Gearless Drive System, 2 x 3,800kW, 63 rpm, 631 kNm

Modern Gearless Drive Systems for high capacity belt conveyors

Authors:

Dipl. Ing. Christian Dirscherl, Siemens AG, Industry Sector, Germany
Dipl. Ing. Peter Sehl, ThyssenKrupp Robins, Denver, USA

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In many mining areas, ore grades are declining. New mines are being developed in more remote areas, pits are getting deeper and more hard-rock mines are switching to underground operations. This means that more material must be transported over longer distances, which creates new challenges. In order to achieve the increasing volumes and high demands for availability, conveying systems will need to implement the technologies made possible by today's larger drive systems.

Partnership for large conveying systems

For many years ThyssenKrupp and Siemens have partnered to help build some of the most impressive conveyor systems in the mining industry. One of the greatest success stories is the Los Pelambres downhill conveyor in Chile, which remains since 1999 the highest tension conveyor belt in the world. The conveyor is transporting copper ore over a distance of 12.7 km from 3200 m above sea level down to 1600 m and is generating up to 17 MW of electrical energy.

Technical limits of conventional drive systems

Gear reducers that have traditionally been used to drive conveyors are reaching their physical limits for demanding applications, such as steep angle or high capacity installations. For example, a modern conveyor system with a total drive power demand of 20,000 kW or more would require at least eight traditional gear reducer drives, each equipped with 2,500 kW motors. The traditional gear reducer solution has the disadvantage of reduced overall availability associated with the large number of mechanical components - such as the 60 bearings for 8 x 2500kW gearboxes -, which result in a smaller Mean-Time-Between-Failures (MTBF).

Gearless Drive characteristics and advantages

Gearless Drives are an alternative and an attractive solution for conveyors with higher power requirements. Due to its simple construction, a gearless drive system has very high availability, robustness, reduced operating and maintenance costs, and reduced noise while offering the benefits of a variable-speed drive.

With Gearless Drive systems, a slow-running synchronous motor is directly connected to the shaft of the drive pulley. Because of the slow motor speed, a gear reducer is not required. The rotor of the synchronous motor (see Fig. 1) is flanged into the pulley shaft.

Gearless drive technology is nothing new to the mining business. Mining companies have been installing high power Gearless Drives for mine hoists, excavators, draglines, pumps and mill applications for many years. While the technology is similar, the requirements differ for conveyor applications. Similar to mills, conveyors require a lot of torque during start-up, especially in uphill applications. Gearless Drives increase operating efficiency while at the same time providing high reliability and low maintenance requirements.

For the previous 20,000 kW example, a gearless drive solution for such a conveyor would be accomplished with only 3 or 4 low speed motors and no bearings or couplings. With fewer components, the drive station and electrical building requires a smaller footprint (see Fig. 2). This is especially beneficial for underground applications where the number of expensive excavations for drive stations is minimized.

Figure 1: Gearless Drive rotor during shop inspection at Siemens

For downhill operation, the drives are able to work in regenerative mode and supply the mine operation with additional electrical energy. Advances in conveyor belt technology are also supporting the capabilities offered by gearless drive systems. Newly developed stronger belts (ST-10,000) are now available that can withstand the higher stresses resulting from increased drive power requirements.

Mining companies are striving to reduce energy consumption, CO_2 emissions and increase system reliability. Gearless Drives meet these requirements by significantly reducing the number of mechanical components, such as gears, bearings and couplings (see Fig. 3). For higher powered conveyors, the CAPEX for a gearless drive conveyor is equal to or less than conventional geared drives, especially if capital spare parts are a consideration.

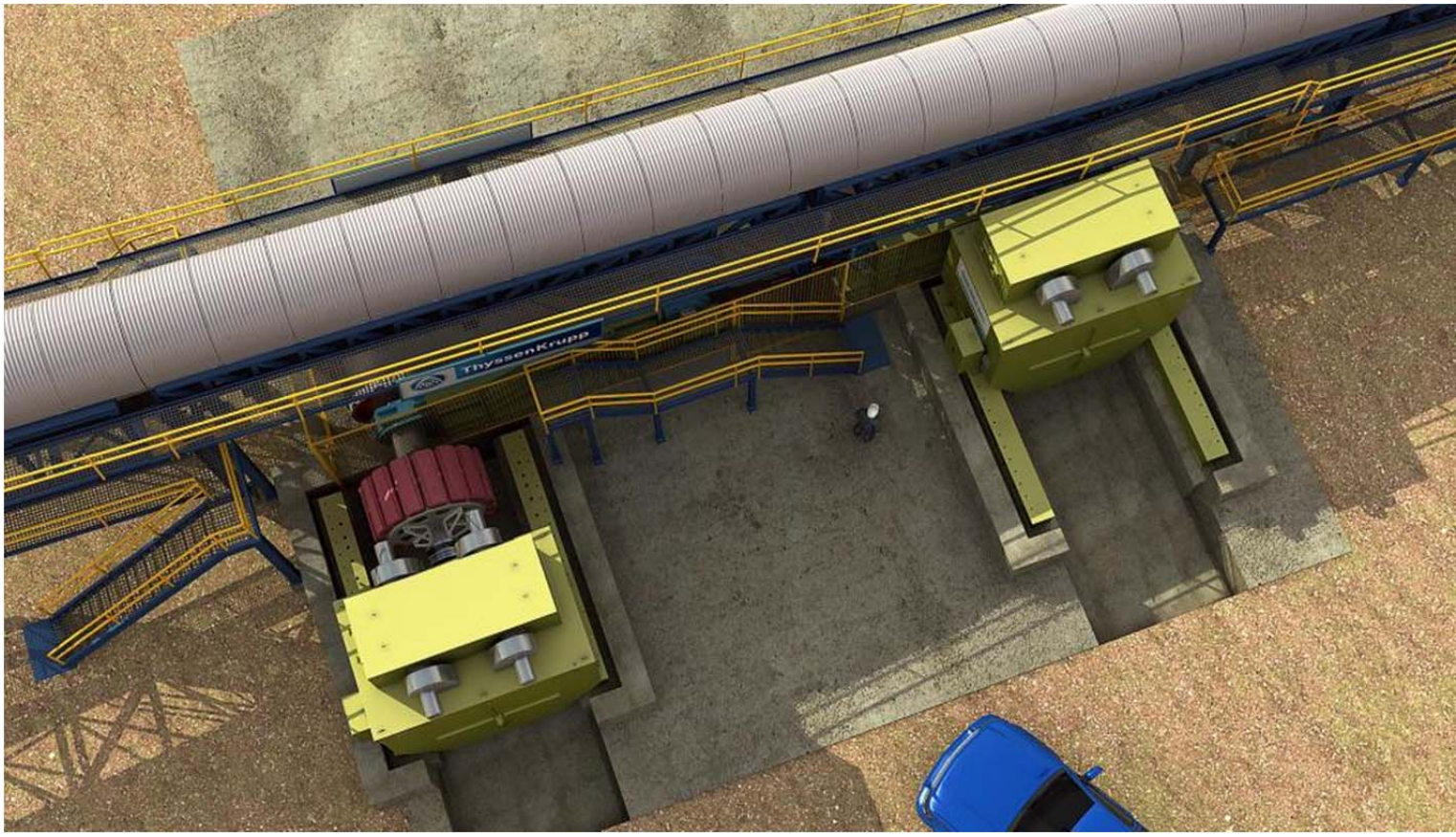

Figure 2: Reduced foot print of gearless drive system (left motor is shown in maintenance position with the stator housing moved away).

First reference for gearless drives in German coal mine.

In 1985, ThyssenKrupp (formerly O&K) and Siemens installed the first gearless direct-drive belt conveyor with cycloconverter-fed synchronous motors. Engineers at RAG Deutsche Steinkohle were impressed by converter technology and decided to apply it to the underground Prosper-Haniel coal mine in Germany (see Fig. 4). More than a quarter-century later, the belt drives are still in operation – to the complete satisfaction of the mine. The conveyor system provides an availability of more than 99%.

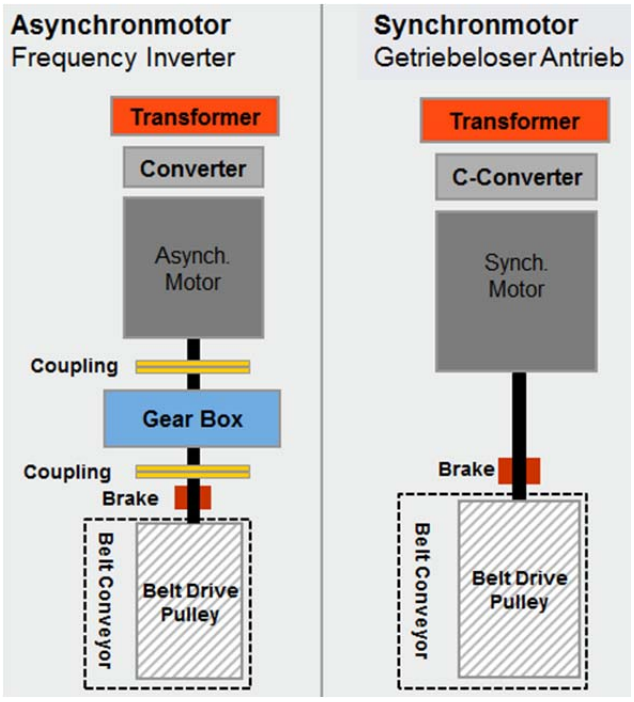

Figure 3. Comparison of standard vs. gearless drive solution

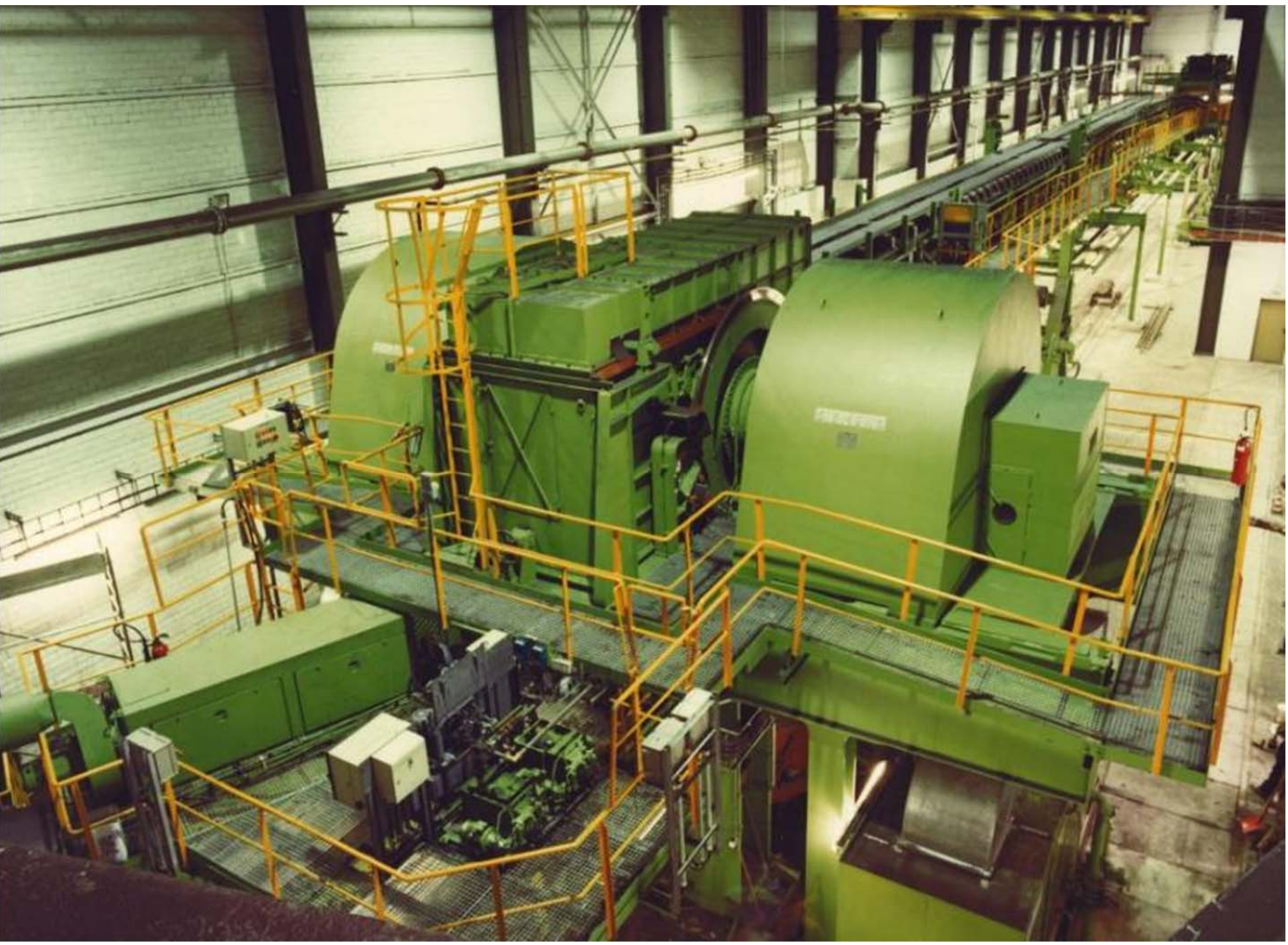

Figure 4, Prosper Haniel, conveyor drive station with Gearless Drive system, 2 x 3,100 kW

Managers at RAG indicate that:

- There have been no significant interruptions or failures attributable to motors and converters.
- Maintenance costs are significantly less than for conveyor drives with gearboxes.
- Estimated electrical energy savings of 10% are achieved annually compared to fixed-speed gear-driven drive arrangements.

New Gearless Drive System for client in Peru

Continuing their successful teamwork, ThyssenKrupp and Siemens are delivering an overland conveyor to Xstrata Copper's new Antapaccay mine in Peru, which features a gearless drive system from Siemens (see Fig. 5). The conveyor system will transport ore over a distance of some 6.5 km from the mine to the processing plant on a 1370 mm wide belt travelling at 6.2 m/s. When the belt conveyer system is commissioned in 2012, it will be capable of transporting up to 5,260 tons of copper ore

Figure 5: Rendering of Drive Station for Xstrata Copper Antapaccay mine in Peru

per hour. The drive system comprises two low-speed synchronous motors – each with a rated power output of 3,800 kW – and the associated cycloconverters, motor cooling system, converter transformers and complete electrical house for the drive station. A closed loop control system improves load sharing between the two motors.

Summary

Long conveyors with large throughputs and/or high lifts require a significant amount of power. When the demand for power exceeds 3 MW per pulley, Gearless Drives for the conveyor become the preferred solution.

The mining industry, particularly in South America, is looking increasingly at large, high capacity conveyors as a solution to meet ore and overburden transportation requirements.

Gearless Drive solutions have the potential to meet these new requirements, and are allowing mining companies to consider more efficient high capacity conveying solutions that result in lower operating costs.

Gearless drive solutions provide many benefits compared to gear-reducer drive systems:

- Higher plant availability by eliminating electrical components, couplings, bearings, and gearboxes – therefore minimizing the risk of downtime;
- Up to four percent higher energy efficiency achievable with gearless direct-drive technology.
- Longer conveyors with fewer drive stations and smaller footprints resulting in less excavation for underground applications;
- Higher available power at the pulley;
- Reduced maintenance achieved by reducing the potential for mechanical breakdowns through the use of robust components;
- Fewer spare parts resulting in lower inventories and lower investment costs;
- Reduction in noise levels achieved by eliminating the gear reducer(s), which are the noisiest component in a traditional drive system.