Dual personality*

Mike Gawinski, Rulmeca Corp., US, explains the excitement behind dual conveyor drives.

Dual drive technology for belt conveyors is well-known and the benefits are well-established. This article attempts to illustrate its applications to industry groups less acquainted with it. The case stories are not from coal mines, but the usefulness of multiple drive technology may be readily applied to coal mines, coal preparation plants, coal transfer terminals and coal-fired power plants.

The Conveyor Equipment Manufacturers Association (CEMA) defines multiple drive systems as follows: "A multiple-pulley drive uses two or more separate motors, one or more driving the primary drive pulley and one or more driving secondary drive pulleys."[1] Regarding "booster drives", CEMA states: "Theoretically, the best drive would continuously add energy along the belt path as it is being removed through movement resistance and potential energy."[2]

The primary benefit of using multiple drives, especially on long conveyors, is a significant reduction in slack side tension required to prevent slippage of the conveyor belt on the drive pulley system. A reduction in slack side tension decreases maximum belt tension.

The combination of "multiple drive" and motorised pulley technology results in an even larger reduction in conveyor drive system size, weight, and complexity. A recent Rulmeca survey revealed that a typical 150 hp. motorised pulley dual drive system, consisting of two 75 hp. model 630H motorised pulleys mounted on a frame, weighed approximately 50% of comparable 150 hp. dual drive systems using exposed drive systems. The width of the motorised pulley dual drive system was less than two thirds of the width of comparable exposed drive systems. With weight and size reductions of that magnitude, the advantage of the drive system, especially when used in 42 in. (107 cm) coal seams is obvious.

Since Rulmeca motorised pulleys enclose all drive components within an oil-filled and hermetically-sealed pulley shell (Figure 1), they significantly increase system reliability, lower maintenance expense, improve personnel safety, save space and reduce power consumption.

Figure 1. Motorised pulley seals motor and gearbox within oil-filled pulley shell.

Dual drive benefits in new installations

Some plant operators are unaware of the benefits of dual drive technology and, consequently, could install less-than-optimal drives in new conveyors. For example, Rulmeca recently received a request for a quotation for a drive for a new conveyor in a rock quarry in the US, calling for a single 300 hp. drive with a 384 ft/min (117 m/min) belt speed to move 1000 tph on a 1000 ft (305 m) long conveyor with a rise of 176 ft (54 m). Rulmeca determined that a belt capable of withstanding a maximum (T1) tension of 26,000 lb would be required.

After discussions concerning multiple drives and an alternate belt speed, the operator decided to use dual motorised pulleys at 150 hp./drive. With 360° of belt wrap (instead of 210°) and a 600 ft/min (183 m/min) belt speed (instead of 384 ft/min [117 m/min]), the total belt tension to move the same amount of material on the same conveyor profile dropped to 16,000 lb, a maximum belt tension reduction of 38%.

Figure 2. Overview of 800 tph portable recirculating crushing/screening plant which incorporated compact dual 15 hp. motorised pulleys to drive the screen feed conveyor.

Case studies: dual drive benefits in retrofit applications

The application stories below explain how dual drive systems solved the problems of belt slippage, belt bounce, size restrictions and belt tracking, while extending belt life and eliminating belt and structural damage.

Size restriction on mobile crushing/screening plant

The H4000 portable recirculating crushing/screening plant design required an innovative approach to drive a 36 in. (91.4 cm) screen feed belt to move 800 tph of stone at 384 ft/min (117 m/min) (Figure 2). Wayne Lauterbach, engineering manager, remembers the challenge. "When we discussed this design with Mike Gawinski in 1995 I knew we had a conveyor drive pulley face width problem. Our system design required that the screen feed conveyor pivot from above the screen into a position adjacent to the screen for transport."

The rig's maximum width was 12 ft (3.6 m) in order to adhere to the US highway department regulations. The plant needed to put a 25 hp. drive at the head end of the conveyor, but its overall width could not exceed 50 in. (127 cm).[3]

"At first we did not think that driving a conveyor from the head and tail would work without sophisticated control equipment. However, we have put more than six of these rigs into service since 1995 and had no problems with the dual drive concept. We installed a 15 hp. unit (with a 16 in. [40.6 cm] dia. and 50 in. [127 cm] face width) at the head and an identical one

at the tail instead of a 25 hp. unit because it would not fit at the head."

Neither special motor nor control circuits were required. No effort to synchronise the drives was necessary. Normal Design C, AC squirrel cage induction motors were used. If one motor attempts to spin faster than the other, it draws a negligibly higher amount of current.

Size restriction on bucket wheel reclaimer at ship loading terminal

The Allouez Dock in Superior, Wisconsin, installed three Rulmeca motorised pulleys to upgrade conveyor drives on a 40 year old bucket wheel reclaimer in 2004 (Figure 3). Since that time the terminal installed six more motorised pulleys, upgrading two additional reclaimers. After five seasons of use, Gary Kucharyski, Allouez Dock maintenance supervisor, said: "The use of two motorised pulleys on each of our three reclaimer discharge conveyors has enabled us to reduce slack side tension and increase the service life of our belts. We are pleased with the reliability of our Rulmeca motorised pulleys and with the extended belt life they have yielded."[4]

Figure 3. One of three 40 year old 4000 tph bucket wheel reclaimers upgraded by BNSF with three motorised pulleys (one on boom and two on tail.)

Figure 4. Before the upgrade, 550 ft long reclaim tunnel conveyor, which elevates material 138 ft at 400 tph, could not restart under full load.

The dual drive system is "nested" beneath the discharge conveyor. The serpentine arrangement yielded 420° of belt wrap, significantly more than the original 180°. Calculations showed that the additional 240° of belt wrap reduced slack side tension (T2) to prevent belt slippage by 29%, resulting in a 13% reduction in total belt tension (T1).

Nesting a dual drive onto a reclaimer was a new idea in 2004, but underground coal mines have used dual drive systems for many years as booster drives to spread "effective belt tension" (Te) along the length of the conveyor. Minimising the amount of tension that a conveyor belt must withstand reduces its weight, which is essential to assembling and relocating conveyors underground efficiently.[5]

Belt bounce in reclaim tunnel at cement plant

Personnel at Buzzi Unicem USA's plant in Pryor, Oklahoma, solved an operational problem with dual motorised pulleys, when they replaced a 75 hp. exposed drive system on a 550 ft (168 m) long tunnel reclaim conveyor in 2009.

DeWayne Wagnon, electrical supervisor at the plant, said: "Our reclaim tunnel conveyor is fed by six belt feeders and has a concave vertical curve (Figure 4), elevating material from beneath the storage pile 138 ft (42 m) up to the transfer tower. It had been causing us production delays for years. If we overloaded the conveyor and tripped the breaker, we would have to shovel material off the belt to restart it. When we started the conveyor with an empty belt, it bounced up at least 4 ft (1.2 m), damaging the belt and our feeder support structure."[6]

Buzzi replaced the 75 hp. head drive with two model 630H motorised pulleys, each at 50 hp., in the head and tail positions. The dual drive system

offered more power and offered 360° of belt wrap instead of 180°. Slack side tension was reduced by 2000 lb, extending belt life significantly. Furthermore, instead of replacing the 30 in. (76.2 cm) wide 3 ply belt with a 4 ply belt, as originally planned, the dual drive system enabled the plant to continue using the 3 ply belt, even with 33% more drive power.

One of the most significant benefits of the head and tail drive configuration is the complete elimination of belt bounce (Figure 5). Now, the belt remains snugly within the troughing idlers throughout the concave curve, even when started empty, because effective belt tension is spread evenly between the head and tail pulleys. The two motorised pulleys are controlled and synchronised through the use of two flux vector VFDs, insuring load-sharing.

Belt slippage on radial stacker at underground mine

During 2010, Rulmeca learned that a major mine in western US had improved the production rate of its longwall mining equipment, but encountered stoppages during rainy weather. This was because all production had to pass through a 30 year old radial stacker (Figure 6) and the belt would slip on the 100 hp. tail-mounted belt drive if it got wet.

The solution was to install a second drive (on the boom tip) to increase belt wrap from 180° to 360°. Since the new drive would be a 50 hp. motorised pulley and the old drive was an external motor with a chain-and-sprocket arrangement, the two motors had to be synchronised. This improvement stopped belt slippage completely.

Engineers were initially concerned about the weight of the new motorised pulley, which was to be located at the tip of the stacker boom. The original design placed the drive at the tail to keep the truss tip load as light as possible. Since the 50 hp. model 630H motorised pulley weighs only 2600 lb (1.17 t) and the original pulley weighed 3200 lb (1.5 t), there was clearly no danger of structural overstress.

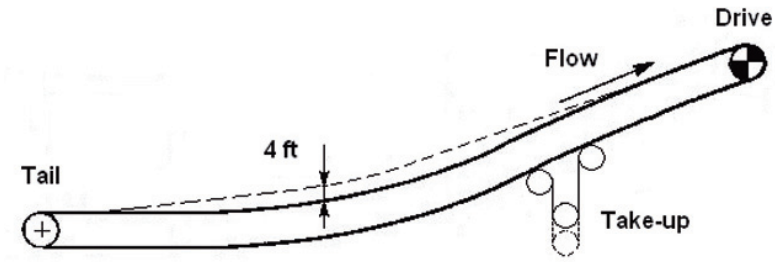

Figure 5. Before the upgrade, concave vertical curve with 75 hp. head drive "bounced up" when starting with empty belt, damaging belt and tunnel feeder supports.

Figure 6. Radial stacker disrupted mine production due to belt slippage on 30 year old 100 hp. tail drive during rainy conditions

Figure 7. Single drive on reversing conveyor above woodchip bins slipped during winter weather due to stiff belt, prior to conversion to dual 15 hp. drives (one at each end).

The reason that a motorised pulley's weight is so light is that, rather than adding a cast iron motor enclosure and a cast iron gearbox enclosure, it uses the pulley shell as an enclosure. Also, the motor frame and gearbox are used as

structural members, eliminating the need for a large diameter through-shaft. In the example above, the original idler pulley was outfitted with a 66 in. (168 cm) long 7 in. (17.8 cm) dia. shaft weighing 720 lb (327 kg).

Belt slippage on reversing belt at paper pulp mill in eastern US

Another weather-related operational problem consistently caused production delays during cold weather at a major paper pulp mill on the reversing horizontal conveyor that loaded woodchips into three storage bins (Figure 7).

The reversing transfer belt is loaded via a centre chute. Material is loaded into the centre bin by activating a flop gate and avoiding the horizontal conveyor. Material is transferred into the left bin by activating the horizontal conveyor and into the right bin by reversing the direction of the conveyor.

The operational difficulty occurred when the belt was "stiff" in cold weather because the 15 hp. conveyor drive, located at the left end of the conveyor, could not provide enough traction. The old exposed drive system was replaced with two 15 hp. model 400H motorised pulleys, one at each end. Now, since both drives rotate simultaneously either clockwise or counterclockwise, 360° of belt wrap prevent slippage in all operating conditions.

Conclusion

Multiple drives may be used to distribute effective tension more efficiently, especially on long conveyors. Multiple drives can also solve operational problems, including belt slippage, belt bounce, belt tracking and drive size restrictions, while extending belt life and eliminating belt and structural damage.

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