Analysis and Discussion on Tension of Long Transport Belt

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Abstract. The technical field of belt tensioning force studied in this paper, in particular, relates to a hydraulic belt tensioning device, including a base, a hydraulic system and a rail fixed on the base, and a tail wheel trolley sliding on the rail. This device can provide a large tension to the tail wheel of the conveyor belt to meet the tension required by the long conveyor belt. At the same time, it can automatically adjust the tension to the tail wheel of the conveyor belt according to the tension of the conveyor belt to realize the dynamic tension control of the conveyor belt; The device prevents belt deviation and material leakage, reduces labor intensity of workers, avoids equipment accidents, and improves industrial production capacity.

Key words: Long conveyor belt; Hydraulic pressure; Tension; Dynamic equilibrium.

1. Introduction

The conveyor belt was originally developed from the conveyor belt. With the continuous expansion of the use of the conveyor and the development of science and technology, the variety of the conveyor belt is expanding to meet the requirements of the conveyor. However, all conveyors may make the conveyor belt lengthen and deform after a period of operation. The lengthening of the conveyor belt is composed of elastic elongation and permanent elongation. The conveyor belt was originally developed from the conveyor belt. With the continuous expansion of the use of the conveyor and the development of science and technology, the variety of the conveyor belt is expanding to meet the requirements of the conveyor. However, all conveyors may make the conveyor belt lengthen and deform after a period of operation. The lengthening of the conveyor belt is composed of elastic elongation and permanent elongation. Therefore, a tensioning device is required to overcome the defects caused by the lengthening of the conveyor belt. Most of the tensioning devices currently used are realized by counterweights, but for long belts, the tension brought by counterweights is far from the required tensioning force [1].

2. Hydraulic tensioning scheme of conveyor belt

For a long belt, the tension brought by the counterweight is far from the required tension. In order to overcome the above shortcomings, we have conceived a hydraulic belt tensioning device that can provide a large tension to the tail pulley of the belt to meet the required tension of the long belt.

The hydraulic tensioning device of the conveyor belt comprises a base, a hydraulic system and a rail fixedly mounted on the base, and a tail wheel trolley sliding mounted on the rail. The hydraulic system comprises an oil tank, a tensioning oil cylinder and an accumulator. The tensioning oil cylinder is provided with a cylinder body, a piston rod sliding mounted in the cylinder body, and a rod cavity and a rod free cavity formed in the cylinder body. The rod cavity is connected and connected with the accumulator through the tensioning oil circuit, The rodless chamber is connected and connected with the oil tank, and the tail wheel trolley is fixedly connected with the output end of the piston rod far from the cylinder body through the connection part [2].

The hydraulic system also includes a hydraulic servo system, a main oil outlet, a pressure regulating valve, a first oil outlet, a second oil outlet, a third oil outlet and a first reversing valve. The oil inlet and outlet of the hydraulic servo system are respectively connected with the oil inlet of the oil tank and the main oil outlet. The main oil outlet is connected to the oil tank through the pressure regulating valve. The four interfaces of the first reversing valve are respectively connected with the oil outlet of the main oil outlet, the oil inlet of the first oil outlet The oil inlet of the second oil outlet circuit is
The rope winding drive module includes a winch and two hydraulic motors which are arranged in parallel on the drive oil circuit. When the second reversing valve is switched, the second oil outlet circuit is connected with the fifth oil outlet circuit, and the drive oil circuit is provided with a hydraulic motor. When the second reversing valve is switched, the second oil outlet circuit is connected with the fifth oil outlet circuit, and the drive oil circuit is provided with a hydraulic motor. When the second reversing valve is switched, the second oil outlet circuit is connected with the fifth oil outlet circuit, and the drive oil circuit is provided with a hydraulic motor. When the second reversing valve is switched, the second oil outlet circuit is connected with the fifth oil outlet circuit, and the drive oil circuit is provided with a hydraulic motor. When the second reversing valve is switched, the second oil outlet circuit is connected with the fifth oil outlet circuit, and the drive oil circuit is provided with a hydraulic motor. When the second reversing valve is switched, the second oil outlet circuit is connected with the fifth oil outlet circuit, and the drive oil circuit is provided with a hydraulic motor.

The hydraulic system also includes a pressure measuring oil circuit, which is arranged on the pressure measuring oil circuit in turn [3]. The connecting part includes a connecting rope and a winding unit arranged on the tail wheel trolley. The hydraulic tensioning device of the conveyor belt also includes a rope winding drive mechanism fixedly installed on the base. One end of the connecting rope is fixedly installed on the base, and the other end passes through the winding unit and is connected with the output end of the sliding plug rod. The connecting part includes a connecting rope and a winding unit arranged on the tail wheel trolley. The hydraulic tensioning device of the conveyor belt also includes a rope winding drive mechanism fixedly installed on the base. One end of the connecting rope is fixedly installed on the rotary drive shaft of the rope winding drive mechanism, and the other end passes through the winding unit and is connected with the output end of the sliding plug rod. The rope winding drive module comprises a winch and a hydraulic motor for driving the rotation of the rotary drive shaft of the winch. wonderful tensioning system comprises a second reversing valve, a fourth oil circuit, a fifth oil circuit, a sixth oil circuit and a driving oil circuit. The four interfaces of the second reversing valve are respectively connected to the oil outlet of the second oil outlet circuit, the oil inlet of the fourth oil circuit, the oil inlet of the sixth oil circuit, and the oil outlet of the second oil outlet circuit.

The hydraulic system also comprises a manual ball valve, which is arranged on the pressure measuring oil circuit in turn [3].

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3. Tensioner operation theory

As shown in Figure 2, the hydraulic tensioning device of the conveyor belt includes a base, a rope winding drive mechanism, a hydraulic system and a rail fixed on the base, and a tail wheel trolley sliding on the rail.

![Fig. 2 Structural Diagram of Hydraulic Tensioner of Conveyor Belt](image)


The base is a cement column fixed on the foundation. The connection part also comprises two rope guide pulleys which are symmetrically arranged and rotatably installed on the base, and the other end of the connecting rope bypasses one of the rope guide pulleys, the first pulley, the movable pulley and the second fixed pulley in turn and is fixed on the other rope guide pulley.

The rope winding drive mechanism also comprises a safety pin, a first safety hole is uniformly arranged on the baffle on one side of the winch, a second safety hole corresponding to the first safety hole is arranged on the base, and the safety pin is used to insert the first safety hole and the second safety hole in turn.
The four interfaces of the circuit is connected to the four interfaces of the first reversing valve. The pressure regulating valve is an internal control valve. The pressure regulating valve is connected to the oil tank through the pressure regulating oil circuit. The oil inlet of the main oil outlet is connected with the oil outlet of the main oil outlet, and the main oil outlet is connected to the oil outlet of the oil pump, and the main oil outlet is connected to the oil tank. The output shaft of the drive motor is fixedly connected with the input end of the oil pump. The hydraulic servo system includes oil pump and drive motor. The oil pump is immersed in the oil tank, and its oil inlet is connected with the oil tank. The output shaft of the drive motor is fixedly connected with the input end of the oil pump.

The hydraulic system includes oil tank, tensioning cylinder, tensioning oil circuit, accumulator, hydraulic servo system, main oil outlet, pressure regulating valve, first oil outlet, second oil outlet, third oil return circuit, first reversing valve, fourth oil outlet, fifth oil outlet, sixth oil outlet, second reversing valve, second reversing valve, second reversing valve and drive oil circuit, pressure measuring oil circuit, manual ball valve and pressure gauge.

The tensioning cylinder has a cylinder block and a piston rod. The cylinder block is fixedly installed on the base through the oil cylinder mounting base. The piston end of the piston rod is slidably installed in the inner cavity of the cylinder block, so that the inner cavity of the cylinder block is divided into rod cavity and rodless cavity. The rod cavity is connected and connected with the accumulator through the tensioning oil circuit. The axial direction of the piston rod is parallel to the sliding direction of the tail wheel trolley. The axial direction of the piston rod passes through the center of the tail wheel trolley. The stroke of the tensioning cylinder is determined according to the required tension on site. The hydraulic servo system includes oil pump and drive motor. The oil pump is immersed in the oil tank, and its oil inlet is connected with the oil tank. The output shaft of the drive motor is fixedly connected with the input end of the oil pump.

![Fig. 3 Partial enlarged view of hydraulic servo system and rope winding drive mechanism](image)

The oil inlet of the main oil outlet is connected with the oil outlet of the oil pump, and the main oil outlet is connected to the oil tank through the pressure regulating valve. The pressure regulating valve is an internal control sequence valve. The tension of the belt is controlled by adjusting the set pressure of the pressure regulating valve. When the pressure regulating valve increases the pressure, the oil pressure of the buffer cylinder will increase and the tension generated will increase. The first reversing valve is a two position four-way electromagnetic reversing valve. The four interfaces of the electromagnetic directional valve are respectively connected with the oil outlet of the main oil outlet, the oil inlet of the first oil outlet, the oil inlet of the second oil outlet and one port of the third oil outlet. The oil outlet of the second oil outlet is connected to the tensioning oil outlet. The oil outlet of the second oil outlet is connected to the tensioning oil outlet. The other port of the third oil outlet and return circuit is connected to the rodless chamber, and one port of the third outlet and return circuit is always connected with the oil inlet of the second outlet circuit through the first reversing valve.

When the first reversing valve is not energized, the main oil circuit is connected with the third oil outlet and return circuit, and the oil outlet of the second oil circuit is disconnected from the other three interfaces of the first reversing valve; When the first reversing valve is energized, the main oil circuit is connected with the oil inlet of the second oil outlet circuit. Second directional valve Second directional valve Three position four-way manual directional valve. The four interfaces of the manual directional valve are respectively connected to the oil outlet of the second oil outlet, the oil outlet of the fourth oil return, the oil inlet of the fifth oil outlet and the oil inlet of the sixth oil inlet.

The oil outlet of the fourth oil return circuit is connected to the oil tank. The first oil port and the second oil port of the drive oil circuit are respectively connected with the oil outlet of the fifth oil circuit and the oil outlet of the sixth oil inlet circuit, and two hydraulic motors are arranged in parallel on the drive oil circuit. When the second reversing valve of the second reversing valve switches, the second oil outlet is connected with the oil outlet of the fifth oil outlet and the sixth oil outlet is connected with the fourth oil outlet, or the second oil outlet is connected with the sixth oil outlet and the fifth oil outlet is connected with the fourth oil outlet, or the second oil outlet is connected with the fourth oil outlet and the fifth oil outlet and the sixth oil outlet are not connected with the second reversing valve of the second reversing valve. The pressure measuring oil circuit is connected to the tensioning oil circuit. The manual ball valve and pressure gauge are set on the pressure measuring oil circuit in turn. The pressure gauge is a mechanical pressure gauge. Manual ball valve is set to facilitate online replacement of mechanical pressure gauge.

![Fig. 4 Partial enlarged view at mechanical pressure gauge](image)
The tail wheel trolley is fixedly connected with the output end of the piston rod far from the cylinder body and the rotary drive shaft of the winch through the connecting part. Specifically, the connecting part comprises a first fixed pulley, a second fixed pulley, two rope guide pulleys and a connecting rope. The driven wheel of the conveyor belt can be rotatably installed on the tail wheel trolley. The first pulley and the second pulley are symmetrically arranged relative to the central axis of the piston rod and can be rotatably installed on both sides of the tail wheel trolley. The two rope sheaves are symmetrically arranged relative to the central axis of the piston rod and are rotatably installed on the base. The two rope guide pulleys are the first rope guide pulley and the second rope guide pulley. The first rope guide pulley and the first pulley are located at one side of the piston rod; The second rope guide pulley and the second fixed pulley are located on the other side of the piston rod. The connecting rope is a steel wire rope, one end of which is fixed on the rotary drive shaft of the rope winding drive mechanism, and the other end is fixed on the second rope guide pulley after bypassing the first rope guide pulley, the first pulley, the movable pulley and the second fixed pulley. The steel wire rope is supported by the first guide sheave to prevent the steel wire rope from falling to the ground due to looseness. The first pulley and the second pulley are respectively located on both sides of the tail wheel trolley to facilitate the connecting rope to pull the tail wheel trolley.

The operating principle of the hydraulic tensioning device for the conveyor belt is: when the electromagnetic reversing valve is not energized, start the oil pump, connect the second oil outlet with the fifth oil outlet and the sixth oil outlet with the fourth oil outlet through the manual reversing valve, drive one of the hydraulic motors to rotate forward, and the hydraulic horse to drive the winch to rotate forward, tighten the wire rope, pull the tail wheel trolley backward to a proper position, so as to tighten the conveyor belt, The second oil outlet can also be connected with the sixth oil outlet and the fifth oil outlet can be connected with the fourth oil outlet through the manual directional valve, which can drive the motor to reverse and adjust the position of the tail wheel trolley [4].

4. Conclusion

To sum up, the hydraulic tensioning device of the conveyor belt can provide a large tension to the tail pulley of the conveyor belt to meet the tension required by the long conveyor belt. The tension to the tail pulley of the conveyor belt can be automatically adjusted according to the tension of the conveyor belt to achieve dynamic tensioning control of the conveyor belt. The device prevents belt deviation and material leakage, reduces labor intensity of workers, avoids equipment accidents, and improves industrial production capacity.

References


