

Design of integrated protection systems for Endless-rope Winder in Coal mines

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Abstract: In order to improve the safety and intelligence level of coal mine endless-rope winch and adapt to the intelligent construction needs of coal mine industry, a comprehensive protection system for coal mine endless-rope winches is proposed. Based on the analysis of the development direction of coal industry and the use environment and structural characteristics of coal mine endless-rope winch, the integrated protection system of coal mine endless-rope winch is designed based on PLC, and the over-roll protection, overload protection and overspeed protection functions are designed in detail to provide reference for the development of intelligent technology of coal mine endless-rope winch.

1. Introduction

The coal industry is an industry sector engaged in the exploration, development, production, storage and transportation, processing and conversion of coal resources and environmental protection, and has played an important role in the world's economic development as a traditional industry and basic industry for a long time. As China's basic energy and an important industrial raw material, coal accounts for a relatively high proportion of the primary energy production and consumption structure, providing strong support for the stable and rapid development of China's social economy. With the rapid development of new energy industries such as solar energy, nuclear energy, wind energy and biomass energy, the proportion of coal in primary energy production and consumption decreases year by year, but due to new energy industrialization technology bottlenecks and the characteristics of China's energy structure restrictions, the main position of coal in the energy structure should not be shaken. Coal mine intelligence is the core technology support for the high-quality development of the coal industry. Promote comprehensive mechanized coal mining, accelerate the development of intelligent coal mines, the construction of intelligent and green coal industry new system to achieve

intelligent, safe, efficient and green development and clean and efficient use of coal resources, is the strategic task of high-quality development of the coal industry and the way to go.

2. Coal mine endless-rope winches

The coal mine endless-rope winch is a kind of common rail continuous transport equipment which is pulled by steel wire rope in the underground tunnel of the coal mine. It is suitable for the transport of materials and equipment under long distance, large inclination, variable slope and large tonnage working conditions. The coal mine endless-rope winches is driven by the frictional force generated by the rotation of the endless-rope winch drum and the steel wire rope, thus pulling the vehicle along the track reciprocally. The coal mine induction rope winch replaces the traditional small winch relay and pair pull transport method. It is the ideal choice for the transport of hydraulic supports and various equipment in underground mines. The coal mine endless-rope winch can also be used in underground tunnels and on the surface of metal mines, where the track inclination must not be greater than 20° and the running track can have undulating changes. The coal mine endless-rope winch has the advantages of simple structure, high reliability and adaptability, and is widely used in underground coal mines. The safety of coal mine endless-rope winches is directly related to the safety of the mine transport system. In recent years, various universities and enterprises have carried out a lot of research work on the protection system of coal mine endless-rope winches.

3. Integrated protection system for endless-rope winches in coal mines

The integrated protection system for coal mine endless-rope winches is based on a PLC as the core processor and mainly consists of speed sensors, over-roll switches, acoustic and optical signalers, handheld signal terminals, tension overload sensors, displays and controls, and operating buttons. The protection system provides comprehensive protection functions for the safe operation of the winch, including over-roll protection, over-speed protection, under-speed protection, voice broadcast along the line, emergency stop along the line, emergency stop for handhelds etc., ensuring that the winch can be stopped immediately in the event of a fault. The coal mine endless-rope winch protection system provides a comprehensive and intuitive display which includes the winch's trajectory, operating position, operating speed and fault alarm information. The general diagram of the integrated protection system for induction rope winches in coal mines is shown in Figure 1.

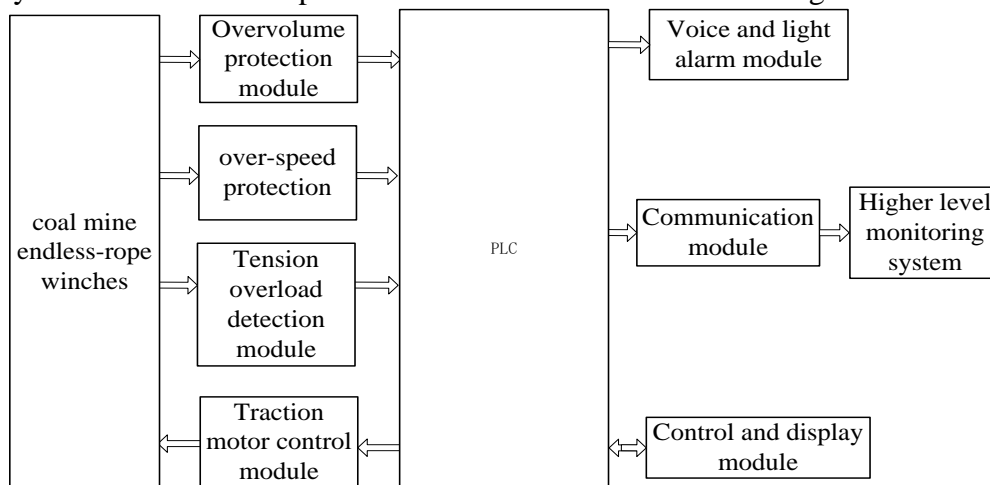


Figure 1: General view of the structure of the integrated protection system for endless-rope winches in coal mines

3.1 Speed detection module

Speed is an important indicator of the safety characteristics of a coal mine endless-rope winch. As the system is used in underground coal mines containing explosive gases such as gas, the intrinsically safe speed sensor is selected for speed parameter detection. The intrinsically safe speed sensor is made using the Hall induction principle and is installed next to the rope guide sheave on the inlet side of the rope press sheave unit. Six magnets are installed on the rope guide sheave and the speed sensor continuously sends speed signals to the protection system as the rope guide sheave rotates after the winch is started. The intrinsically safe mine speed sensor has a rated operating voltage of 12 V DC and an operating current of 10 mA. The intrinsically safe mine speed sensor outputs a high and low level square wave signal with a frequency of 0-60 Hz (corresponding to a speed of 0-2 m/s). The output square wave signal of mine intrinsically safe speed sensor has a high level of not less than 11V and a low level of not more than 0.5V. The PLC calculates the speed of the winch according to the feedback signal of the mine intrinsically safe speed sensor. Coal mine endless-rope winch integrated protection system selected mine intrinsically safe speed sensor anti-physical as shown in Figure 2.



Figure 2: Intrinsically safe speed sensor for mining

3.2 Overvoltage protection module

Over-roll protection is an important protection parameter for the safety of coal mine endless-rope winches, and is achieved by means of an Over-roll switch to protect coal mine endless-rope winches from Over-rolling. As the equipment is used in underground coal mines with explosive atmospheres such as gas and dust, it is selected as an explosion-proof or intrinsically safe device according to the requirements of the coal mine safety regulations. The Over-roll switch is bolted to the outside of the track where the limit point is required and the height of the switch is adjusted to detect whether the coal mine endless-rope winch is over-coiled. When the coal mine endless-rope winch over-rolls the guide rod of the over-roll switch with a force of 10 to 100N, the guide rod deflects along the axis of the over-roll switch. When the deflection angle is greater than 40°, the over-coil switch is operated, the normally open contact is switched on, the normally closed contact is switched off and the over-coil signal is fed back to the PLC. the contact capacity of the over-coil switch is generally 0.1A/12V, the operation angle is generally 40° and the permissible deviation is generally $\pm 5^\circ$. The over-roll switch is shown in Figure 3.



Figure 3: Over-roll switch

4. Conclusion

The protection system of coal mine endless-rope winch uses highly integrated technology to realise fault detection and protection functions for overwinding, overloading and overspeeding, enhancing the safety and automation and intelligence of the equipment in the underground coal mine transport system and laying the foundation for the intelligent development of coal mines.

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