Optimization Design of Electric Tractor for Small Seeding Machinery

Yan-yu GAO, Xi WANG and Jian-jun LI*
Yunnan Agricultural University, Faculty of Mechanical and Electrical Engineering,
Kunming 650201, China
*Corresponding author

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Abstract. Aimed at the complicated structure of existing planters and the serious pollution of tractor exhaust gas, a small electric tractor for planter was designed. The structure and working principle of the machine are introduced, and the selection of main parts is expounded. The design can complete the operation of loose soil, sowing, and covering soil, and provide reference for the planting machine of crops in small areas.

Introduction

Tractor is a self-propelled power machine for hauling and driving work machines to complete various mobile operations, and can also be used as a fixed work power. It is composed of system or devices such as engine, transmission, walking, steering, hydraulic suspension, power output, electrical instrumentation, driving control and traction.

The engine power is transmitted from the transmission system to the drive wheels to drive the tractor. In real life, it is common to use a rubber belt as a power transmission medium. According to the function and purpose, it can be divided into tractors for agriculture, industry and special purposes; it can be divided into wheel type, track type, ship-shaped tractor and self-propelled chassis according to structural type [1-3]. However, most of the existing tractors are driven by diesel engines and face problems such as noise, heavy pollution, and low efficiency. With the popularization of new energy sources, electric tractors have begun to be applied, therefore, the electric tractor for sowing needs to be redesigned in the electrification.

Analysis of Tractor Characteristics

Characteristics of Traditional Tractor

With the continuous improvement of tractor technology, there are more and more tractor manufacturers in China and tractors have been developed in various regions. The existing tractors basically use diesel as a power source, which increases emissions, causing serious problems such as environmental pollution and oil shortages. The cost is greatly increased and reliability is also a challenge [4]. The main problems with tractors are as follows:

1. Large vibration, poor driving seat environment and low comfort. When the tractor is working in the field, it will produce severe vibration, and the driver's operation will be degraded due to the stability of the tractor operation, which will easily lead to accidents [5-8]. Tractors often operate in paddy fields or in arid soil environments. Dust or dirt in the soil can cause the driver to be in a relatively poor environment and affect operations.

2. Exhaust gas pollution is serious and damages the environment. The main pollutants emitted by diesel tractors during work are hydrocarbons, carbon monoxide, nitrogen oxides, and particulate matter. The exhaust emissions are more serious.

3. Many farmers in the use of tractor for easy, often overloaded, in violation of relevant provisions of the "Road Traffic Safety Law," will result in the occurrence of accidents.
Characteristics of Electric Tractor

In recent years, with the rapid development of electric vehicles and electric vehicles, many agricultural machinery researchers have begun to do a lot of research on agricultural machinery based on the characteristics of simple structure and flexible operation of electric vehicles. At present, many electric tractors are studied. The core electric tractor is an electric drive system, the motor converts electrical energy into mechanical energy. The output shaft of the motor transmits the power to the wheels and the power output shaft in turn through the mechanical transmission device. Some of the electric tractors using the hub motor can directly drive the wheels; the power output shaft is driven by the independent motor, and the other components that need to be driven can also directly adopt the electrification equipment. Nowadays, the research of electric tractors in our country is more and more concerned by people. The existing electric tractors mainly have the following features:

1. Electric tractor is traveling by the electric drive, emissions pollution problems do not exist. Existing electric tractors use electric energy converted into mechanical energy to provide power for tractor operation under the premise of meeting operational requirements. This avoids the traditional diesel tractor due cause pipeline blockage, emissions increase, the limited oil resources, requiring regular maintenance situation to some extent.

2. The vehicle structure is simple and easy to operate. In the new type of electric tractor structure, the components such as the fuel tank and the air filter element in the conventional tractor are eliminated, and the intelligent operation interface is added, and the driver is easy to operate.

3. Noise and vibration are small and the environment is comfortable. As the electric tractor is driven by electricity, during the operation process, the vibration is reduced, so that the noise is small; some electric tractors also have a closed cab, equipped with air conditioning and other equipment, can reduce the external dust on the human body, effectively improve the driver's comfortability.

Based on the characteristics of the existing electric tractors, combined with the planting conditions of crops, an electric tractor for sowing machinery was designed to complete operations such as loose soil, sowing, and earth covering. This design has a simple structure, easy operation, and good workability in small plots.

Structure of Small Electric Tractor for Sowing Machinery

The existing seeding device is linked to the tractor's power output shaft through a suspension system, and is driven by the tractor. This has a phenomenon of missing broadcast and replay to a certain extent. In addition, the traditional diesel engine is also replaced by an electric motor. This design integrates the seeding part with the electric tractor, which changes the traditional power transmission method and has a compact structure.

Structure of the Whole Machine

The small-sized electric tractor for the sowing machine is mainly composed of a frame, a power system, a sowing device, and a tiller device, as shown in Fig. 1. The power system is mounted on a frame for driving the sowing device and the earth-moving device. The seeding device is provided with a silo, a plurality of feed chutes are arranged in the lower part of the silo, and a silo door and a gutter door are respectively slidably arranged in the silo and the feed chute, and a seed tube is arranged below each feed chute. The sliding of the bin door and the slot door is used to control the opening and closing of the seed in and out channel, so that the seed enters the seed tube through the blanking slot. The earth-turning device includes a soil-turning wheel and a earth-covering board which are arranged on both sides of the bin. The power system is an electric motor and is used to drive the action of the earth-turning wheel, bin door and slot door.
Principle of Work

Before the tractor works, it is necessary to carefully check whether the battery and motor working conditions are normal. After the power is turned on, the motor drives the opening and closing wheels to realize the reciprocal movement of the door and the door of the slot door, thereby achieving the opening and closing of the door and the slot door. The seed can be smoothly transferred from the silo to the feeding trough and dropped into the soil through the seed tube. In addition, the rotation of the soil-turning wheel causes the soil-turning claws to loosen the soil, and the seeds enter the loose soil. The soil on the hooks falls on the conveyor belt and is transported to the soil storage tank. The soil leaked from the opening at the bottom of the silo and was compacted by the cover soil to achieve the integrated operation of loose soil, sowing and earth covering.

Design of Major Components

Power Selection

The power source for the electric tractor used in the sowing machine is an electric motor, and its technical development plays an important role in the power, economy, and safety of the entire electric tractor\(^9\). As shown in Figure 2, the motor is connected to a battery and is commonly electrically connected to a control switch. This paper adopts the combination of motor and battery to provide power. It has the advantages of light weight, large energy storage, no pollution, long service life and so on. During the operation of the aircraft, soil loosening, seeding and earth covering operations are required to complete, and the energy consumption is relatively small. The combination of the motor and the battery will meet the power requirements of the work.
Selection of Transmission System

At present, many tractors use chains, belts, etc. to transmit power. This has the disadvantages of easy slippage and low efficiency in the work process. For this reason, this design selects gear transmission as a power transmission device. The gear transmission transmits the motion and power between any two axes through the direct contact of gear tooth profiles. It has the advantages of large transmission power range, high transmission efficiency, accurate transmission ratio, long service life, and reliable operation[10].

Design of Earth-Covering Devices

The earth-turning wheel is provided with a wheel hub, and a plurality of soil-turning claws are arranged on the soil-turning wheel and are driven by a motor. The soil-turning claw is provided with a hook portion for picking up dirt. In addition, a conveyor belt is arranged on the upper portion of the casing, and one end of the conveyor belt away from the casing is located at the lower part of the earth-turning wheel. The earth-covered board is also provided with a dirt silo for receiving the soil conveyed on the conveyor belt. The bottom of the earth silo is provided with an opening for leaking mud.

The Design of Seeding Devices

When the door is opened under the action of the shutter lever, the seed in the seed box immediately enters into the feed chute. At this point, the slot door is open, the seed enters the seeding tube, and under its own gravity, the seed falls into the soil to complete the seeding operation. Compared with the conventional sowing device, the advantages are low seed damage rate and uniform seeding.

Conclusion

By analyzing the characteristics of the existing sowing mechanism and tractor, a new type of electric tractor for sowing machinery was designed. The machine is simple in structure and can realize automatic operation of loose soil, sowing and earth covering, high seeding reliability, simple maintenance and high seeding efficiency.

References


