structure to change, and the different interface states directly affect the vibration characteristics of the structure.

In order to accurately conduct the dynamic analysis of the combined mechanism, it is necessary to obtain the contact stiffness of the rough surface [8]. The cross scale calculation method combining the analysis of the microelement body model with the same interface roughness and the macroscopic size is adopted. The interface normal contact stiffness of the combined rotor under the action of preload is obtained by using equations (1) and (2) :

$$K = \frac{S_1}{S_2} k_n \tag{1}$$

$$F = P \times S_1 \tag{2}$$

Where: S1 is the contact interface area of the wheel; S2 is the contact interface area of the microelement; P is the interface pressure after pre-tightening; Kn is the normal contact stiffness of the microelement body model; F is the preload force of the combined rotor; K is the interface normal contact stiffness [9-12].

In the dynamic analysis of the combined rotor, the contact interface is treated with equivalent treatment. When the normal stiffness is known, the contact stiffness is equivalent to the elastic modulus $\overline{E}$ of the virtual material layer according to the principle of strain energy equality. The equivalent formula is

$$\overline{E} = \frac{Kh}{S_1} \tag{3}$$

Where, h is the thickness of the virtual material layer.

2.1.2. Stability Analysis of Combined Rotor

For simple analysis and calculation, the magnetic flux leakage effect between ALA segment and SPM segment was ignored and the isotropy of SPM segment was assumed. The state equation of the combined rotor motor in coordinates d and q:

$$\frac{\mathrm{d}i_d}{\mathrm{d}t} = -\frac{R}{L_d} i_d + \frac{L_q i_q - \psi_\mathrm{f} \sin\alpha}{\mathrm{L}_d} \omega_\mathrm{r} - \frac{\mathrm{V}}{\mathrm{L}_d} (\delta - \alpha) \tag{4}$$

$$\frac{\mathrm{d}i_q}{\mathrm{d}t} = -\frac{R}{L_q} i_q - \frac{L_d}{L_q} i_d \omega_r - \frac{\psi_f \cos\alpha}{L_q} \omega_r + \frac{V}{L_q} \cos(\delta - \alpha) \tag{5}$$

$$\frac{\mathrm{d}\delta}{\mathrm{d}t} = \omega_s - \omega_t \tag{6}$$

$$\frac{\mathrm{d}\omega_t}{\mathrm{d}t} = \frac{3p^2}{2J} \left[\psi_f i_q \sin\alpha + \psi_f i_d \cos\alpha + (L_d - L_q) i_d i_q \right] - \frac{B}{J} \omega_r - \frac{p}{J} T_L \tag{7}$$

Where, B is the coefficient of mechanical viscous friction damping; ψ_f is the permanent magnetic linkage of the combined rotor motor; ω_S is the synchronous angular velocity; T_L is load torque; J is the moment of inertia of the motor; δ is the power Angle.

2.2. Failure of Farm Tractor

2.2.1. Principles of Fault Analysis

The breakdown of tractor, its performance symbol is various, its generation reason is intricate. A fault may appear as a variety of phenomena, and a phenomenon may reflect a variety of faults, which brings complexity to fault analysis.

The following principles must be followed in fault analysis and inspection:

(1) During fault analysis, do not disassemble or disassemble randomly.

(2) When conducting fault analysis, first of all, we should learn to apply materialist dialectics, do more investigation and research, take the phenomenon as the guide of understanding, through the phenomenon to see the essence; To use the point of view of development and change to see the problem, the specific situation specific analysis.

(3) In fault analysis, the structure and contact principle should be combined.

(4) Failure analysis, but also follow from simple to complex, from the surface to the inside, easy before difficult, according to the points of segmentation. Follow the rules.

(5) When conducting fault analysis, be good at summarizing and accumulating experience.

2.2.2. Troubleshooting Methods

(1) Division: the fault area is preliminarily judged, and then the work of a system or a part is partially isolated or cut off, and the fault range is determined by observing the change of signs.

(2) Trial method: for some parts within the fault range, through tentative elimination or adjustment measures, to judge whether it is normal.

(3) Comparison method: replace the parts that may have problems with the same parts that work

normally, and judge whether there is a fault according to the change of signs.

(4) Empirical method: determine the technical status of each tractor component mainly by the feeling of the ear, eye, nose, body and other organs of the operator.

(5) Instrument method: the use of special instruments, instruments, in the case of less disassembly or disassembly more accurately understand the quality of the tractor.

2.2.3. Problems That Should Be Paid Attention To

(1) Do not tighten the screws and bolts

For screws or bolts in important parts such as tractor transmission box, cylinder head, wheel hub, connecting rod and front bridge, the operating tools and tightening torque are specifically stipulated in the manual, for example, screw and bolt will be broken due to manual tightening, or screw thread or buckle will cause failure. General screw or bolt, its tightening torque can be generally 4 times the thread diameter of the tightening torque to tighten.

(2) Avoid changing lubricating oil without cleaning oil channel

Many farm operators lack maintenance knowledge or are lazy, and do not clean the oil channel when changing lubricating oil, thus burying safety risks for themselves. It is important to know that after the use of lubricating oil, there is a lot of residual mechanical impurities in the oil. Especially after the new or overhaul of the locomotive, more impurities after the test run, if not cleaned in a hurry to put into use, it is easy to cause burning tile, axle and other accidents.

(3) Avoid not to choose lubricating oil according to the season

Many farm operators do not pay attention to the selection of lubricants according to the season, winter use of summer lubricants, summer use of winter lubricants, regardless of quality, cheap to buy, resulting in locomotive starting difficulties and burning bushing and other undesirable phenomena. It is hoped that agricultural machine operators should choose the lubricating oil that has passed the quality test and the applicable temperature label.

(4) Do not install the piston with open flame heating

The thickness of each part of the piston is not uniform, and the heat expansion and cold contraction degrees are different, which is easy to cause deformation. If the piston is heated with an open flame to a certain high temperature, the metal structure will be damaged after natural cooling and reduce wear resistance, its service life will be greatly shortened.

(5) Do not use butter when installing the cylinder cushion

Many farmers are used to butter the cylinder when installing the gasket, thinking that this can increase the sealing of the cylinder, but I do not know that this practice is just the opposite. Because the butter is partly lost when exposed to high temperature, the gap between cylinder pad, cylinder head and the plane of the body is generated, the high temperature and high pressure gas is easy to impact from here, destroy the cylinder pad, resulting in air leakage. In addition, butter for a long time in the state of high temperature will produce carbon accumulation, resulting in premature aging and deterioration of cylinder cushion.

2.2.4. Agricultural Tractor Maintenance Operation Points

At present, in the tractor maintenance aspect, because the consciousness is weak and the method is backward, so, seriously affected the tractor service life. To this end, must thoroughly understand the current tractor maintenance situation, master the specific maintenance method, only in this way can ensure the normal operation of the tractor. Tractor technical maintenance, the engine must be shut off, with farm tools, should be farm tools landing. Technically complex maintenance must be carried out indoors.

(1) Wash regularly

Can keep the tractor clean, filling oil or lubricating oil, to avoid dust, debris and other into the machine. In addition, it can timely detect external hazards and prevent blockage, damage and corrosion of parts. Therefore, after each shift, to carefully remove the dust and grease outside the tractor after other maintenance work.

(2) Remove scale of cooling system

The engine cooling system requires the use of clean soft water to slow down the formation of scale and ensure the heat dissipation efficiency. Otherwise, scale will form in the cooling system, which will lead to overheating of the engine and insufficient power due to poor heat dissipation. In serious cases, accidents such as burning tiles and drawing cylinders will also occur. Therefore, keep the cooling system clean, clean cooling system scale, is not allowed to ignore the maintenance operations.

(3) Filling of grease

Add fresh grease according to the lubrication point, oil filling time interval and filling quantity specified in the technical maintenance regulations. Filling, often due to the existence of air in the butter gun, resulting in the actual injection amount is insufficient, therefore, to ensure that the amount of oil into the filling.

(4) Maintenance of filtration device

Air, fuel and lubricating oil filters are the key parts to retain impurities and reduce wear and tear of machine parts. The maintenance of air filter is mainly to remove dust in the accumulation cup, clean the central air inlet pipe, clean the filter screen and oil pan and change the oil. After using the paper filter element of diesel oil and oil filter for a long time, impurities are blocked and remain in the surface micropore, which gradually reduces the performance of the filter screen, increases the pressure difference between the inside and outside of the filter element, and even presses the folded piece together or destroys it. Therefore, check frequently. When the filter block is not serious, can be immersed in diesel oil with a pump blow wash from the inside out to restore its filtration capacity; If the blockage is serious, it should be replaced .

(5) Remove carbon deposits on the surface of piston, injector and other parts

Clear the surface of carbon accumulation cannot use metal articles to scrape, so as not to damage the surface of parts, should be cleaned parts in the metal cleaning agent after soaking, with brush, soft cloth to remove, not easy to remove the part of bamboo, wood chips can be gently scraped off.

(6) Oil addition and replacement

Tractor oil, in use will have a small amount of consumption. Therefore, the locomotive should be checked before each start, if necessary, according to the oil scale. The ruler line has two upper and lower, the oil capacity between the two lines is for regular consumption under normal operation. Generally the oil level should be between two lines and close to the upper line is advisable. Oil in use due to high temperature oxidation, produce colloid, carbon accumulation, mixed as grinding dust, resulting in oil deterioration, dirt, lubrication effect. Therefore, the oil should be used for a certain period of time, according to the technical maintenance requirements, to be replaced, otherwise it will accelerate the wear parts.

3. The Experiments

3.1. Experimental Settings

3.1.1. Experimental Background

The tractor is a kind of farm machinery commonly used in agricultural production in corn planting. Based on the above long-term production practice, the common fault diagnosis and elimination methods of the combined rotor performance degradation diagnosis in agricultural tractors are obtained. The unbalanced response of the combined rotor with different degrees of degradation was analyzed, and the degradation characteristics of the combined rotor were obtained. The unbalanced response of the combined rotor with different degrees of degradation was analyzed, and the degradation characteristics of the combined rotor were obtained.

3.1.2. Experimental Setting Process

Five farms were selected in guizhou city, and five tractors were selected from each farm for the experiment. The performance degradation of the combined rotor was diagnosed and studied, and the causes of the degradation and the influence of the degradation on maize planting were studied. According to the experimental phenomenon, various data were recorded, and the Excel software owned by the computer was used for data statistics. The one-way ANOVA program of SPSS19.0 analysis software was used for data variance analysis and comparison. The data results were expressed in the form of average value.

3.2. Experimental Steps

(1) Test the combined physical parameters of the rotor of the agricultural tractor in corn planting, such as the total length of the rotor, the length of part of the wheel, the length of part of the rotating shaft, the diameter of part of the wheel, the diameter of part of the rotating shaft and the diameter of the tie rod.

(2) The variation of the first 3 order bending frequency with time of the combined rotor of the tractor required for each farm experiment was detected in 5 farms

(3) Test 5 farms, and compare the experimental and simulation results of the combined rotor of the tractor required in each farm experiment with the bending vibration frequency at different times, and analyze and obtain the natural frequency of the combined rotor.

3.3. Matters Needing Attention in the Experiment

3.3.1. The Principle of Contrast

In setting up the experiment, usually create two group, one is using a combination of corn farm tractors in diagnosis for rotor performance degradation data of the experimental group, one is to use professional artificial measured data of the control group, then through intervention or control corn farm tractors combined rotor performance degradation after diagnosis to eliminate or reduce data error, can see more clear, more comparative corn farm tractors combination performance degradation in the diagnosis of rotor parameters in precision. Among them, the use of a lot of control methods, by positive control, standard control, self-control, etc., but the most commonly used is the blank control method.

3.3.2. Randomness Principle

The randomness principle of the performance degradation diagnosis experiment of the combined rotor of agricultural tractor in maize planting refers to the random sampling of the studied samples in the experimental range of the performance degradation diagnosis parameters of the combined rotor of agricultural tractor in maize planting. Only in this way can we ensure the significance of the diagnostic experiment of the performance degradation of the combined rotor of agricultural tractor in maize planting, reduce the unnecessary error of the diagnostic system of the combined rotor of agricultural tractor in maize planting, and balance the conditions brought by each application.

3.3.3. The Principle of Parallel Repetition

That is to show the variation range of one of the applied data in the performance degradation diagnosis of the combination rotor of agricultural tractor in maize planting and observe the difference of temperature in the performance degradation diagnosis of the combination rotor of agricultural tractor in professional artificial and maize planting. For the sake of scientific rigor, this experiment must be repeated many times. In order to minimize the data errors caused by unnecessary factors, samples must be randomly selected. Of course, this cannot guarantee that all the influences caused by unnecessary factors can be completely eliminated. The principle of parallel repetition is the answer to this confusion.

3.3.4. Single Factor Variable Principle

That is, the control variable, which highlights one application data of the performance degradation diagnosis experiment of the combined rotor of agricultural tractor in maize planting, while the other variables are controlled unchanged. To observe the effect of the data on the performance degradation of the combined rotor of the agricultural tractor in maize planting, that is, the other variables controlled unchanged must be consistent. It is precisely because when doing experiments, we may habitually forget some basic principles, which leads to errors in solving or designing experiments. Therefore, we must pay attention to the necessity and criticality of the basic principle in the diagnosis experiment of the performance degradation of the combined rotor of agricultural tractor in maize planting.

4. Discussion

4.1. Effectiveness of Diagnostic Study on Performance Degradation of Combined Rotor of Agricultural Tractor in Corn Planting

(1) The experiment of tractor combined rotor has carried on the physical parameters of the corn field, such as the total length of the rotor, wheel parts length, length of shaft parts, wheel diameter, diameter, rod diameter shaft parts, the combination of physical parameters on the farm tractors rotor performance degradation diagnosis research plays an important role, to be able to observe combined rotor degradation problem where is the key. The data show that the physical parameters of all the tractor combined rotors used in the five farms surveyed are similar, and the total length of the rotors is basically within the range of 370mm-400mm. The length of the turntable is within the range of 30mm-50mm; There are similar data in the length of the rotating shaft, the diameter of the rotating disc and the diameter of the rotating shaft respectively, which proves that the combined rotors of agricultural tractors selected by these five farms have similar physical data, which is of great significance for the diagnosis of the following performance degradation and reduces unnecessary errors caused by the test. The data acquisition table is shown in table 1 and figure 1.

Table 1. Physical parameters of the combined rotor

Farm	l_{rotor}/mm	l_{disk}/mm	l_{shaft}/mm	d_{disk}/mm	d_{shaft}/mm	d_{rod}/mm
Farm 1	380	30	50	120	40	10
Farm 2	400	50	70	135	55	20
Farm 3	390	35	45	135	60	20
Farm 4	370	45	60	145	50	15
Farm 5	400	50	65	150	55	15

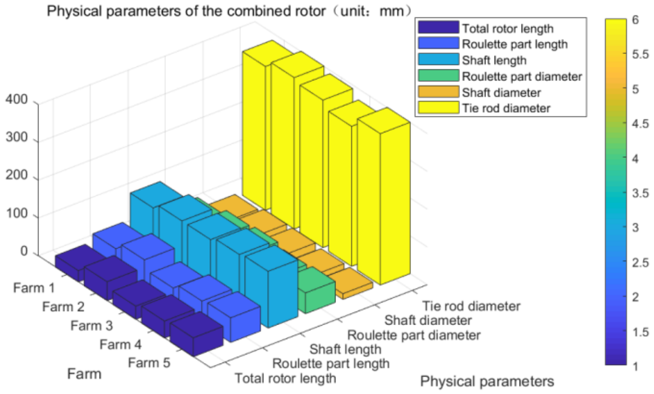

Figure 1. Physical parameters of the combined rotor

(2) In this experiment, the dynamic analysis of the combined rotor of agricultural tractor in corn planting was carried out. Since the crack of the tie rod has a great influence on the normal stiffness of the contact interface, the normal contact stiffness mainly has a great influence on the bending characteristics of the rotor, only the bending vibration characteristics of the combined rotor are analyzed here. In order to judge the degradation of the equipment, the main performance parameters are usually selected as the performance degradation characteristic parameters. Second, with the extension of product work or test time; Has the obvious trend change, can reflect the work state of the product objectively. The data show that the bending frequency of the first 3 orders of the combined rotor with the initial crack size of 0.1mm varies with time. The data acquisition table is shown in table 2 and figure 2.

Table 2. Variation of natural rotor frequency with time

Time / d	Natural frequency / Hz		
	1st order bending vibration	2nd order bending vibration	3rd order bending vibration
0	44.830	133.960	258.600
100	44.829	133.959	258.600
200	44.829	133.959	258.600
300	44.829	133.958	258.600
400	44.828	133.958	258.599
500	44.828	133.958	258.599
600	44.828	133.957	258.599
700	44.827	133.956	258.598
800	44.827	133.956	258.597
900	44.827	133.956	258.548
1000	44.826	133.920	258.497

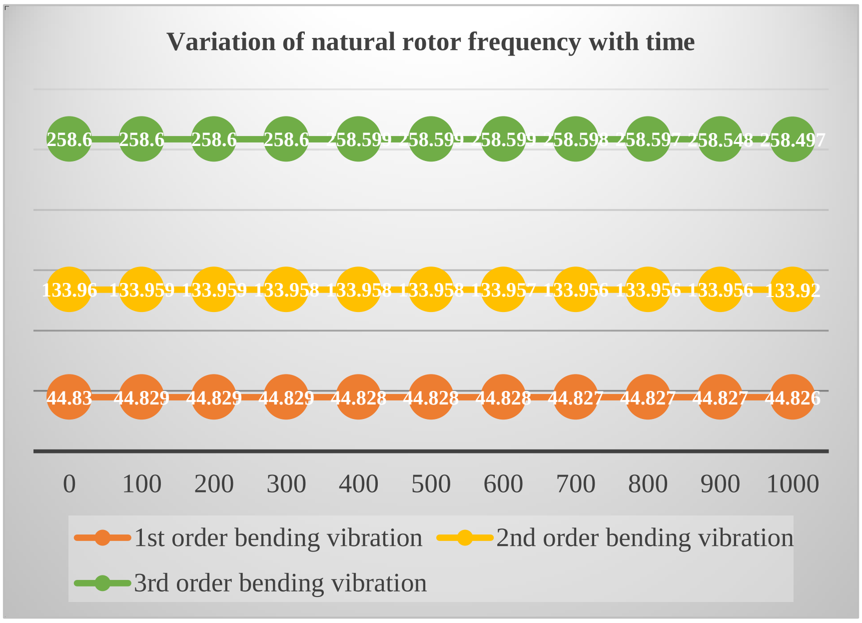

Figure 2. Variation of natural rotor frequency with time

4.2. Convenience of Diagnostic Study on Performance Degradation of Combined Rotor of Agricultural Tractor in Corn Planting

Firstly, the creep analysis of the experimental model was carried out to obtain the preload of the compressor end and the turbine end at different times, and then the inherent characteristics of the combined rotor were tested and calculated by using the experimental method and the finite element method respectively. In the experimental study, pulse excitation is applied on the composite rotor by means of hammer stroke to cause the free vibration of the composite rotor. Then, the response of the composite rotor is collected by means of displacement sensor, and the natural frequency of the composite rotor is obtained through analysis. The data acquisition table is shown in table 3 and figure 3.

Table 3. Comparison of experimental and simulation results of flexural vibration frequency

Time / h	Turbine end pretension / N	Compressor end pretension / N	Simulation value / Hz	Experimental value / Hz
0	42.00	42.20	48.91	48.08
10	41.85	42.00	48.83	48.00
20	41.15	41.85	48.76	47.93
30	40.60	41.70	48.71	47.88
40	40.10	41.55	48.67	47.84
50	39.65	41.45	48.64	47.82
60	39.25	41.35	48.61	47.79
70	38.85	41.25	48.59	47.76
80	38.45	41.15	48.57	47.74

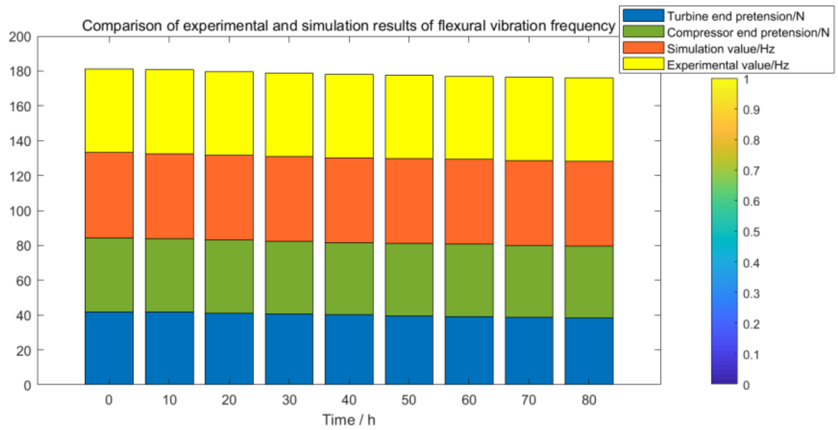

Figure 3. Comparison of experimental and simulation results of flexural vibration frequency

5. Conclusion

(1) The performance of the combined rotor of the agricultural tractor in corn planting is very important, but there are still many misunderstandings. To corn farm tractors in the combination of the rotor performance is more scientific and reasonable, you need according to the actual situation, combined with technical parameters of farm tractors, detailed analysis of the mechanical state, at the same time to organize technical training for corn farm tractors in hand, make them understand the basic working principle of the mechanical, master corn farm tractors in the combination of the rotor performance technology, in order to improve the corn farm tractors in efficiency, prolong its service life.

(2) Due to the influence of various factors, corn planting agricultural tractors still cannot be integrated, so the corn production level cannot be improved. According to the complicated geographical situation in the north, measures must be taken to integrate the agricultural tractor and agronomy in corn planting, so as to facilitate the production of corn. The performance degradation of combined rotor, as the core component of agricultural tractor in maize planting, will have a great influence on the performance of the whole agricultural tractor. In order to reveal the performance degradation mechanism caused by the damage of the combined rotor structure, the stress relaxation of the tie bolt at high temperature is considered, and the time history based change law of the tie bolt preload is obtained. The degradation index of the composite rotor was defined by the preload of the tie rod, and the degradation degree of the composite rotor was evaluated. The contact stiffness of the wheel interface is calculated, and the dynamic analysis of the combined rotor considering the contact interface is carried out. Temperature is a sensitive parameter affecting the performance degradation of composite rotor. The relaxation of the tie rod leads to the natural frequency drift of the combined rotor. The reduction rate of the first 3 natural frequencies of the combined rotor differs little and is linear with the degradation amount within a certain range.

(3) Among the food crops in north China, corn plays a very important role. The purpose of this paper is to study the diagnosis of performance degradation of the combined rotor of agricultural tractor in maize planting. Based on corn fields farm tractors combination performance of the rotor as the research object, select 5 farms in guizhou city, each farm choose 5 tractors, doing experiments on the sample first, mathematical statistical analysis were used to detect the corn planting farm tractors in the total length of the rotor, roulette section length, length of shaft parts, wheel diameter, rotating shaft part diameter, diameter of these composite rotor bar each physical parameter; The variation law of bending frequency of the first 3 orders with time was analyzed by statistical method. And a single variable method is used to compare the experimental and simulation

results of bending frequencies at different moments. The experimental data show that the bending frequency of the first 3 orders of the combined rotor increases with the change of time. There is little difference between the performance degradation trajectory of the model and the simulation results, which to some extent verifies the correctness of the research theory and method of performance degradation of the combined rotor caused by disk creep. The experimental study shows that with the increase of time, the disc creep will cause the performance degradation of the combined rotor. The higher the speed and the more the number of pull rods are, the faster the degradation rate of the combined rotor will be. The performance degradation diagnosis study increases the speed by 84.34% to observe the degradation degree of the combined rotor to reduce the tractor failure problem.

Funding

This article is not supported by any foundation.

Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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