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Intermediate drive technology as a cost-saving solution for belt conveyor upgrades

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INTERMEDIATE DRIVE TECHNOLOGY AS A COST-SAVING SOLUTION FOR BELT CONVEYOR UPGRADES

Blake Burgeth[1]

ABSTRACT: The demand on belt conveyors continues to increase. Availability and reliability are key factors for increased productivity. Linear booster drives for mining conveyors were initially used in the US in the 1980-90's with marginal success. The primary issue of this technology was controlling and transferring the power to the belt. Voith has successfully applied linear booster drives to over 300 installations worldwide. The Voith TurboBelt "TT Linear Booster Drive", is optimized in a complex engineering process to meet the customers' targets. Linear booster drives can save 25% or more on both Capex and Opex costs. This paper highlights the advantages of the TT are Drive concept, the potential applications that can benefit from this type of conveyor design, and cover examples of this technology. The TT Drive solution significantly reduces the belt tensions, allowing the use of lower rated and lower cost belts. This can benefit new installations as well as extend the life and/or upgrade the capacity for existing conveyor installations.

Voith Turbo, a Group Division of Voith GmbH, is a specialist for intelligent drive solutions, systems, and comprehensive engineering services. Customers from highly diverse industries such as oil and gas, energy, rail and commercial vehicles, ship technology, mining, and mechanical engineering rely on the advanced technologies and solutions-driven expertise of Voith Turbo.

INTRODUCTION

Already for decades, Voith Turbo GmbH and Co. KG has gathered experience with drive components for mining and mineral processing equipment and bulk material handling conveyors. This experience, combined with the service and sales organization established all over the world, is expanded more and more to turn it into a competence center for drive solutions and optimizations of belt conveyor systems. Among others, the product portfolio in Figure 1 for belt conveyors comprises of TurboBelt Hese Pulleys, high tension turbine T design conveyor pulleys, TurboBelt Transfer Stations, TurboBelt Tension Stations, TurboBelt Storage Loop, and the TurboBelt TT Linear Booster Drive.

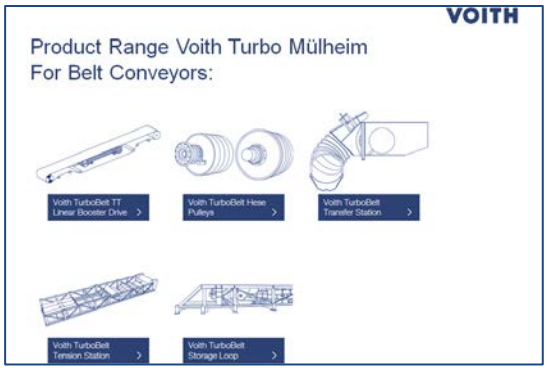

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Figure 1: Extract from the product portfolio of voith turbo GmbH and Co. KG for belt conveyors

Having that background, Voith was well prepared when RAG turned to Voith in 2015 to work out a comprehensive solution for the upcoming replacement of a 16-year-old steel cord belt.

DRIVE UPGRADE WITH THE VOITH TURBOBELT TT LINEAR BOOSTER DRIVE

The TurboBelt TT Linear Booster Drive (TT Drive) is a high-performance intermediate drive for belt conveyors. It extends the lifetime of belts in existing systems and influences the requirement to the belt rating considerably, by reducing the belt tensions, which results in a significant cost savings. Compared to the conventional intermediate tripper drive technology, the TT Drive does not require material transfer points. This reduces the strain on the belt and increases its lifetime by reduced top cover wear, less bending cycles on the belt splices, and eliminating potential belt rip risks due to errant tramp metal originating from the transfer point.

Eliminating belt transfer points also leads to considerable lower dust formation negating the requirement for any dust suppression or dust collection equipment. Moreover, systems with TT Drives require less space than conventional systems which is an important aspect in underground mining. On long conveyors, the TT Drive reduces the belt tensions so that a lower rated belt can be used saving enormous costs by using fabric belts instead of steel cord belts. Smaller drive components (motor, gearbox, pulleys, etc.) can be used too. Therefore, there is less space required for the conveyor drive or drives. On existing belt conveyor systems, the TT Drive allows for increasing the conveying capacity while retaining the same belt. In addition, the current drives, take-up winch, and pulleys may also be retained.

Voith Turbobelt TT linear booster drive – functional principle

Equipped with a head and tail station, the TT Drive is integrated into the actual belt conveyor so that the top run of the existing carrying belt rests on the top belt of the TT Drive belt. Power is transmitted linearly by means of friction between the TT Drive belt and the carrying belt. Belt tension forces are reduced through the length of the TT Drive resulting in a reduction of the maximum belt tensions.

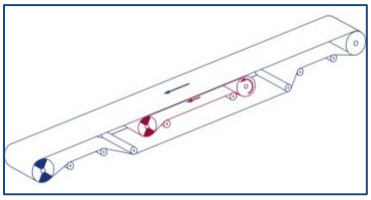

Figure 2: VoithTurboBelt TT linear booster drive – functional principle

Voith Turbobelt TT linear booster drive – existing conveyor systems

When planning an increase of the conveying capacity on an existing conveyor, or system of conveyors, drive power will need to be increased as long as the conveying cross sectional area is sufficient to achieve the target.

For a conventional drive solution this would mean that the existing belt needs to be replaced by a new one rated for the increased tensions. In addition, higher forces on the pulley, structural steel, and foundations at the drive station would require further modifications. An engineering review of the other high tension pulleys, low tension pulleys, and take-up would also be required potentially leading to other equipment, structural steel, and foundation improvements. This problem can be economically and timely, be solved by implementing TT Drives. The existing

head drive with its pulleys and the belt remain unchanged, while TT Drives can be installed and commissioned during a short shutdown period.

Increasing the conveying capacity and/or extension of belt the lifetime on existing large conveyor systems by means of TT Drives provides:

- Longer lifetime of belt compared to conventional intermediate drive technology
- Increase of conveying capacity on existing conveyor systems
- No need to replace the conveyor belt
- No need to convert the existing drive system and modifying steel structures and foundations

Voith Turbobelt TT linear booster drive – new conveyor systems

For conveyor systems with large elevation changes and high conveying capacities, high strength steel cord belts and large drive units are commonly required. Moreover, greater mine excavation with corresponding foundations for support structures must be prepared for the head drive(s). For conveyors utilizing TT Drives, the use of significantly smaller drive units and lower belt ratings are possible.

Long belt conveyors with high conveying capacity in new systems utilizing TT Drives provide:

- Utilization of lower rated belts
- Smaller drive units
- Smaller pulleys
- Reduced space requirements
- Optimized and standardized multi-motor drives

CASE STUDY – DRIVE UPGRADE AND BELT PROJECT FOR CONVEYOR H2 AT PROSPER HANIEL

The underground Prosper-Haniel coal mine in Bottrop belongs to RAG Deutsche Steinkohle and conveys 3,000,000 tons of hard coal per annum. There is a network of 141 km of underground tunnels extending to a depth of 1,150 m. The entire H conveyor line is designed for a conveying capacity of 2,000 t/h. The speed for conveyors H3 and H2 is 3.2 m/s. The material velocity was increased to 4.2 m/s by means of accelerating the conveyor in order to have a smoother material transfer to conveyor H1 which runs at a speed of 6 m/s. Figure 3 shows the flow diagram for the material transport system.

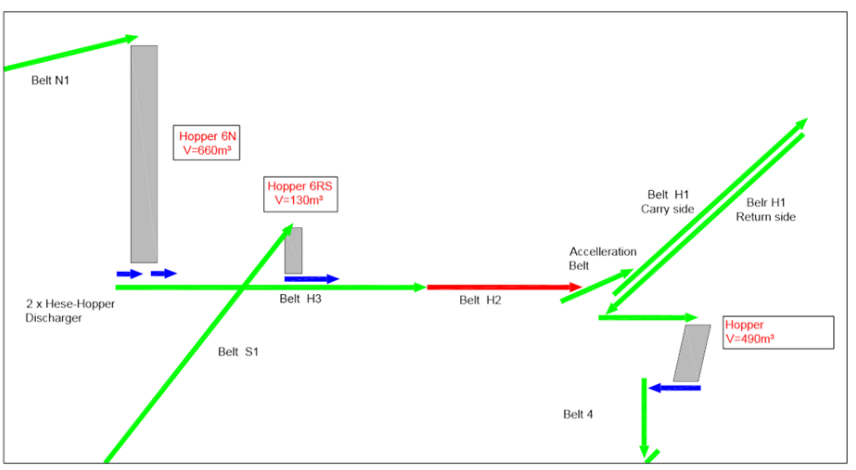

Figure 3: Flow Diagram for the H conveyor line

The H2 belt conveyor transports all the hard coal extracted from the longwall and the material from the drift excavation over a length of 1,270 m and has a lift of 186 m. The belting installed on conveyor H2 is a steel cord ST 5000 12/10. The last replacement of the belt on conveyor H2 was performed in 1999. In addition, the repair and maintenance demand on this steel cord belt has increased considerably over the past years.

Due to the very poor condition of the steel cord belt and as reliability couldn't be guaranteed any longer, the option to replace the conveyor H2 belt came up in winter, 2015. The premise for the belt replacement was to refrain from using the expensive ST 5000 steel cord belt and to use a fabric conveyor belt of PVG 2000/1. In order to be able to technically implement this measure with the significantly reduced belt strength (2,000 N/mm instead of 5,000 N/mm), the use of two TT Drives was required.

Design and planning of the drive upgrade and belt replacement on conveyor H2

The customer's key requirement was to be able to replace the ST 5000 steel cord belt with a considerably cheaper PVG 2000/1 fabric belt. The installation of two VoithTurboBelt TT Linear Booster Drives makes this possible by reducing belt tensions, thus reducing the required belt rating from 5,000 N/mm to 2,000 N/mm. Comparisons of the calculation results, with the most important parameters, are depicted in Table 1.

Table 1: Calculation results for conveyor H2 (old - new)

		Conveyor H2 Drive Upgrade and Belt Replacement Project	
		ST 5000 12/10	PVG 2000/1 and 2 Voith TT Linear Booster Drives
Center Distance		1,270 m	1,270 m
Belt Width		1,200 mm	1,200 mm
Height of Lift		186 m	186 m
Mass Flow		2,000 t/h	2,000 t/h
Belt Rating		ST 5000	PVG 2000
Input Power Required		1,547 kW	1,468 kW
Splitting of the Input Power			
Head Drive	Drive Pulley	2 x 400 kW	1 x 300 kW
	Drive Pulley	2 x 400 kW	1 x 300 kW
TT Drive #1	Drive Pulley	-	1 x 250 kW
	Drive Pulley	-	1 x 250 kW
TT Drive #2	Drive Pulley	-	1 x 250 kW
	Drive Pulley	-	1 x 250 kW

As it can be gathered from the comparison of the conveyor calculations with and without TT Drives, the maximum belt tensions in the area of the discharge pulley are reduced from 646 kN to 240 kN through the use of TT Drives (Figure 4). This reduction of the maximum belt tension allows the use of a fabric conveyor belt with a rating of PVG 2000/1 while complying with all safety requirements. Moreover, it's beneficial for the 30-year-old drive and the conveyor structure which were reinforced and repeatedly repaired due to corrosion damage.

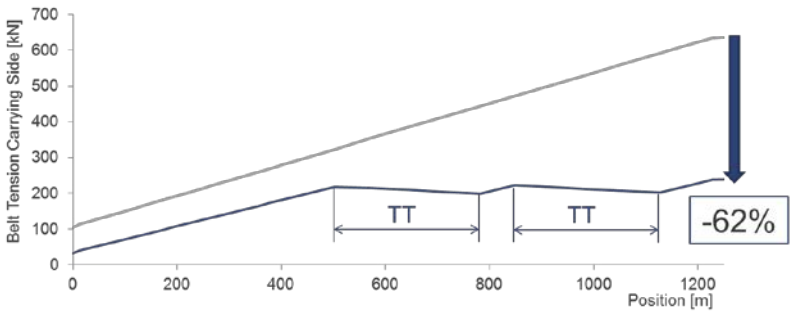

Figure 4: Belt tension force diagram

According to the results of the analysis, Voith developed the following solution for Conveyor H2:

- Install the first Voith TT Drive reducing the belt tension so that the lifetime will be extended until the next scheduled shutdown
- Install the second Voith TT Drive to further reduce the belt tension
- Replacement of the ST 5000 conveyor belt with a PVG 2000/1

Cost savings – conveyor H2 drive upgrade and belt replacement project

The installation of two 280 m long TT Drive systems reduced the belt tension forces and thus made it feasible to use a less expensive PVG 2000/1 fabric belt instead of an ST 5000 steel cord belt. Despite the additional PVG 1600/1 belts required for the intermediate TT Drive systems, there was a significant savings regarding belting costs. However, for the analysis of the total installed costs, the procurement of the two TT Drive systems must also be considered. According to the data in Table 2, the final result are a total savings of approximately 10%.

Table 2: Comparison of drive upgrade and belt replacement project supply and costs

	Project Supply Differences
Belt	PVG 2000 Instead of ST 5000
Belt Costs	60% Cost Savings
Belt Splice Costs	55% Cost Savings
Total Costs Including Supplying TT Drives	10% Overall Approximate Savings

CONCLUSIONS

Using a scheduled shutdown, and without additional downtime, Voith installed the first TT Linear Booster drive on Conveyor H2 at the Prosper-Haniel coal mine. With the installation of the first TT Drive complete, Voith enabled the Prosper-Haniel mine to continue using a severely damaged ST 5000 steel cord belt until the next scheduled shutdown thus avoiding unexpected downtime and corresponding loss of production.

During the next scheduled shutdown, Voith installed a second TT Drive on Conveyor H2. With that, the belt tension forces where further reduced allowing Prosper-Haniel to operate the belt conveyor with a less expensive PVG 2000/1 fabric belt. The project managers from RAG Deutsche Steinkohle, Ralf Dohle and Wolfgang Kosiuk, were fully satisfied with the Voith Project Management and Engineering Team and the results of the Voith TT Linear Booster Drives: "We have a double benefit of the solution offered by Voith. On the one hand, we could avoid unscheduled downtime caused by the damaged belt, and on the other hand, we now can use a fabric belt on the system instead of an expensive steel cord belt. We would opt again for Voith's solution at any time."

Completing the installation of the TT Drives provided the mining company a comprehensive solution and achieved an overall cost reduction and schedule of the project.