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RESEARCH ARTICLE

RESEARCH ON IMPROVEMENT OF BELT CONVEYOR PERFORMANCE

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ABSTRACT

Belt conveyor is one of the most important transport equipment in various industries and fields, which requires high security and stability. Aiming at the problems existing in the control system and key components of the belt conveyor, the improvement of the belt conveyor is studied based on frequency conversion control, hydraulic tensioning system and belt material. The optimized belt conveyor achieves remarkable results and greatly improves its working capacity, which is of great significance to the improvement of economic benefits.

INTRODUCTION

With the progress of mechanical technology, the working capacity of belt conveyor has been greatly developed, making it gradually become one of the most reliable and economical conveying equipment. Since the 1980s, belt conveyor has entered a stage of rapid development. Its overall carrying capacity, such as ultimate load, ultimate speed, ultimate distance, power and so on, has made a qualitative leap. Its types and structural forms are various, which can meet the production conditions of different types of coal mines. At present, the ultimate speed of belt conveyor has exceeded 10 m/s, the maximum width of belt is more than 4 m, and the ultimate load capacity is as high as 30 000 t/h. However, there are still some shortcomings and shortcomings in frequency conversion soft start control, automatic tension control and belt material selection of belt conveyor. Some problems have become barriers to some safe production, and conveyor manufacturers have not paid enough attention to them. In actual production, the common material of belt conveyor is PVG whole core flame retardant belt. The belt has a higher elongation and a faster response speed (less than 10s) in the soft start mechanical equipment. However, the rapid response of the tension system has a certain negative impact, and in many cases cannot meet the requirements of tension. Therefore, the frequency conversion control content can be added to adapt to the belt tension process.

Application and improvement of frequency conversion control

Application principle: The principle of frequency conversion control is to realize the electrodeless speed regulation function of motor by means of vector control. In order to ensure the accuracy and reliability of speed regulation, it is necessary to install speed sensor in the position of driving motor of belt conveyor. However, limited by coal mine production conditions, the installation of speed sensors is often difficult, and increases the cost of equipment maintenance in the later period. If other sensors are used to accurately represent the speed, this problem can be effectively improved, such as no speed sensor. Speed sensorless is vector control, which conforms to frequency conversion control mechanism. In its work, it mainly converts the key analog parameters of drum drive motor, such as excitation current and torque current, into speed parameters and torque parameters, and finally completes vector control. It has good application effect in common asynchronous motors, and can output higher precision at lower working frequency. The parameter monitoring value ensures the reliability of frequency conversion control. In view of the working conditions and capability of belt conveyor, this paper proposes adding ZJT series Flameproof Frequency Converter as the core control element. The frequency converter of the system is manufactured by SIEMENS Company of Germany, which can maintain good working performance in complex and harsh environment. Its circuit system uses two parts of 3300VDC 400A module, which can realize double starting capacity of torque.

Application effect analysis: The soft start function of belt conveyor is one of the most important functions to ensure the working life of the conveyor. Through frequency conversion control, the speed and torque of belt conveyor during starting and stopping can be effectively adjusted, the impact of mechanical parts of belt team can be reduced, and the impact of sudden change of current on power grid can be alleviated. In order to avoid overload, the belt is usually made of flexible material, which can store large mechanical energy. Frequency conversion control can effectively control the release of this energy. In order to match the performance of the belt, the S-

type acceleration and deceleration startup is proposed in this paper, which can make the cushioning effect of startup or parking better. The working condition of belt conveyor will stop and restart quickly in a short time at any time. Under this frequency conversion control condition, low-frequency heavy-load start can be realized, that is, high-torque start can be realized at lower operating frequency based on speed sensorless vector control condition, which can generally reach 1.5-2 times rated torque and greatly shorten start-up time. Belt bears heavy-duty wear for a long time in work. It is easy to fail and needs regular maintenance. Low-speed inspection is an indispensable link to ensure normal production. Through stepless frequency conversion speed regulation, maintenance can be realized under long-term and different low-speed conditions.

Construction reform of frequency conversion control system: In order to facilitate installation, it is necessary to remove the mechanical soft start equipment between the current asynchronous motor and the reducer, so that it can be converted into a cylindrical pin-tooth coupling with elastic characteristics. For the reducer, it is necessary to remove its chassis, design tooling by welding method, and fix the motor base. In order to ensure the speed and heavy load capacity of low belt conveyor, it is necessary to continuously debug the frequency converter to ensure the best setting conditions, especially after the belt is replaced or repaired. At present, the rated voltage of the motor at the tail of the belt conveyor is 660V, while the rated voltage of the four asynchronous motors at the position of the driving drum of the conveyor is 1140V. Therefore, unified treatment is needed to adjust the transformer at the tail so that the rated voltage of the output is 1140V.

Improvement of hydraulic tension system

Type analysis of tension system: In the spiral tension mode, the movable part is the movable frame, so it is necessary to install the main shaft of the drum to the movable frame. The moving pair of spiral tension is guideway type. The nut on the movable part moves synchronously with the movable frame during the tension work, thus realizing the tension and relaxation of the belt. The mechanical structure of this kind of tension mode is relatively simple and easy to install and maintain, but the maximum tension stroke is limited, which is not suitable for large-scale long-distance conveyors. Gravity tension is a kind of tension method widely used in various belt conveyors. Its structure is very simple. The travel of the mechanism can be realized by the weight of the heavy hammer or the gravity car, which makes the belt tension. The gravity tension method has greater flexibility and is suitable for various working conditions, and can better compensate for the relaxation of the belt. This kind of tension mode does not need additional drive, and the tension stroke is adjusted automatically, but the tension force is constant and difficult to adjust. Gravity tension is suitable for fixed long-distance transport. It has high reliability in long-term work. It is necessary to reserve large space for gravity device when installing, but it is not suitable in small space. Fixed winch tension needs the help of specific winch tools. Generally, this kind of winch occupies a small space. When moving, it is tightened by the steel rope, which is wound around a small drum and driven by worm gear reducer. The tension efficiency of fixed winch tension mode is very high, the ultimate tension force is large, and it has good application effect under the condition of narrow space. However, the tension mode cannot be automatically adjusted, and when the winch fails, the larger tension force will be lost instantaneously, and the overall reliability is relatively low.

Retrofit requirements of tension system: According to the working principle of the above tension modes, it cannot automatically adjust the tension according to the pulling force of the driving drum of the belt conveyor, so there are some limitations. For long-distance conveyors with large loads, the belt will have greater elastic sliding phenomenon under larger working loads, which has a serious impact on the continuous start and stop. For the automatic tension of belt conveyor required for long distance conveying, not only the tension force is large enough to ensure the maximum friction of the belt, but also the stable tension can be maintained for a long time in the stage of uniform speed operation, and the range of variation cannot be too large. For the automatic tensioning system, it is required to be sufficiently sensitive to the mechanical response. If the tension system responds slowly, it will cause the belt to operate under heavy load and relaxation conditions, which will not only increase power consumption, but also reduce the service life of the belt. Wave emergence occurs during long distance transportation. Sensitive response and large tension are the basic guarantee for the safety of tension system. The inertia effect is fully considered in the design of the retrofit of the automatic tensioning system. Under the condition of high-speed operation, the belt carrying material will have greater inertia, and there is a dynamic balance relationship between the belt and the friction force. When the tensioner works, the lag displacement of inertia must be ensured. If the lag displacement cannot be compensated in time, the belt conveyor will be unstable. In China, there are not many belt conveyors using soft start control, which makes the acceleration of starting or stopping very large, and makes the automatic tension device unable to respond in real time. According to engineering practice, the combination of frequency conversion soft start control and automatic tension control has a good application effect.

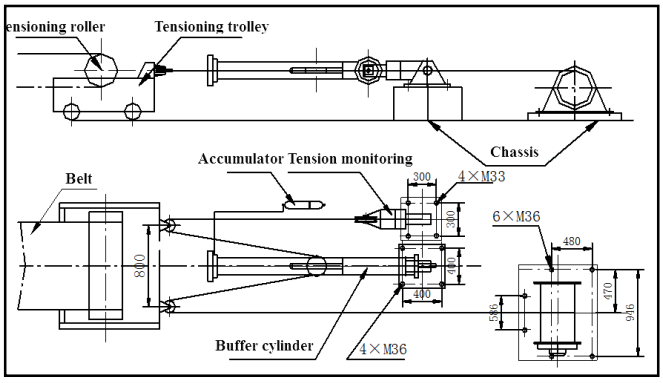

Fig.1 Schematic diagram of tension system after modification

Improvement of hydraulic automatic tension system: According to the revamping requirements of the tensioning system, the mechanical energy stored and released by the belt flexible body needs to be properly handled by the tensioning device. In order to cushion the negative effect of this energy on the conveyor drum, an accumulator is added in the tension system to effectively reduce the continuous fluctuation of the belt. The structural diagram of the hydraulic automatic tensioning system is shown in Fig. 1. It can be seen that the tensioning system is based on the fixed winch tensioning device. When the conveyor is running, the tension system will

drive the quantitative pump to fill the front chamber of the tension cylinder through the motor, so that the tension force of the cylinder piston rod will be generated, and the tension force will be controlled by the relief valve. In normal operation, the motor of the oil pump is in a stop state. At this time, the accumulator ensures the stable tension force of the belt in normal operation. When the system pressure exceeds the set range of pressure, the upper and lower limit of pressure is determined by pressure relay to determine the working state of oil pump motor.

Optimization and improvement of belt material

Generally speaking, most belts used in belt conveyors are flexible materials. According to the difference of inner core structure and material, belt core material can be divided into two types: fabric core and steel wire core. The belt of fabric core type can be divided into layered fabric core and integral braided fabric core according to the structural characteristics. The two kinds of fabric core have significant differences. The core types of integral braided fabrics have better equal strength and flexibility, good impact resistance under high strength tension, and the probability of transverse tearing is small. However, the requirement for tightening travel is higher because of the larger elongation ratio. There are many fine flexible steel wires in the belt of steel wire rope core type, which can be divided into various strength series or models according to the diameter and parallel spacing of steel wires. It has very high longitudinal tensile strength and low elongation, so it requires less tension stroke than the integral braided core belt. The belt used in the belt conveyor studied in this paper is a steel cord belt. According to the field experience, the wear thickness of the belt decreases after a long period of work, and finally grinds to the core of the wire rope. When the core of steel wire rope is exposed to air, oxidation will occur quickly, and the particles of air will accelerate abrasive wear, which will eventually lead to fatigue damage, wire drawing or fracture, greatly reduce the working life of the belt, and serious safety accidents will occur. Through many investigations and experiments, it is found that the use of whole core belt (PVG) can effectively eliminate the shortcomings of wear resistance and strength of steel wire rope core belt. This kind of belt has better tear resistance and fatigue resistance than steel cord belt, and is more suitable for the current working environment of belt conveyor. The test results show that the belt is light in weight, low in power consumption and easy to install and connect, but it needs a larger stretching stroke. Aiming at the reform of automatic tension system, the belt fully meets the working requirements in tension. According to the result of demonstration, it is necessary and effective to improve the technology of replacing steel cord belt with whole core belt.

Conclusion

Under the transformation condition of the belt conveyor system studied in this paper, the process of starting and stopping under various working conditions shows stronger stability and safety, which is more in line with the working requirements of heavy-duty, long-distance and high-power belt conveyors, and meets the engineering design targets, and has good economic and social benefits. According to the long-term field practice and experience, the application of frequency conversion control, automatic tension system and belt material improvement have mutually reinforcing benefits. On the whole, the cost of this type of transformation is low, which is in line with the actual situation. The later maintenance cost is less, and the quality and economy are in line with the demand.

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