Len Eros, ABB

A new impetus for gearless conveyor drives

Gearless conveyor drives (GCDs) have been available for over 30 years, but are now receiving a new impetus. Here Len Eros, Global Mining Manager for the Robotics and Motion division in ABB, explains how, with a medium power solution that uses low voltage permanent magnet motors.

Above: Len Eros is the Global Mining Manager for the Robotics and Motion division in ABB.

Gearless conveyor drives (GCDs) are a favourite topic among conveyor engineers since relatively recent improvements in technology mean that they now offer increased tangible advantages. Using a GCD eliminates the necessity for gearboxes, which increases system efficiency, while reducing maintenance requirements. This is accomplished by using a large, low-speed synchronous motor coupled directly to a drive pulley. This enables direct transmission of the high forces produced by the electrical machinery without any kind of fluid coupling or gearbox.

The motor is controlled by a variable speed drive (VSD) to produce a motor shaft rotational speed of typically 50-70rpm. There are usually several drive modules in a drive station and there can be multiple drive stations on the conveyor. With existing GCD technology, the motors have ranged typically around 2.5-7MW, with a total connected power in the range of 5-20MW.

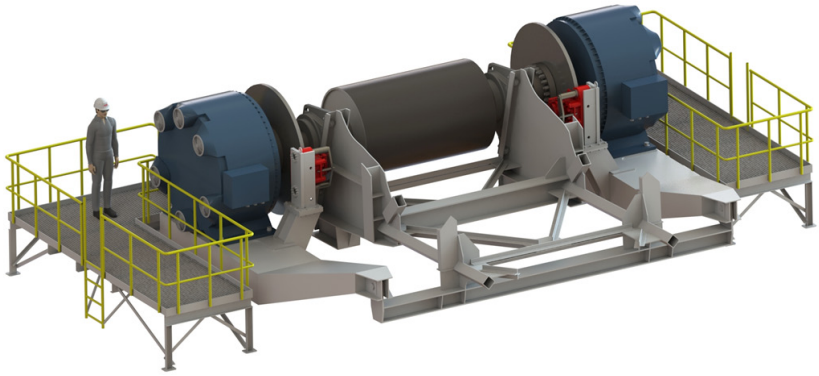
The concept is not new, given that the first GCD installation was at the Prosper Haniel mine in Germany in 1985. It is still in operation today. While this installation proved the viability and robustness of the design, it was not commercially cost effective. However, the introduction of the ST10000 steel cable belt helped to address this. The belt has the strength to use the high power input from these drives, greatly increasing the capacity of the conveyor. This can result in longer belts, heavier loads or higher lifts, all using a single flight of belt where multiple flights would be needed with conventional systems.

Improved reliability and efficiency

The elimination of numerous mechanical and electrical components increases reliability while improving the efficiency of the overall conveyor system by several percentage points. At the same time, the maintenance requirements of the GCDs are substantially lower than a conventional drive system. Further, the gain of 2-3% in the efficiency of high power systems represents huge savings in electrical costs over the life of the installation.

The technology used for GCDs is the same that is used for mine hoist drive systems. In fact, the operating conditions in mine hoist applications are much more demanding than in overland conveyor applications. This is because with a hoist, the number of start and stop cycles is significantly higher and the application is characterised by frequent changes between motor and regenerative operation.

The chief drawback of a GCD has been that its capital costs are significantly higher compared to conventional geared designs until the individual power modules reach ratings above 3-4MW. As a result, it has only been cost competitive in high power drive designs with reasonably long operating lives. There are only a handful of systems operating globally. All of these, with the exception of the Prosper Haniel system, have been installed in the past five years. The result is that potential cement industry customers for this technology are not yet confident in the design concept as they naturally want to see a larger installed base that has more running time.



Right: Schematic of a low voltage GCD.

New GCDs using low voltage permanent magnet motors

Left: Pilot low voltage GCD installation based on permanent magnet motors.

Recognising that many customers could achieve significant benefits from the GCD technology if it is cost competitive in smaller and more common applications, ABB has developed a new approach to the gearless conveyor drive system. This uses high-efficiency low voltage permanent magnet motors in place of the medium voltage synchronous motors. The initial power ratings for these motors are in the 900kW to 2MW range, which means that the new GCDs are applicable to a very large number of new and retrofit drive systems. By using a low voltage drive, the cost is competitive with conventional geared systems for this power range.

This pioneering GCD concept is lightweight and compact and can be used with either air or liquid cooling methods. With this concept the motors can be foot mounted if desired but shaft mounting the motor provides an easy alignment method and a quicker installation. The shaft mounted design also reduces the concrete foundation requirements. The heavy-duty design is robust enough to deal with shocks and vibrations associated with cement industry conveyor applications and its IP66 rating means it is completely protected from dust and water contamination. An added benefit is that the GCD will lower operational noise levels.

GCDs offer significant advantages

Compared to geared options, a negligible extra investment in a GCD solution for medium power conveyors offers these significant advantages:

- Operational cost savings (OPEX);
- Energy loss reduced by over 30%;
- No monitoring and testing of gearboxes;
- >50% higher reliability and improved equipment utilisation, leading to lower production losses;
- Faster return on investment.

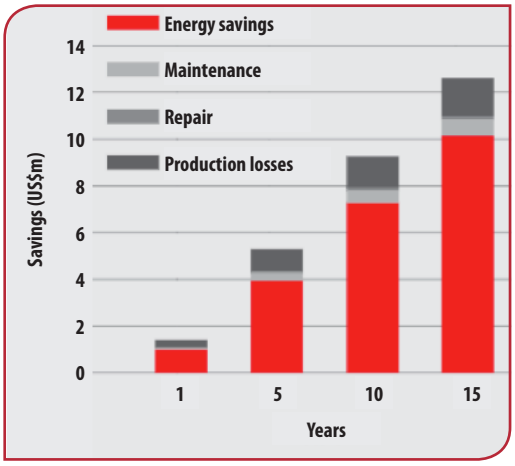
A practical example of convincing cost benefits

The following example demonstrates how the new GCD can reduce operational costs for cement industry conveyor systems. It is based on the following conveyor system design:

Conveyor line:	Four flights
Drives:	12 drives in total
Power:	1000kW
Tonnage:	8800t/hr
Energy cost:	US$0.10/kWh
Gearbox efficiency:	96%
Annual operation time:	6900hr

The results are presented in Figure 1, which shows the cumulated cost savings (including investment) after one, five, 10 and 15 years of a conveyor system equipped with GCD compared to the same system with geared drives.

The major cost factors are electric energy, system maintenance, repair and loss of production. The four pillars show the saved cost for each time frame. It is obvious that savings in electric energy and lower loss of production are most significant. After 15 years, a mine would have saved about US$12m by using the GCD.



Summary

Despite their many benefits, the uptake of GCDs has so far been slow in the cement sector. With the capital cost of medium voltage drives and synchronous motors limiting the number of applications where GCD technology could be cost competitive, it is easy to understand why the current installed base is low. However, with a new approach that uses low voltage variable speed drives and permanent magnet motors, the benefits of GCDs are now available to a wide range of new and retrofit medium power cement conveyors. In applications in which increased energy efficiency, reduced maintenance requirements and improved reliability are important, ABB's medium power GCDs should be considered.