Extract Henderson Mine Presentation

SUMMARY

The Henderson Mine is located approximately 50 miles west of Denver, Colorado, USA. A material handling project was completed in the fall of 1999 to replace the rail system, which transported molybdenum ore 24 km from the mine to the mill using a three flight conveyor system.

The first conveyor (PC1) is a 1km high lift conveyor, which transports the ore from an underground crushing station to the end of the existing rail tunnel.

The second conveyor (PC 2) is 17 km in length and utilizes the existing rail tunnel to transport the ore from the mine, which is on the East Side of the continental divide, to the mill located on the West Side.

The third conveyor (PC 3) is 6.3 km long, takes ore from the tunnel portal to the mill through a series of 9 horizontal and 9 vertical curves and inclines up to 15 degrees.

The project applied advanced conveyor design to tackle the installation of the system in an operating mine and achieve the highest possible level of reliability. Man Takraf were the principal designers of PC2 and PC3. Fluor Daniel Inc. were the principal designers of PC1.

This paper outlines the basic design parameters of this system and discusses the special consideration which was given to the idler rolls and conveyor modules used throughout the installation.

CONVEYOR PC1

Conveyor PC1 is the shortest conveyor in the system. The belt width is 1220mm and the conveyor length is approximately 1.2 km long with 160 m of lift, transporting ore at 4,5m/s (max) from beneath the crusher area up to the transfer of conveyor PC2.

Idler frames and rolls were chosen identical to the idlers for tunnel conveyor PC2 (see Fig. 8), this was done to keep common idler roll inventory underground.

CONVEYOR PC2

Conveyor PC2 forms the central link in the ore handling system. Belt width is also 1220mm and the belt speed is 6,1m/s (max).

The installation of 17 km of conveyor modules and idlers in the existing rail tunnel was accomplished by using the existing rail tracks as a foundation, and then clamping the Lorbrand designed (based on Man Takraf’s conceptual design) and manufactured conveyor modules to the rail without the need for welding or drilling of the rails during installation.

In order to meet the construction schedule the modules, approximately 1900 units complete with idler frames and idler rolls, were pre-assembled at the tunnel portal. All conveyor modules were pre-assembled in jigs.

Idler rolls on each table were then precisely aligned to within 1 mm both in the vertical and horizontal plane.

CONVEYOR PC3

Conveyor PC3 is the final link between the mine and the mill. Belt width is 1220mm and the belt speed is 4,5m/s (max). Idler rolls were designed to operate under extreme climatic conditions between +25ºC and –45ºC.

There are 9 horizontal curves along the PC3 conveyor route. The tightest of these curves is located approximately 300 m from the tail of the conveyor and is 1500 m in radius. The design for the curves incorporates banking of the idler frames as well as a forward tilt applied to the wing rolls.

In the 1500-m radius horizontal curve the return strand of the belt uses a 3 roll idler configuration to control belt tracking. Idler frames were individually built per the specifications provided by MAN Takraf and Fluor Daniel Inc., the material-handling designers.

No shim packs had to be used anywhere along the entire conveyor line. The belt tracking in the horizontal curves was generally better than predicted; this is mainly attributed to the very tight alignment tolerances and to lower than expected rolling resistance values of the Lorbrand idler rolls. The low rolling resistance substantially lowered the operating belt tension and significantly improved belt tracking.

IDLERS

Standards like CEMA (Conveyor Equipment Manufacturing Association) quantify and classify idler rolls and make recommendations with regard to allowable loading and the application of different type of idlers.

However very little attention is generally given to the selection of the correct idler in view of power consumption, noise generation and lowering belt tensions.

Most idler designs have been around for some time but no great emphasis has been put on selecting the appropriate idler roll assembly quality, sealing arrangement, correct grease selection and bearing type.

Bearing type:

Idlers typically consist of an axle (it does not transmit a torque), a shell or often called a “Can”, two end discs, two seals and two bearings. The axle is located and secured against rotation in a bracket, which is integral to a cradle or idler frame. Bearings are either Ball or Taper Roll Bearings.

Ball bearings are used in Europe, Australia, South Africa and increasingly in South American operations. The US operators tend to use Taper Roll bearings in their idler roll, the main reason being that almost exclusively taper roll bearing equipped idler rolls are being manufactured and sold by US idler manufacturers.

Specifically for the PC2 installation, it was imperative to provide a high quality low drag idler roll. This 17km long conveyor has 55,000 individual rolls installed, so each additional 1 N drag per roll would necessitate an additional 350 kW drive power.

The system rolling friction values, which were achieved for PC2, are the lowest yet recorded, absorbed power is way below expectations with the obvious saving in operating power cost.

Rolling resistance:

Rolling resistance of a conveying system is comprised of various components. These are rubber losses caused by the indentation of the belt at each roller, flexing resistance of the conveyed material and the belt, bearing rolling friction, viscosity of the bearing grease and temperature and resistances caused in the bearings by misalignment of the idler roll assembly.

Taper roll bearings show substantially greater rolling resistance than do ball bearings. Tests conducted by an American idler manufacturer some years ago using both taper roll and ball bearing type idlers showed that ball bearing equipped idlers generated substantially lower rolling friction than did taper roll bearing idlers.

The drag values for ball bearing type idlers per these earlier measurements were and are consistent with the measurements obtained from the Lorbrand idlers under test conditions and in-situ, operating at the Henderson Mine.

Seal design:

Idlers have a number of failure modes. Typically either the shell or the bearings wear out. End disc to shell welding failures and support frame failures have been observed but are a rare occasion.

Shell failures occur when the shell is not sufficiently thick, 1/4" (6 mm) shells seem to be the upper range, 1/8" (3 mm) is considered the lower end of the scale.

Clearly the thinner shell will wear proportionately faster than a thicker shell. Bearings can either fail due to excessive misalignment caused by excessive axle deflection, which can be caused by idler roll assembly quality problems, overloading of the belt or under design of the bearing.

Taper roll bearings are more susceptible to misalignment than ball bearings. The former can tolerate 6 radians of deflection whilst a ball bearing can negotiate a deflection of 12 radians.

More often than not the ingress of particles (dust, water, chemicals) through the sealing arrangement causes premature failure of one or both bearings in a roll.

Quality of manufacturing and assembly:

The various idler manufacturers have implemented many different seal designs. Test have shown that over a relatively short period of operating time, the seal friction does equalize for most seal designs, a shear plane in the grease is created between the stationary and rotating parts of the labyrinth seals which reduces grease friction substantially.

Low drag values, TIR run out and bearing life is predominantly driven by the accuracy of manufacture and assembly of the individual idler roll and frame parts and not necessarily by a complex seal arrangement.

Testing of idler rolls:

Hannover University was employed for the Henderson project to evaluate idler roll drag and roll run-out (TIR). Identical rolls were solicited from idler manufacturers around the globe.

All rolls had antifriction ball bearings and only differed in the end disc design, sealing arrangement and manufacturing and assembly method.

The Lorbrand idlers featured most favorably in this test and were subsequently chosen for the installation at Henderson.

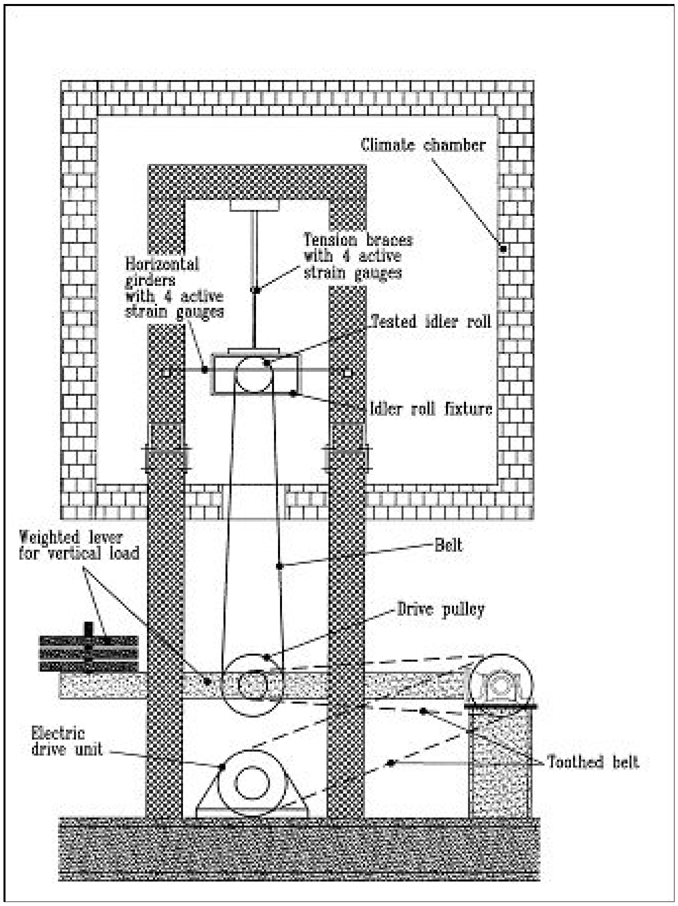
The series of tests were performed at the Institute of Material Handling at the University of Hannover in Germany.

Purpose of tests:

Evaluate drag of rolls in order to be able to accurately determine conveyor belt tensions and required drive power. Evaluate Total Indicator Run out (TIR), a measure of the roundness of the roll assembly and overall quality of manufacture

Test equipment:

The test stand at the University of Hannover, Germany, as shown below, was used to obtain data of idler roll drag values.



Rolls tested:

12 idler rolls were obtained from three different pre-qualified manufacturers. A fourth Manufacturer "D" who was not pre-qualified, but was accepted for testing and supplied three rolls.

> **A:** Lorbrand - South Africa
> **B:** Supplier B
> **C:** Supplier C
> **D:** Supplier D

All test rolls had a diameter of 219mm (8.62") consistent with the ultimately used center roll for PC2 conveyor at Henderson. Roll face length was 508 mm. Each roll was fitted with 40mm diameter ball bearings.

The only differences in the various manufacturers' rolls were:

- Manufacturer
- Assembly tolerances
- Manufacturing and assembly methods
- Sealing arrangements
- Type of grease used in bearings

The Institute at Hannover ran each roll in for 12 hours. The rolling resistance or drag was measured at a temperature of 180 C, at w = 525 RPM which equates to a belt speed of 6m/s (1200 feet per minute). A vertical load of 110 kg was applied during the tests. Rolls were tested bi-directionally.

Summary of test results as follows:

Manufacturer	**Roll drag (peripheral force in N)**	**TIR in 1/1000 mm Right/Center/Left**
Lorbrand	2.0	491/575/464
Supplier B	2.7	359/291/375
Supplier C	5.1	368/363/363
Supplier D	4.2	487/663/360

Subsequent to the tests, over 65,000 rolls were procured from Lorbrand. Another 100 rolls off the production run were tested by the Institute in order to maintain and assure quality standards. Average running resistance was lower than the 2 N initially measured, with the lowest values at 1.5 N. TIR values of 0.360 mm were consistently measured for the actual production run.

Cost Benefit:

For example on a 1.6 km (1 mile) long conveyor having an idler spacing of 1.0 m at the top and 3.0 m at the return strand, operating at a belt speed of 5 m/s (1000 fpm), each Newton of idler drag equates to 35 kW additional power.

Thus comparing a Lorbrand idler to the highest drag idler tested, for each 1.6 km (1mile) of conveyor length per above example, an additional (5.1-2.0)*35 = 108 kW is required. Assuming a power cost of 0.05c per kWh and 8000 operating hours per annum, the difference in operating power cost per mile of conveyor per annum equates to over US$40,000.

CONCLUSION

The Henderson Coarse Ore Conveying System has shown to be one of the most advanced systems of its type in the world. Ten years ago the information and technology was not available to allow this type of system to be used in this application.

Advances in construction, horizontal curve design, drive control technology as well as research into minimizing running resistance has allowed the construction of these conveyors. All conveyors have been evaluated using the latest simulation and design software.

This conveying system has placed the Henderson Mine at the leading edge of material handling system technology. Lorbrand is proud to have made a significant contribution to the success of this project by supplying a high quality product, which delivered what it set out to achieve.

Extract Reference:

High Quality Idlers at the Henderson Mine,
Prepared by Ralph Granig,
Director of Lorbrand Pty Ltd