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Motorized Pulleys Solve Materials Handling Problems in North America

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1. Introduction

Motorized pulleys were first introduced to the North American bulk materials handling industry, without fanfare, in the 1960's and 1970's on equipment imported from Europe. At that time German equipment manufacturers delivered machinery, such as the bucket wheel stacker reclaimer with motorized pulleys to drive belt conveyors shown in Fig. 1.

Fig. 1: German-engineered bucket wheel stacker reclaimer installed at a rail-to-ship transfer terminal for taconite pellets in Escanaba, Michigan in 1980. This machine still uses 200 HP motorized pulleys to drive boom and tail belts.

As with many stacker reclaimers, this machine has a 5,000 tph ore handling rate. It includes two 40 inch diameter motorized pulleys, one on the boom and one on the tail, each with 200 HP of belt drive capability.

European motorized pulley manufacturers began marketing these products in North America directly in the 1980's. This paper reviews some of those early successes and highlights several recent applications useful to bulk materials handling systems and equipment engineers.

2. Motorized Pulley Design Concept

Well known in Europe for decades, the motorized pulley (also known as "drum motor") includes the use of an AC motor and a gearbox within the shell of a hermetically sealed conveyor belt drive pulley. For example, TAKRAF used motorized pulleys as standard equipment on machinery throughout Eastern Europe, as shown in Fig. 2.

Fig. 2: One of three mobile primary crushers installed in an open pit continuous limestone mine in Rubeland, Germany in 1983. This mobile crusher still uses a 50 HP tail-mounted motorized pulley to drive elevating transfer belt.

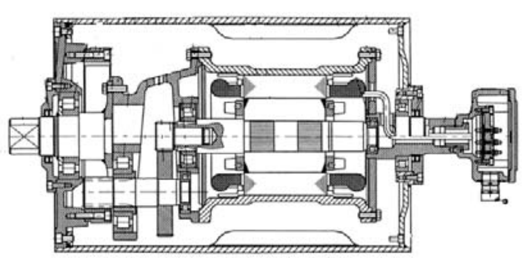

Fig. 3: Cross sectional diagram of motorized pulley. AC squirrel cage induction motor and helical/spur gearbox are shown. Note that pulley shaft is "dead" (non-rotating) and all electrical terminations are made at the shaft-mounted junction box. "Drip lips" are welded to the pulley shell inner surface to circulate oil for motor cooling and mechanical lubrication.

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Sealing and lubricating a motor and gearbox within a pulley shell protects all moving parts while minimizing the space occupied by the drive.

The pulley is partially filled with oil to lubricate the moving parts and cool the motor. As shown in Fig. 3, "drip lips" are welded to the inside of the pulley shell to pour oil onto the motor stator like a waterwheel. The oil draws heat from the stator and continuously transfers it to the pulley shell.

The conveyor belt then acts like an infinite "heat sink" to pull heat from the pulley shell and maintain an appropriate steady state heat for the drive system.

The purpose of manufacturing conveyor drives in this manner is to accomplish these five goals:

- increase system reliability,
- minimize conveyor drive size and weight,
- decrease maintenance expense,
- improve operator safety, and
- lower electrical power cost.

3. Harsh Handling Conditions (taconite ore)

Enclosing all moving components within a hermetically sealed pulley shell protects these items from all abrasive and corrosive application conditions as shown in Fig. 4.

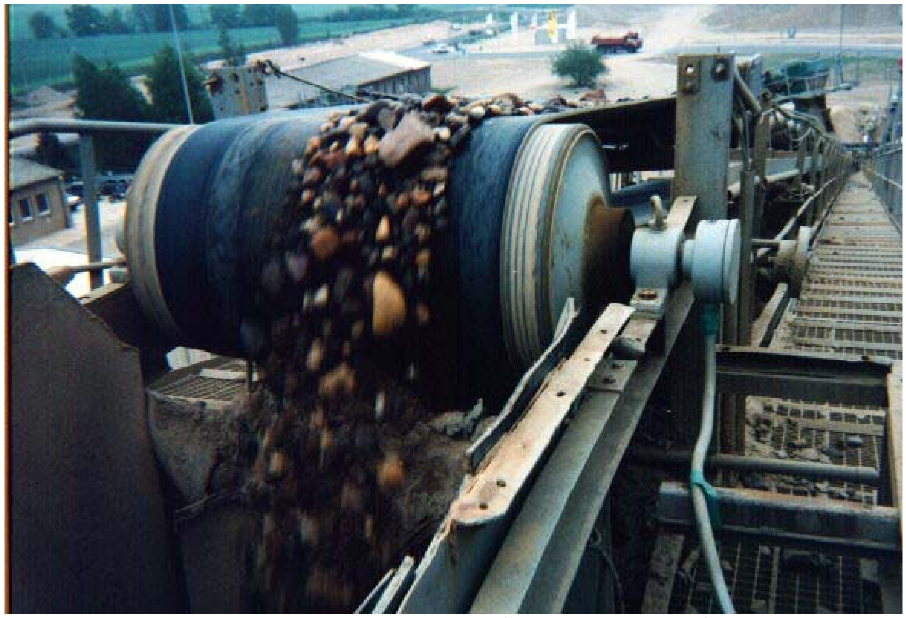

Fig. 4: Primary elevating belt drive installed at sand & gravel lake dredge facility in Zeithan, Germany in 1989. This 30 HP motorized pulley was in continuous service when production capacity was doubled and six new 30 HP units were installed on floating conveyors in 1992.

Fig. 5: Two 7.5 HP motorized pulleys in a congested area of a mobile crushing and screening plant installed in Ottawa, Canada in 1993. All motorized pulleys transfer heat into the conveyor belts they drive. Twenty motorized pulleys helped keep this facility operational throughout the bitterly cold Canadian winter of 1994.

As mentioned above, initial use of the concept in North America was in iron ore handling. Taconite ore is notoriously abrasive on moving parts. In fact, North American bulk handling engineers generally refer to labyrinth seals as "taconite" seals.

Engineering Design Services of Hibbing, Minnesota introduced Interroll motorized pulleys to Minnesota taconite mines and pellet plants ten years ago.

Roger Meittunen, President of EDS

said, “Back then taconite producers were skeptical about using motorized pulleys as conveyor belt drives because they were a new concept here. Now, however, motorized pulleys are not only preferred in many conveyor belt applications, they are even being used as roller feeder drives (see below.) This is because they have proven their value in terms of ‘up time’ and maintenance labor reduction.”

Engineering Design Services is one of Interroll’s key distributors and authorized repair centers and has integrated hundreds of motorized pulleys into the “Iron Range” of Minnesota.

Popularity of the motorized pulley started with taconite producers and has grown to include bulk handlers throughout Canada, Mexico, and the United States. Motorized pulleys are now driving bulk belts to transport: potash, aragonite, silica sand, cullet, stone, gravel, sewage sludge, salt, recycled concrete, foundry sand, paper pulp, meat, fish, and vegetables.

4. Space Restrictions (Mobile Crushing and Screening Plants)

Ten years ago the compactness of motorized pulleys was not as interesting to North American stacker reclaimer designers as it was to mobile crushing and screening plant manufacturers.

Faced with the challenge of building light, transportable, cost effective systems, these manufacturers turned to motorized pulleys as they sought to improve the design of their equipment (see Fig. 5). Now American, Canadian, Norwegian, and Swedish mobile plant manufacturers all use motorized pulleys as standard equipment.

One obvious place to use motorized pulleys was “cross belt” drives.

Fig. 6: Two 3 HP drives for 24 inch “cross belts” and four 4 HP drives for 30 inch “cross belts” were installed in this mobile screen central transfer point. Enclosing motors and gearboxes within motorized pulley shells enabled this Canadian manufacturer to simplify the design, assembly, and maintenance of this rig.

Fig. 7: Overview of 800 tph mobile crushing/screening plant deigned by US subsidiary of Swedish equipment manufacturer. US highway restrictions limited this rig to 13’-6” high by 12’-0” wide. Driving the 36” wide elevating screen feed belt at 384 fpm required 23.5 HP. Equipment designer selected Interroll’s “dual drive” arrangement.

These belts transfer material from one of several screen decks outward from the rig. As many as six drives can be tightly packed into the center of a double deck screening plant (see Fig. 6).

Because motorized pulleys require no cantilevered motor, gearbox, and V-belt assembly, they are also commonly used to drive crusher recirculating belts, under screen belts, and screen feed belts.

One particular crushing/screening plant design required an innovative approach to drive a screen feed belt (See Fig. 7).

Wayne Lauterbach, Engineering Manager of Mpressive Nterprises of Neenah, Wisconsin, remembers the challenge. “When we first approached Interroll 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 feet in order to adhere to the US highway department regulations.

We needed to put a 25 HP drive at the head end of the conveyor, but its overall width could not exceed 50 inches.

Interroll suggested that we use a ‘dual drive’ option. At first we did not think that driving a conveyor from the head and tail would work without sophisticated control equipment. However, we’ve put more than six of these rigs into service since 1995 and had no problems with the dual drive concept. As Interroll suggested, we installed a 15 HP unit (with a16 inch diameter and 50 inch face width) at the head and an identical one at the tail instead of a 25 HP unit (with a 20 inch diameter and 60 inch face width) because it would not fit at the head.”

Fig. 8: Close-up of 800 tph pivoting screen feed belt (pinned in transport position.) US highway clearance requirements limited head pulley maximum width to 50 inches. 25 HP drive pulley width would have been 60 inches. Therefore, two 15 HP drives were used (at head and tail.)

Fig. 9: Close-up of 15 HP elevating screen feed head drive pulley (in operating position.) Note optimal use of limited space. Motorized pulley was fixed to bottom of pivoting conveyor structure.

In Fig. 8 the screen feed belt is in the transport mode. This 36 inch wide conveyor was required to transfer 800 tph of stone from the tail to the centerline of the upper screen deck at 384 fpm and also rest onto the support bracket adjacent to the screen for transport.

The 15 HP head drive unit is shown in Fig. 9. Note that the drive pulley was easily mounted onto the bottom flange of the support structure.

The tail drive of the dual drive design is shown in Fig. 10. Note that the motorized pulley was mounted onto a screw take-up. The only special arrangement necessary was to allow enough power cable festoon loop to accommodate screw take up travel as the belt stretches.

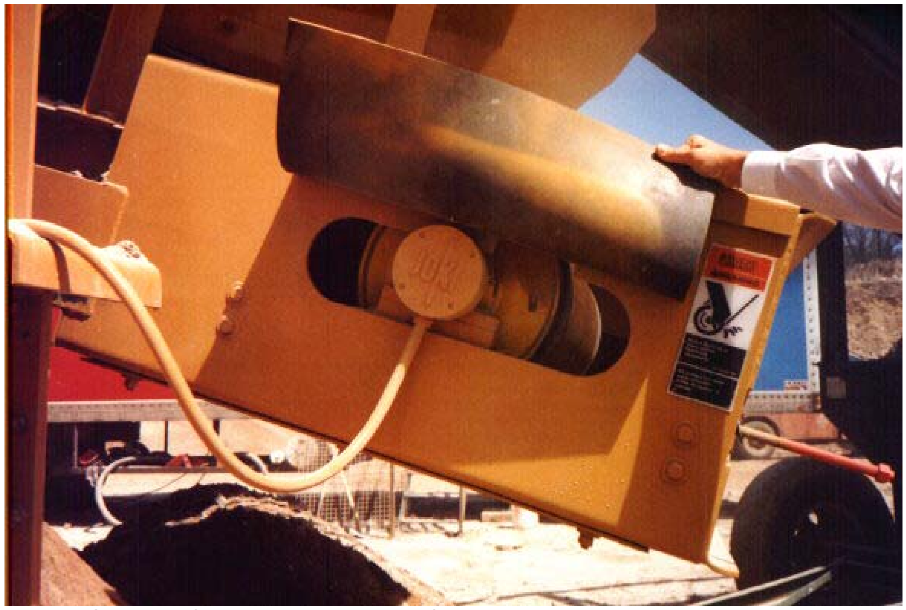

Fig. 10: Close-up of 15 HP elevating screen feed tail drive pulley. Motorized pulley was mounted in screw take up. Festoon loop provides enough power cord to accommodate belt stretch.

Neither special motor nor control circuits were required. Each drive is independently powered by 460 volt 3 phase 60 Hertz power source. No effort to synchronize the drives was necessary. Normal Design C, Class F, AC squirrel cage induction motors with 5% slip at full load were used. If one motor attempts to spin faster than the other, it draws a negligibly higher amount of current.

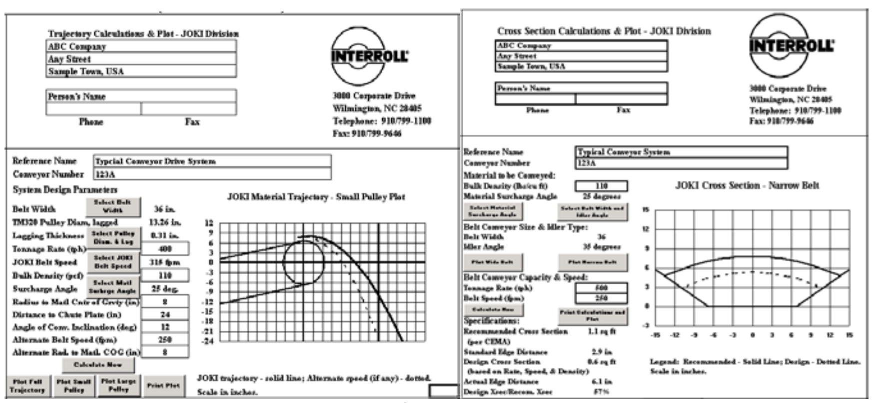

Fig. 11: Interroll conveyor drive design software output. In addition to enabling conveyor designers to determine belt drive power requirements, this CEMA-based software plots material trajectory and belt fill cross section. These tools enable designers to easily make the optimal "belt width versus belt speed" decision.

5. Conveyor Drive Design Software

Interroll developed a software package to assist bulk materials handling systems and equipment designers in 1994. This software was presented in several seminars throughout the USA in 1995 and has been in use since that time. It is available free of charge to any bulk handling design engineers.

Based on Conveyor Equipment Manufacturers Association (CEMA) guidelines as well as other reliable technical sources, this software calculates conveyor drive horsepower requirements and checks material trajectories and belt fill cross sections (see Fig. 11). It incorporates allowances for feeder belt drives, slider beds, cleated

Fig. 12: This mobile crushing/screening plant manufacturer has used Interroll motorized pulleys as standard equipment in the United States and Canada for ten years.

belts, and traveling trippers.

The purpose of the software is to enable designers to quickly calculate drive power requirements while optimizing the belt speed versus belt width decision. This allows designers to choose the smallest motorized pulley drives to fit their particular mobile plant application (see Fig. 12).

6. Roller Feeder Drives (update to 25 year old technology)

One of the most useful and unusual applications of motorized pulleys has been their implementation as green taconite pellet roller feeder drives. Designed by German engineers in the 1970's roller feeders are used to precisely size pellets while moving them to indurating ovens for hardening.

Roller feeder designs vary, but the plant that used the motorized pulley drive concept has three beds of 43 rollers per bed. As shown in Fig. 13, each 14 ft 9 inch long roller was driven with a motor, gearbox, jack shaft, two couplings, and three pillow blocks. Covered with taconite dust in a hot ambient environment, these 25 year old drives were a frequent source of downtime and maintenance expense.

After several months of testing, Engineering Design Services of Hibbing, Minnesota replaced all of the existing drives with Interroll motorized pulleys in the first feeder in 1996. The second and third feeders were converted in 1997 and 1998. The motorized pulley diameter is 8.5 inches and the roller diameter is 4.5 inches. Therefore, the drives were staggered between the left and right side of the roller feeder (see Fig. 14).

Each motorized pulley provides 3 HP at 72 RPM. The 2,600 degree F indurating oven is separated from the feeder room by a curtain.

Fig. 13: Close-up of 1996 test of motorized pulley driving green taconite pellet feeder roll. Original German-designed equipment installed in Hibbing, Minnesota in 1972, included a motor, gearbox, jackshaft, two couplings, and three pillow blocks to drive each of 43 rollers.

Fig. 14: Overview of 43 roller taconite pellet feeder after 1996 conversion to motorized pulleys. Engineering Design Services of Hibbing, Minnesota has now converted more than 150 feeder rolls for three taconite producers in the USA.

However, ambient feeder room temperature can still approach 150 degrees F. Therefore, outside air is brought in through ducts to air cool the motorized pulleys.

Interest in this roller feeder drive retrofit package is anticipated from taconite producers in Brazil, Canada, Australia, Europe, and elsewhere. Additional information on this innovative concept is available from Engineering Design Services at 218-263-9173 or at www.rollfeeder.com.

7. Conclusion

Since its humble beginning in the North American market, the motorized pulley has grown to be a significant element of the bulk materials handling engineer's design options. Major parcel and package handlers in the USA have even specified motorized pulleys as the drive of choice in some of the largest materials handling projects in US history for the reasons mentioned above.

Several brands are now available and sizes vary from as small as 3.15 inches in diameter and 0.07 HP to 31.5 inches in diameter and 180 HP (see Fig. 15). Belt speeds vary from 10 fpm to 1,000 fpm. Motorized pulleys function straightforwardly with variable frequency drives and are available with mechanical backstops, labyrinth seals, and electromagnetic brakes.

Fig. 15: Close-up of motorized pulley installed on TAKRAF mobile primary crusher in 1983. The motorized pulley concept simplified the mounting of this 50 HP conveyor drive in the tail position in a screw take-up.

Note to reader:

Bulk Solids Handling originally published this paper when Mike Gawinski was Product Manager with Interroll Corporation.

Rulli Rulmeca S.p.A., Italian idler producer, subsequently acquired Interroll's bulk handling business unit, including motorized pulley and idler production facilities in Germany, Spain, the United Kingdom, and Thailand.

With this acquisition Rulmeca strengthened its standing as supplier of components to the world bulk materials handling industry, completing a process which was initiated in 2000 with the acquisition of the companies of the Precismeca Group, including idler production facilities in Germany, Canada, and France.

Rulli Rulmeca formed Rulmeca Corporation in 2003, headquartered in Wilmington, North Carolina, USA, to serve the North American bulk materials handling market with Precismeca Limited of Nisku, Alberta, Canada.

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