Conveyor Tension Control Basics

Running a conveyor belt is done by friction on a Drive Roller. The Conveyor Belt needs to be tensioned to create sufficient friction between the rubber-coated Drive Roller and the Conveyor Belt. The loading of the belt determines how much power is needed. The heavier the load, the longer the belt and the elevation all add to the need for power.

The higher the power the greater the friction required to move the belt. As with a car, getting started requires a higher power level than when up to speed.

As with a car the higher the power used in start up, the higher will be the acceleration rate. Different acceleration control devices are used to control the acceleration of a conveyor belt:

1) Hydraulic (Fluid) Coupling. These are very common and usually have a delayed fill characteristic to soften and shape the acceleration rate. However these absorb a lot of energy and get hot. If they get too hot a safety valve opens to let out the oil. The acceleration characteristic is designed for full load. An empty belt is consequently accelerated roughly.
2) Magnetic Coupling. These are adjustable but also absorb a lot of energy.
3) AC Variable Drive. The Acceleration rate can be precisely controlled to any function. Generally there is an initial 'pull away' followed by linear acceleration and ending with a 'backing off' as the final speed is approached.

The running tension of a conveyor is easily determined with the aid of the many conveyor design programs. The starting tension can also be calculated but, of course, the acceleration characteristic must be known.

Conveyor Tension Take-Up

The drive force applied to the conveyor causes the conveyor belt to stretch. Increasing the acceleration rate cause the belt to stretch more. It take time for tension variations to spread down the belt; pluck a long rope and you can see the wave travelling down and 'echoing' back; a conveyor obeys all the laws of dynamics, and the classical 'Distributed Mass-Spring Model'. Variations in the acceleration rate will cause longitudinal tension waves to propagate along the belt.

Types of Conveyor Belt

1) Fabric belts are woven from heavy cord on 'Carpet Weaving' Machines. They are then impregnated with various synthetic materials. The strength is in the weave but the elasticity varies with the type of rubber or synthetic is added to it. A layer of pure rubber or synthetic is added as top and bottom

covers to prevent damage by the material being conveyed. A 1km fabric belt 1250mm wide with 30kN of tension will typically stretch 7.2 metres.

2) Steel Cord Belts are typically made from 90 x 6mm flexible steel ropes and then covered with rubber or synthetic top and bottom. A 1km Steel Cord belt 1250mm wide with 20kN of tension will typically stretch 650mm.

A Fabric belt is about 10 times more elastic than a steel cord belt. This stretch must be accommodated with a Take-Up Trolley otherwise the conveyor drive pulley will slip, heat up and even catch fire. Various methods of Take-Up are used:

a) Very short belts often have a fixed stretch adjustable with a screw mechanism

b) A Gravity Tower is very common. However this requires a large volume for installation and this is prohibitive underground. The mass of the counterweight has to be able to handle the acceleration and is therefore always over tensioned.

c) Take-Up Winches – These are compact and vary a great deal in operation:

    a. Manual Winch – for very short belts

    b. Motorised fixed-speed (Forward/Reverse) winches. Very common but the winch need to be slow for automatic control but fast during start-up. Generally the available winches are too slow for the stretching during start-up and a higher starting tension is applied to compensate for this. Consequently these have a serious limitation for long conveyors. The speed of these winches is around 6 metres per minute. These are too fast for short belts and too slow for long belts. These winches have a high inertia.

    c. Tension/Torque Controlled Winches.
        i. Some winches have an adjustable magnetic (Eddy Current) clutch which controls the tension. These winches run continuously dissipating energy in the coupling (typically 30 to 40kW and higher) and have an integral cooling fan. This winch is not environmentally friendly but has a good performance.
        ii. Torque Motor Winches are stationary ‘at tension’. These also require continuous cooling. These winches have a fixed gearbox and consequently a very high inertia.

    d. Fixed Speed Winches with AC Variable Drive have the potential of slow response during running and fast response during start-up. Both the winch speed and tension ratings need to be specified correctly to ensure that the rate of take-up matches the acceleration rate. These winches can advantage of hyper cycling within the allowable rating of the motor. Winches vary in rope speed from 1 metre per minute to 30 metres per minute of higher. The actual rope tension is used to control the maximum Winch Motor Speed. The control of these winches with 4-quadrant control, make them very responsive.

Conveyor Take-Up Problems

Take-Up Trolleys are notoriously high in friction; primarily due to poor design. All moving parts of a Conveyor Take-Up System, including Wheels, pulleys etc should be on roller bearings. There is no place for any kind of bushes in a Take-Up Trolley.

With the vast majority of Take-Up Systems relying on bushes the problems are chronic. Blaming the controller system is routine. The average Take-Up Trolley with a 2000kg mass will have more than 0.5kN of friction per 'good' (bushed) wheel. A single seized wheel on an 'Angle Iron' Rail has typically 4kN of friction. Trolleys with 4 seized wheels are not uncommon.

Determining why a Take-Up System is malfunctioning is very difficult and confusing but the starting point should always be the mechanical components. These problems are so common that the Tension Controller needs to be able to analyse and communicate these problems to central control.

Comment

The field of conveyor tensioning is extremely deceptive; it all looks so easy. It is however riddled with pitfalls. A conveyor belt is designed for a particular task. In time the customer may increase the belt speed, increase the load and extend the belt. All these action change the way the conveyor belt behaves. The design is no longer valid. The Take-Up System becomes totally inadequate. The mechanical components of the Tension Take-Up System deteriorate and over 3 to 4 years become increasingly dysfunctional. Mechanical design standards have dropped in the interests of reducing costs. The need for a comprehensive tension controller that can provide the full performance, comprehensive monitoring and relevant diagnostics is paramount.

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