Optimising conveyor systems

Using an overland conveyor for long-distance haulage over a fixed path can provide cost savings in energy, manpower and consumables. Ailbhe Goodbody examines the latest technologies.

Overland conveyors are an effective way of transporting bulk materials over long distances. Of course, it can be done with other transportation methods such as truck haulage, which benefits from high flexibility but also has disadvantages such as increased fuel prices, increased labour costs to operate, maintenance costs, and shortages of parts such as tyres, which can have lead times of over six months.

In comparison, overland conveyors are not only more cost-efficient, faster and safer, but also show higher availability. Markus Keller, general manager at Sempertrans, says: “In contrast with trucking, belt conveyors can transport higher tonnages at higher efficiency, allowing cost and time savings and reducing the manpower required to operate them.”

The continuous material flow provides high productivity at low maintenance and personnel demand, incurring lower operating costs. Overland conveyors don’t require as much maintenance as truck haulage as they have fewer components that can break or need repair, and most conveyor replacement parts are available locally. In comparison, more downtime is required to keep trucks and loaders running efficiently.

Dan Tiernan, marketing communications at Superior Industries, notes: “Conveyor systems are also less labour-intensive, as trucks or loaders require one or sometimes two operators. Conveyors will also operate at maximum efficiency every hour of operation. This can decrease workforce and training requirements.”

They are also are arguably more environmentally friendly, which is important in an era of ever-tightening environmental regulations. Individual haulage trucks emit and stir pollution along the entire transfer path; as production sites expand and encroach on suburban development, concerns arise over dust, noise and traffic.

Conveyors, in contrast, are powered by electric motors, so they have a much smaller impact on the environment, with less gas emission, less fuel consumption and less noise. Peter Botka, segment management/marketing at Voith, says: “Overland conveyors not only significantly reduce the CO2 footprint, but radically reduce the need for infrastructure, thus contributing to environmental protection. This includes lower noise and dust emission compared with rail or truck transportation.”

Compared with truck haulage, conveyors can achieve higher energy efficiency. Botka explains that this is “through a better dead weight/payload ratio, the potential to recuperate energy in downhill operation and the feature to have lower running resistance”.

He tells Mining Magazine that the dead weight/payload ratio is 30%/70% for conveyors, compared with 60%/40% for trucks (averaging the load cycle and the idle cycle).

In addition, recovering energy in downhill operation is a natural feature of conveyors, while in trucks it is only possible for trolley systems; the running resistance is only 1.5-2.5% of moving weight for conveyors but 2-5% for trucks.

Conveyors can also climb higher inclines than trucks – 16% for smooth belts and 30% for chevron belts – while trucks can climb inclines of 8%, meaning that serpentines haul roads are needed for steep inclinations, slowing down truck speed and resulting in more trucks being needed.

However, Leonard Eros, global mining manager for the cement, mining and minerals industry at ABB, cautions: “In many cases overland conveyors can provide benefits over truck haulage, but it’s always best to start by looking at the application and specific requirements.

“An overland conveyor handles large amounts of material but in general has fixed loading and unloading points. Of course, conveyors can be moved as needed but the larger overland systems are normally permanent installations.”

A system needs to be based in reality, and according to your specific site parameters. Tiernan says: “What is the lay of the land? What is the percentage of incline? Will you need to cross roads or streams? What is the best way to route the conveyor? What is your power availability? What are your horsepower requirements?

“Answering these questions will provide a clearer picture of what conveyor system will not only work for you, but will make your operation an environmentally friendly neighbour, reduce safety issues for your associates, and save you mountains of money.”

Drive Systems

When selecting the basic parameters such as capacity, speed and belt width for a conveyor, there are a huge number of factors that go...
into consideration, including the tonnage, material properties, terrain profile and weather conditions. The structural design can be carried out based on these factors; however, the most important question is how to design the drive system in order to achieve the maximum benefit and optimal energy efficiency. “The first consideration is usually how much total power is required and will there be one or multiple drive stations,” recommends Eros.

“Another factor to review in the early stages of design is the profile of the conveyor. Is it regenerative, or under certain conditions could it be regenerative? And will the drive be used to stop the belt or does it stop itself satisfactorily when power is removed?”

The selection process also includes evaluating the cost of procurement, the cost of operation, the energy efficiency level and the expected system reliability.

Botka says: “For instance, an intelligent measure to optimise energy efficiency is to use Turbo-Belt TT Linear Booster Drives, lowering belt forces and allowing the use of energy-optimised, lighter-weight belting without transfer points.”

“For a long, high-load conveyor the use of a single-point very high torque-drive with a high efficiency can result in the opposite, a loss of efficiency, due to the fact that extremely high belt forces require extremely heavy belting, which on a long conveyor increases the power demand significantly compared with a more intelligent drive set-up.”

Making financial calculations requires specifying the design life of the conveyor. Conveyors designed for a long life may be good candidates for a higher-initial-cost drive system that will provide a lower cost of operation, while conveyors designed for shorter lives would not run long enough to realise an acceptable payback on the higher initial cost and therefore a lower cost drive system may be desirable.

Eros comments: “The fact that we live in times of rapidly changing technology dictates that design engineers must stay current in their understanding of new technologies. That’s important when evaluating how various technologies may impact system performance, reliability and the maintenance.”

What’s available?

Mining Magazine spoke to two providers of conveyors and two providers of drive systems to find out what is new in this area and what their R&D is focusing on

SEMPERTRANS

Semptrans offers steel cord belt-ing for heavy-duty and long-distance transportation based on the newest and most efficient energy-saving compounds. These compounds can significantly reduce the so-called indentation loss at the idler stations, which is responsible for up to 70% of the overall running resistance of the belt. This technology can also reduce the power consumption needed to run the conveyor system by up to 25%.

“A remarkable example of engineering prowess on an overland conveyor system is the Flyingbelt,” says Keller. “It started running in July 2016 after a successful collaboration between Semptrans and Agudio, a brand of Leitner. For the expansion of its Barroso cement plant in Minas Gerais, Brazil, Lafarge-Holcim was seeking an innovative conveyor solution that would withstand a demanding production capacity without wreaking havoc on the surroundings.”

The Flyingbelt is an aerial conveyor system suspended on four track ropes. Standing on a ropeway 7.2km long and up to 36m high, this installation transports 1,500t/h of limestone and clay from the quarry to Lafarge-Holcim’s cement plant, while crossing valleys and dense vegetation without ever touching the ground. Keller notes: “That is the equivalent of more than 40 trucks per hour that would have to travel 24km of road instead. It is the longest Flyingbelt in the world and a more cost-effective, efficient and environmentally friendly conveying solution than conventional truck transportation.”

This unusual structure used Semptrans’ Metaltrans belt. “It has a steel carcass construction with a low elastic modulus, which allows for optimum elongation,” says Keller. “This feature ensures that the belt is supple and can stretch out enough to fit the deformation imposed by the very small radius curves on the pylon stations supporting the Flyingbelt.”

The company’s R&D focuses on developing compounds, such as the energy-saving TransEvo covers, which are based on a special rubber compound that significantly reduces rolling resistance due to indentation losses while the belt is running over the idlers. It is also looking at optimising belt-splicing technologies, as for overland conveyors many belt sections need to be spliced on-site. Semptrans offers special splicing compounds and procedures to provide high splicing efficiency and durable splices.

Keller states: “Our customers need customised solutions that ensure long-lasting operations while reducing operating costs. At Semptrans, we see ourselves as partners that help the customer find "The fact that we live in times of rapidly changing technology dictates that design engineers must stay current in their understanding of new technologies"
Superior Industries’ Zipline conveyor is a pre-engineered, modular overland system designed for quick, toolless installations. These products are found in all types of mines and conveyor applications globally.

“Many customers appreciate the benefits of the GCD [gearless conveyor drives] technology but recognise it is currently limited to a small percentage of conveyor applications,” says Eros. “ABB has developed a gearless conveyor drive system that utilises low-voltage permanent-magnet motors in place of the medium-voltage synchronous motors. The initial power ratings for these motors will be in the 1-3MW range, which means it will be applicable to a very large number of new and retrofit drive systems. And by using a low-voltage drive, the cost has come down to be competitive with conventional geared systems in this power range.”

In addition, with the high interest in more energy-efficient systems that not only reduce operating costs but also reduce their carbon footprint, along with designs that provide higher reliability with reduced maintenance requirements, ABB anticipates there will be a lot of interest in this technology when it becomes commercially available. Eros explains: “Initial testing has been completed with very good results and the first field installation is expected to be up and running by mid-year.”

He adds: “In general, our customers are asking us to bring them improvements in technology that will help them increase their productivity, reduce their maintenance requirements and improve the safety of their operations. Many of them believe they should be implementing more of the new technologies that are now available to accomplish these goals. Our goal at ABB is to provide the newest proven technologies and help our customers use that to improve their productivity.”

One ABB’s most interesting recent conveyor projects was an application for operational pace of the high-capacity mine. To make sure that the conveyor systems have the longest service life possible, Sempertrans designed and supplied around 12km of steel cord belts. These high-strength steel cord belts ensure durable and sustainable operations at the highest capacities and warrant ultimate service life and utilisation.

The company has also cooperated with German energy group RWE on an overland conveyor project. Keller comments: “Sempertrans has been the main supplier of steel-cord conveyor belts for RWE since 2014. We fulfilled about half of RWE’s needs for steel-cord conveyor belts on the basis of a multi-year contract.”

SUPERIOR INDUSTRIES

Superior Industries’ overland conveyors are designed to help eliminate unpredictable costs associated with haul trucks, while providing an environmentally friendly means to transfer material. Tiernan says: “Conveyors are powered by electric motors, which means no emissions, less fuel consumption and less noise. This is good for the environment and helps maintain a good relationship with neighbours as well, making it a win-win situation for everyone.”

It also has the Zipline conveyor, which is a pre-engineered, modular overland system designed for quick, toolless installations. “Compared with a spec-by-spec highly engineered system, this unit is a lower-cost overland alternative,” explains Tiernan. “The Zipline conveyor is designed with off-the-shelf components for easy sourcing of replacement idlers, pulleys and accessories. The modular design allows for easy structural additions in the future.”

Superior’s Trailblazer conveyor is a 500ft (152.4m) pre-assembled portable groundline conveyor. The Trailblazer conveyor transports from site to site in one 84ft (25.6m) towable load. “Set-up has been known to take as little as one hour with a small crew,” says Tiernan. “Clean-up costs and power cable management are drastically reduced by only having a single transfer point associated with numerous jump conveyors. If you want to simplify your on-site management and cut unnecessary costs, the Trailblazer conveyor is a viable option that may fit your project’s needs.”

ABB

ABB provides both gearless conveyor drives and numerous types of geared drives. The company also offers conveyor drive systems using both foot- and shaft-mounted conventional reducers coupled with induction, slip ring or synchronous motors.

The induction motors are often controlled using variable-frequency drives (VFDs) but can also be started across the line and utilise a fluid coupling for a short soft start. “ABB also manufactures the Controlled Start Transmission (CST) system, a unique reducer with an internal oil cooled clutch used for long controlled soft starts and load sharing,” notes Eros.

“While this technology was first developed in the early 1980s, it is still popular in many regions of the world and there have been more than 3,500 shipped. This product is used on applications ranging from 200kW to 2.5MW and because it uses a wet clutch design, the clutch assembly is subjected to very little wear.”

In addition, ABB manufactures pulleys and bearings along with high- and low-speed couplings.

June 2017 www.MinningMagazine.com
ABBB provides both gearless conveyor drives and numerous types of geared drives for overland conveyors.

in the Andes in Peru, where the conveyor transported ore from the mine located in one valley to the mill in the next valley. “To connect these points, the conveyor has to cross the mountain ridge between them,” says Eros. “So when the conveyor is started empty, it behaves as a slope conveyor and requires approximately 9MW of power to lift the load. Once the belt is full, the uphill and downhill sections balance each other and the running power is less than 1MW. When the feeders are shut off and only the downhill section is loaded, the belt is then fully regenerative, producing in excess of 5MW power.” Eros continues: “The control system was very interesting in that it was designed to seamlessly switch between powering and regenerating and during running it has the capability to switch off motors that are not needed. This particular system was designed using controlled-start transmission (CST) technology due to its ability to open the internal clutch and disengage the drive system from the conveyor when it’s not in use. The customer was quite interested in this feature because not only would it increase the life of the drives, but it also reduced the energy consumption by disconnecting drive from the system when they were not in use.”

**VOITH**

Voith provides hydrodynamic drive solutions based on geared drive packages as well as complete intermediate ‘booster’ drive solutions. Botka explains: “Hydrodynamic drives are a unique technology and provide many advantages compared with the solely electrical drives, whether geared or gearless. The physical fact that the main motor has no rigid connection to the driven side – i.e. gearbox shaft, pulley, other drives, etc. -- is a huge benefit for the reliability of the system. At the same time, hydrodynamic drives of the TurboBelt series provide excellent controllability and very high overall efficiency.”

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According to Botka, an overland conveyor can be a challenging machine and has to be considered as part of a material-conveying and processing system with the need of synchronisation, automation and high performance. He explains: “Voith R&D activities focus on the further development of the inherent advantages of the Voith hydrodynamic and linear booster drives: efficiency, reliability (mean time between failures), total cost of ownership, CAPEX and easy handling.”

On one hand, the Voith R&D headquarters in Germany pursues the continuous innovation of mechanical design, and on the other hand the integration of hardware and software design allows the development of new digital products and services. The regional application engineering centres take care of customisation and local needs.

“Mining customers are very much focused on reliability and availability of their equipment,” says Botka. “The increasing pressures of productivity improvements force all major companies to invest in automation, remote control and maintenance support, e.g. condition monitoring, monitoring of energy efficiency, health-check capability or remote adjustments for improved performance. Voith combines its decades of experience in mining applications and drive systems with the power of a newly founded dedicated digital division for solutions that need the productivity needs of our customers – through extremely reliable design and intelligent automation features.”

Voith recently installed a TT linear booster drive on the H2 belt conveyor in RAG’s Prosper-Haniel coal mine in Germany without interrupting normal operation schedules. As a result, it was possible to achieve a comprehensive solution with the subsequent installation of another TT drive that resulted in sustained cost reduction for the mining company. A BTM linear booster allowed for a further reduction in belt tension forces and Prosper-Haniel has since been able to operate the belt conveyor with a cost-saving PVG2000/1 textile belt.