Energy Efficiency Review of a Belt Conveying System

Project Scope:

Equipment: Conveyor Belt

Problem: When a prominent Australian miner changed belt suppliers, they observed a significant difference in power consumption in their conveyor system.

TBS Objective: TUNRA Bulk Solids (TBS) was engaged to help identify differences in material characteristics between the bottom covers of the belts and determine how these differences affect the energy requirements of the belt conveying system.

To better understand the difference in energy loss characteristics, dynamic mechanical analysis (DMA) testing was performed on the two conveyor belt bottom covers using an RSA-G2 Solids Analyzer. The viscoelastic material properties determined from DMA testing were then applied to an indentation rolling resistance model to compare the performance of each conveyor belt compound for two operating temperatures (maximum and minimum).

Test Procedure

The RSA-G2 Solids Analyzer shown in Figure 1 was used to determine the viscoelastic properties of the rubber compounds for this project. A material's viscoelastic properties are obtained by applying an oscillating mechanical deformation to a sample and measuring the resultant stress. From the results of these tests, an elastic (storage) modulus E′, loss modulus E″ and phase angle δ can be calculated.

Figure 1: Dynamic Mechanical Analysis (DMA) Machine

The typical deformation rate of the bottom cover of a conveyor belt due to the idler rolls ranges from 50 Hz to 1000 Hz, which is outside the testable range of the RSA-G2 Solids Analyzer; therefore, time-temperature superposition principles are employed to account for the larger frequencies. Time-temperature Sweeps (TTS) were performed on samples cut from Belt 1 and Belt 2, considering Belt 1 from supplier 1, and Belt 2 from supplier 2. Master curves of the storage modulus, loss modulus, and tan (δ) data were derived from time–temperature sweeps for the two samples.

Indentation Rolling Resistance (IIR) Prediction

The QC-N model [1] was selected to predict the indentation rolling resistance for this project due to previous research showing that this model performs favourably when compared to other commonly used rolling resistance prediction models. QC-N is a one-dimensional IRR model which includes a 'transient term' to account for the contact stresses' transient response to the indentation deformation, which is neglected by other one-dimensional models.

References

1. Qiu, X. and C. Chai, Estimation of Energy Loss in Conveyor Systems due to Idler Indentation Journal of Energy Engineering, 2011. 137: p. 36-43.

Details of the belt conveying system analysed for this project are provided in Table 1.

Table 1: Conveyor System Details for Indentation Rolling Resistance Analysis

Item	Symbol	Value
Conveyor speed	v	+-5 m/s
Operating temperatures	T_0	25°C & 40°C
Pulley (bottom) cover thickness		5 mm
Idler roll diameter (carry side)	D	+-130 mm

Results

Indentation Rolling Resistance (IIR)

The indentation rolling resistance calculated for the system parameters described in Table 1 for each belt are shown in Figure 2, with the indentation rolling resistance being the net force per belt width, per idler, to overcome the rolling friction.

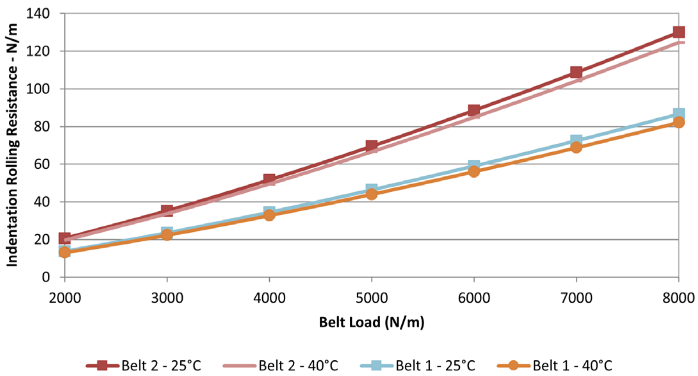

Figure 2: Indentation Rolling Resistance for Belt 1 and Belt 2 at 25 degrees and 40 degrees

Final Analysis

The storage and loss modulus values measured were significantly different for Belt 1 and Belt 2 over the frequency range analysed, which resulted in a considerable difference in the predicted indentation rolling resistance performance. Furthermore, the predicted indentation rolling resistance was slightly higher at the operating temperature of 25°C, compared to 40°C, for both belts.

The testing and analysis comparing the indentation rolling resistance performance of the different belts corroborated what was being seen on site in that for fully loaded, long overland conveying systems, the energy consumption would be substantially higher for Belt 2.

Why TUNRA Bulk Solids?

Experience and Expertise

We have provided expert solutions to industry for over 45 years and are the leading organisation for materials handling research and consulting in Australia and internationally

Research and Development

We have a proven track record in research and development through the close association with The University of Newcastle

Quality Service

We have highly qualified, well-trained and specialist staff that are committed to delivering excellence

First Class Facilities

Our laboratory is a state of the art facility located within the Newcastle Institute of Energy and Resources (NIER) at The University of Newcastle

Industry Standards

We are accredited to ISO 9001, ISO 45001 and ISO 14001

Independent

We are independent and not for profit

Advancing the Bulk Materials Handling Discipline Globally

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