28th Annual International Coal Preparation &
Aggregate Processing Exhibition & Conference
Lexington, KY; May 3-5, 2011

Motorized Pulley Usage in UK & US Coal Mining & Electricity Generation Expands…Next Step Will Be Deep Mines

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ABSTRACT

This presentation expands on the paper presented at the 23rd Annual Coal Prep Conference by Messrs Pringle, Barry, and Gawinski. It includes an update to the utilization of Motorized Pulleys at various coal handling facilities in England and the United States; describes specific environmental, safety, and financial benefits derived by UK Coal since 2003; highlights key technical and regulatory product advancements; describes dual “pony drives” now in use in underground coal mines in the United States; and predicts incorporation of Motorized Pulley technology in deep mines in the U.K. in the near future.

INTRODUCTION

Developed in Europe in 1953, Rulmeca Motorized Pulley (RMP) technology was slow to gain acceptance internationally until the latter part of the twentieth century, but the compactness and high reliability of the concept has been well proven on large materials handling machines at various bulk handling facilities during the last three decades.[1] The concept's acceptance in coal handling facilities in the United Kingdom and the United States has dramatically increased during the last eight years.

UNDERSTANDING MOTORIZED PULLEYS

Motorized Pulleys, which are internally-powered conveyor belt drives, have improved system reliability and personnel safety while lowering maintenance expenses at a variety of surface and underground coal handling facilities in Europe and the United States. The product’s secret is its hermetic seal, which protects the Motorized Pulley's AC motor and gearbox within the oil-filled steel pulley shell. See figure 1.

Bulk materials such as coal are often difficult to handle on belt conveyors which are driven by exposed drive systems. The reason is because it is difficult to protect electromechanical components (e.g. motors, gearboxes, sheaves, chains, sprockets, and couplings) from abrasive and corrosive materials and harsh operating conditions.

Figure 2 illustrates that cast iron enclosures are usually built to protect the components from the environment and expanded metal grating and access doors are installed to protect personnel from the moving components. The bigger the protective enclosure, the more space it occupies.

Figure 1
Rulmeca's AC motor and gearbox are hermetically sealed within the oil-filled Motorized Pulley shell. The circulating oil lubricates all mechanical components while transferring heat from the motor through the pulley shell and into the conveyor belt. The conveyor belt is used as an infinite "heat sink."

Figure 2
Exposed drive system for coal handling conveyor consists of motor, coupling, gearbox, and a second coupling, all protected by cast iron and/or steel enclosures. Note steel enclosures built to protect personnel from large two rotating coupling.

Since Motorized Pulleys eliminate redundant protective enclosures and hide motors and gearboxes out of harm's way within an oil-filled pulley shell, they have proven to be an optimal conveyor drive solution in numerous operating conditions. See figure 3.

Figure 3
Seward Coal Terminal shiploader uses Model 24" diameter 75 HP Motorized Pulley to drive 42" wide 800 fpm shuttle belt to transfer Alaskan coal into export ships at 2,000 tph.

This drive design yields these primary advantages:

- Gears and bearings are continuously and automatically splash lubricated, lowering maintenance requirements.
- Electromechanical components are sealed within pulley shell, increasing reliability, minimizing drive size, improving personnel safety, reducing personnel guarding requirements, providing even drive weight distribution to the conveyor structure, and decreasing noise.
- Redundant enclosures, such as a cast iron motor frame and steel coupling guards are eliminated, decreasing drive weight. See figure 4.

Figure 4
Note huge size of 100 HP external drive system for Kellingley #758 reclaim conveyor (left) and absence of external components on comparable 100 HP RMP (right) on #720 belt.

MOTORIZED PULLEY USAGE AT UK COAL HANDLING FACILITIES

After eliminating a problem of 30 days and 300,000 tons of lost production per year at their Kellingley Colliery in 2003, UK Coal Ltd. quickly expanded their use of Motorized Pulleys.[2] The initial trial was conducted during a one-year period on the colliery's tailings conveyor. A 100 HP Motorized Pulley was installed at the discharge end of the conveyor, replacing a problematic bottom-side belt conveyor drive located near the conveyor tail. See figure 5.

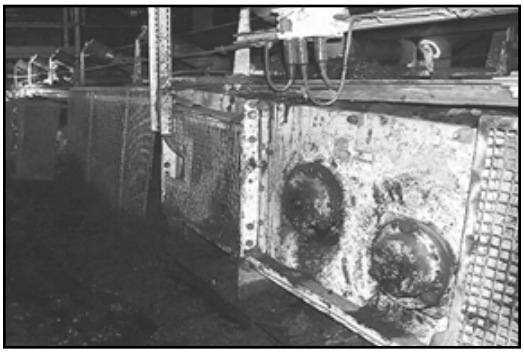

Figure 5
Kellingley Colliery replaced old problematic "bottom belt drive" near tail (left photo) on the main coarse discard conveyor in 2003 with 100 HP Rulmeca Motorized Pulley at discharge end above pile (right photo) and eliminated 300,000 tons of lost production annually.

Within three years UK Coal's installed base of Motorized Pulleys totaled 24, growing to 85 units by 2011. When power plants and terminals are included to the total, 120 Rulmeca Motorized Pulleys were installed in the UK (2 HP to 330 HP.) The primary motivation for the change in conveyor drive technology was the demonstrated annual savings of tens of thousands of dollars in reduced maintenance expense and electrical power consumption, initially on the Kellingley main coarse discard conveyor, then subsequently on numerous other conveyors at four other UK Coal prep plants.

Steve Pringle said "I'll admit that our Plant Managers and Engineers were skeptical about the Motorized Pulley concept in 2003, mainly due to previous experience with drives of a similar design which had been unsuccessful in the 1960's and 70's in the UK. However, the Rulmeca technology has now been thoroughly practically proven within UK Coal Ltd and our confidence with the use of the equipment and the service that we receive from the company continues to pay dividends to our business."

Mr. Pringle continued, "The benefits from the safety aspect of improved access around drive heads and the vastly reduced requirements of guarding are invaluable in what is still a tough and challenging industry. As of March 2011, we have replaced exposed drive systems or newly installed 85 Rulmeca Motorized Pulleys in our Coal Prep Plants. Our Engineering policy is to continue to change out old exposed drives as our budget permits. The development of Motorized Pulleys to be used in underground applications of potentially explosive atmospheres could eventually replace many large and major conveyor drives systems that we use.

MOTORIZED PULLEY USAGE AT US COAL HANDLING FACILITIES

In North America, shipping terminals and power plants were the first coal handling facilities to use Motorized Pulleys. However, US coal mines began using the drives in a dramatic way in 2010. For example, Cline Resources, a US coal producer, recently increased their inventory of Rulmeca Motorized Pulleys to drive panel belts in their underground mines. Just as UK Coal did in West Yorkshire, England in 2003, Cline Resources thoroughly tested a drive system (figure 6) at their mines in West Virginia and Illinois, insisting that Rulmeca provide a spare Motorized Pulley (to reduce the risk of a stoppage) during the trial period.

Figure 6
Two 75 HP Rulmeca Motorized Pulleys in "nested dual" arrangement move 1,200 tph of ROM coal at 600 fpm on 48" wide 1,200' long underground conveyor belt. Note the absence of external motor, gearbox, and pillow blocks. All mechanical components are hermetically sealed within the pulley's oil-filled shell.

The trial at Cline's Maryan Mine consisted of moving 1,200 tph of ROM coal at 600 fpm on a 48" wide conveyor belt with two 75 HP model 630H Rulmeca Motorized Pulleys, nested into a special "EZMP" frame manufactured by Kerco, Inc. of Madisonville, KY. See figure 7.

The trial was conducted on conveyors that extend from 800' to 1,200' long to accommodate the movement of continuous miners. The dual drive system incorporates two model 630H 75 HP Rulmeca Motorized Pulleys and has a narrow footprint since each Motorized Pulley has a 24.80" diameter and 55.12" face width. See figure 8.

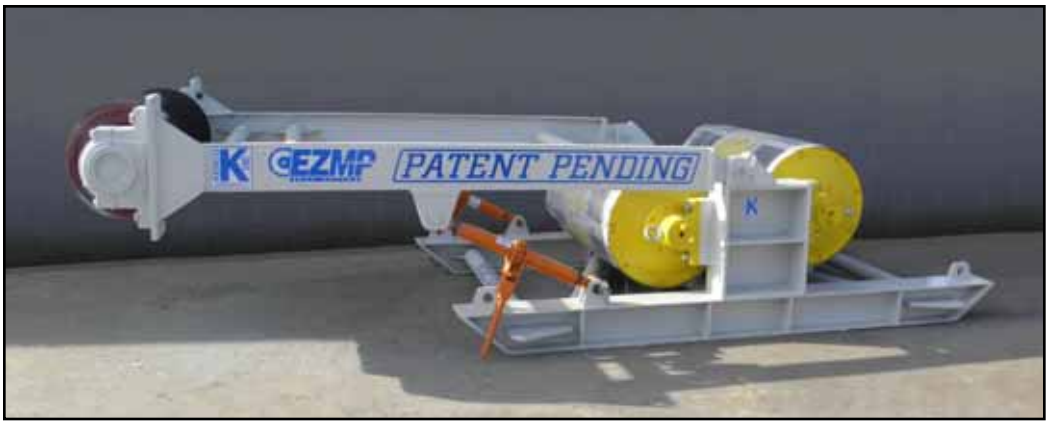

Figure 7
Built for underground coal mines, Kerco's 150 HP EZMP includes twin 75 HP Rulmeca Motorized Pulleys and may be mounted to mine floor or ceiling. Optional boom converts drive from "booster" to discharge. 660 HP EZMP with twin 330 HP RMP is available.

The drive's compactness and light weight are advantageous when moving conveyors in restricted spaces, such as coal mines, hundreds of feet below the earth's surface. Each 75 HP drive only weighs 2,200 lbs, much less than an equivalent exposed drive system.

Ideally, underground coal mine booster (pony) drives and discharge drives should be as small and light as possible due to space restrictions underground. The dual drive described above is built for underground coal mines and incorporates Rulmeca Motorized Pulleys in a "nested dual" configuration. Each drive may be mounted to the mine floor or hung from the ceiling. Currently configured to provide 150 HP with two 24.80" diameter 75 HP Motorized Pulleys, the system is available up to 660 HP with two 40.16" diameter 330 HP Motorized Pulleys.

Figure 8
Model 630H Motorized Pulley has narrow footprint (24.8" diameter and 55.12" face width.) Each drive only weighs 2,200 lbs. Drive compactness and light weight are advantageous when moving conveyor in restricted spaces underground.

SUMMARY OF MOTORIZED PULLEY UTILIZATION IN UK & US

Since Motorized Pulley technology was pioneered in 1953, why was the concept's acceptance in UK and US coal handling systems delayed until this century? The development of higher powered RMP, IP67 oil sealing systems, and use of synthetic oil were key factors. See table 1.

RULMECA MOTORIZED PULLEY USAGE

United Kingdom
(Coal Prep Plants)

- 2003 – Zero
- 2011 – **103** (2 HP – 120 HP Units)

(Power Plants & Terminals)

- 2007 – Zero
- 2011 – **35** (2 HP – 330 HP Units)

United States
(Coal Mines, Power Plants & Terminals)

- 2005 – Zero
- 2011 – **20** (15 HP to 100 HP Units)

Table 1
Growth in Usage of Motorized Pulleys in coal handling installations in UK & US

HEALTH & SAFETY CONSIDERATIONS

In addition to the operational advantages described above, Motorized Pulleys enable conveyor system operators to provide a safer work environment for employees. Eliminating exposed drive system components increases safe personnel access space at all drive assemblies and reduces personnel guarding requirements. See figure 9. Dissipating motor and gearbox heat into the conveyor belt eliminates the danger of radiating heat from exposed motors and gearboxes. Minimizing external moving parts reduces the risk of entrapment. Extending oil change frequency to more than three years reduces the risk of skin problems and slipping on spilled oil.

Figure 9
Note spacious personnel access near 100 HP conveyor drive after RMP conversion

MAINTENANCE COSTS: MOTORIZED PULLEYS VS. EXPOSED DRIVES

UK Coal eliminated numerous maintenance tasks by eliminating their old exposed drive system components and replacing them with new Motorized Pulleys. The following 100 HP drive example illustrates the cost savings.

Annual Exposed Drive Maintenance Schedule (100 HP Example)

1. Make Examinations (6 months)
   Check alignment
   Check spider plate condition
   Change Multidisc
   Check motor bearings
   Check Guarding
   Subtotal = 6 hrs x 2 men x $33.00/hr x 2 = $792.00/year

2. Change Multidisc (6 months)
   Subtotal = $459.00 x 2 = $918.00

3. Do Vibration Analysis & Report (monthly)
   Subtotal = 2 hours/mo x 12 x $33.00/hr = $792.00

4. Analyze Oil Samples & Make Report
   Subtotal = 2 hours/mo x 12 x $33.00/hr = $792.00

Total Annual Maintenance Cost Eliminated = $3,294.00

"BEFORE & AFTER" CONVEYOR DRIVE EXAMPLES

UK Coal shared the news regarding their "new" Motorized Pulley conveyor drives with their customers. E-on's Ratcliffe Power Station soon followed UK Coal's lead and began converting their 30 year old exposed conveyor drives to RMP units. That power plant now has Motorized Pulleys (2 HP to 100 HP) installed on most of their coal handling belts, including the bunker feed system (figure 10), train unloading system (figure 11), and sampling system. As of 2011, 20 Rulmeca Motorized Pulleys are in service at Ratcliffe.

Figure 10
One of four reversing shuttling coal bunker feed conveyors at E-on's Ratcliffe Power Station which has been converted to a Rulmeca Motorized Pulley drive. Note exposed system in foreground and RMP at rear.

Figure 11
Train Unloading Receiving Conveyors at E-on's Ratcliffe Power Station. Left photo shows drive arrangement after conversion to Motorized Pulley (note redundant drive base in foreground). Right photo was taken before original exposed drive system was removed.

The Kellingley Colliery shared the news of their good Motorized Pulley experience with other prep plants within UK Coal and saw other collieries installing the drives within a few years. By 2006, Ellington, Maltby, and Welbeck added the drives to their systems. As of 2010, Thoresby had joined the trend (figure 12), bringing the installed base of RMP to 85 within UK Coal.

Figure 12
Thoresby Colliery replaced the ROM Barrel Feeder drive with 15 HP Motorized Pulley (left) and Barrel Product Conveyor drive with 30 HP Motorized Pulley.

CAPITAL COST, ENERGY CONSUMPTION, NOISE REDUCTION

Initially installed to improve system reliability and eliminate conveyor downtime, Rulmeca Motorized Pulleys yielded additional benefits to the Kellingley Colliery. Tables 2 & 3 below show a reduction in capital outlay for conveyor drives as well as a measured reduction in electrical power consumption. Figure 13 shows sound meter test, which revealed a 15 decibel reduction in noise after a 100 HP Motorized Pulley replaced an exposed drive system.

CAPITAL COST COMPARISON

Rulmeca Motorized Pulley

- Complete Drive System $55,760

Exposed Drive System

Motor	$9,840
Pulley & Bearings	$5,740
20” Gearbox	$37,720
Couplings	$6,560
Baseplate	$820
Total Cost	$60,680

Note: Motorized Pulleys require significantly less time to install than exposed drive systems because internal drives are “pre-aligned”, lighter, and have fewer external components.

Table 2
Comparison of Initial Purchase Price of Motorized Pulley and Exposed Drive System

ENERGY SAVINGS

Annual Savings for One Rulmeca Motorized Pulley (100 HP)

7.8% efficiency improvement for one 100 HP unit =>
$0.115/kw-hr x 5.86 kw-hrs x 8,760 hrs/yr = $5,904/yr

Annual Savings for 14 Rulmeca Motorized Pulleys (2 HP to 120 HP)

$0.115/kw-hr x 3.0 kw-hrs/RMP x 14 RMP x 8,760 hrs/yr = $42,558/yr

Basis for annual energy consumption is all conveyors running 24 hrs/day and 365 days/year.

Table 3
Electrical Power Savings for 14 Motorized Pulleys at Kellingley Colliery

Figure 13
Kellingley Colliery measured a sound level of 75 dB on conveyor #720 after 100 HP RMP was installed, 15 dB less than the 90 dB measured when old exposed drive was in service.

DEVELOPMENT OF MOTORIZED PULLEYS FOR DEEP MINES

With obvious advantages for conveyor operators, especially where space is restricted and operating conditions are harsh, why has the use of Motorized Pulleys been slow to develop within the underground coal mining industry? The reasons are twofold: power and regulations.

In general, underground coal mines use numerous dual drive systems as booster drives to spread "effective belt tension" (Te) along the length of the conveyor. Minimizing the amount of tension that a conveyor belt must withstand reduces its weight, which is essential to assembling and relocating conveyors underground efficiently. Mainline conveyor boosters often consist of two 250 HP drives while dual 75 HP panel belt drives are common. In underground coal mines in the US, motors which are near the active face must have a certified “explosion proof” design. In the UK, all motors in service underground must have “flameproof” design and certification.

Rulmeca’s model 1000HD (220 HP - 330 HP) has completed its development and testing. See figures 14 & 15. The design will kill the proverbial “two birds with one stone” because the design meets both needs... higher power and flameproof capabilities. The product is now being delivered for surface applications while flameproof certification is in process. Figure 16 shows a coal export dock conveyor which will be converted to a 1000HD in 2011.

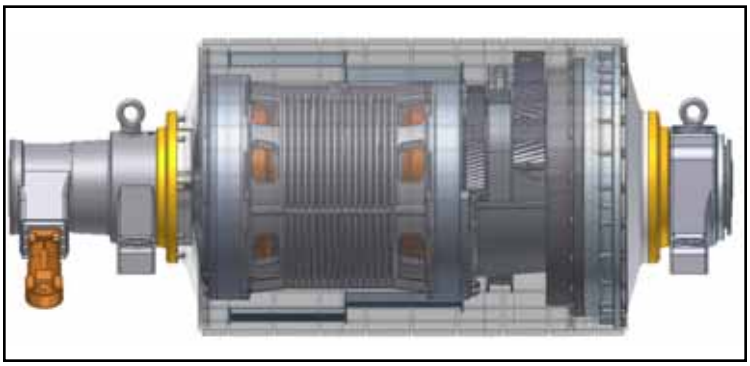

Figure 14
Rulmeca Motorized Pulley model 1000HD has 40” diameter and power up to 330 HP.

Figure 15
Photo shows model 1000HD at 330 HP under full load testing at Rulmeca Germany GmbH facility in Aschersleben, Germany.

Figure 16
Model 1000HD will replace existing dock conveyor drive at this major Scottish coal export/import terminal in 2011.

The flameproof development is based on the European standard IEC 60079 – flame proof enclosure "Ex d". The first prototypes of 100 HP 480 fpm units will be, as per agreement, produced for UK Coal. See figure 17. The following regulations apply in the United Kingdom.

Electricity at Work Regulations 1989

- Reg. 19 – Restriction of equipment in certain zones below ground.
- Equipment and components intended for use in 'potentially' explosive atmospheres in underground mines EN 1710:2005
- Electrical apparatus for 'potentially' explosive atmospheres, Part 25 'Intrinsically Safe Systems' EN 60079-25: 2004.
- Electrical intrinsically safe apparatus for 'potentially' explosive atmospheres. Part 0 'General requirements' EN60079-0:2004 BS50014.
- Electrical apparatus for 'potentially' explosive atmospheres Part 1 Flameproof enclosures 'd' EN 60079-1:2004.

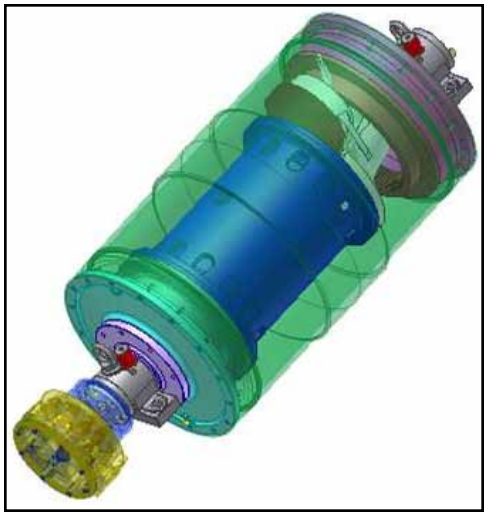

Figure 17
CAD drawing illustrates features which are essential to enable flameproof capability and certification

CONCLUSION

The successful use of Motorized Pulley technology has been well demonstrated within the coal industry in Europe and North America. The fact that the list of applications is growing rapidly indicates that knowledge of the internally-powered conveyor drive technology is spreading among plant operators and engineers at coal prep plants, fossil-fueled electric generating stations, and in deep coal mines.

AUTHORS' NOTE

Please note that this presentation contains the views of the authors and not necessarily the views of UK Coal Ltd.

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