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NOISE SOURCE IDENTIFICATION AND CONTROL OF A CABLE BELT CONVEYOR SYSTEM

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1. INTRODUCTION

Environmental noise restrictions can result in onerous restrictions being placed on the operations of many industrial and mining activities. SVT is an engineering consultancy which helps both industrial and mining companies meet their environmental noise obligations. This paper presents some of the results of an investigation that SVT has undertaken on conveyor noise for a large mining company. The company operates a long conveyor which transports ore from a mine to a refinery. The conveyor system runs through rural areas where it passes very close to a number of occupied houses. Because of the location of the conveyor in a rural setting residents in this area are typically exposed to noise levels lower than the current local regulatory maximum permissible environmental noise levels for the area. Hence the location of the conveyor next to these farm houses has resulted in noise from the conveyor being clearly audible when it is running. To meet the maximum permissible environmental noise levels noise emission from the conveyor system needed to be reduced some 13 dB.

This paper presents some of the results of this investigation into reducing noise from the conveyor system, and also in the development of a prediction system for estimating noise emission from the conveyor for various conveyor speeds.

2. REVIEW OF A LOW NOISE PULLEY SYSTEM

To investigate the noise generation mechanism of the conveyor pulleys a series of noise and vibration tests were carried in a test shed built over the operating conveyor. Octave band and narrow band noise measurements were utilised along with vibration and strain gauge measurements to evaluate the effects of load on noise. Detailed octave band sound intensity measurements of the test pulleys were also taken. Sound intensity measurements were taken because they enabled noise emission from the individual pulleys to be isolated from the noise generated by the other pulleys in the test shed. The average sound intensity level from the pulleys can then be related to the total average sound power level for the pulleys being tested. The sound power level gives an indication of the overall noise reduction expected if the pulleys were installed in the field. The sound intensity measurements also help in identifying areas of high noise emission, ie. whether there is high noise emission from the pulley rim / cable interface, pulley hub, and linestand.

The noise generation mechanisms from the conveyor belt arises due to the meshing of the pulleys with the cable that supports the belt. Because the cable is made up of strands which are wrapped around an inner core this results in each strand of the cable impacting the pulley rim on a periodic basis as it passes over the rotating pulley. The period of impact of the wire strand on the pulley can be determined from the pitch of the wire strands and the speed of the belt. The meshing frequency generated by the cable rovings results in a distinct tonal frequency, where the harmonics of the meshing frequency are predominant, and are clearly visible in the narrow band noise spectra and the vibration spectra.

The noise emission from the impact of the cable strands on the pulley rim results in noise generation at the impact zone, and vibration induced into the cable strands and pulley hub. There are also secondary noise sources from vibration induced into the pulley hub and the linestands, bearing induced noise, windage noise, etc. However, these are not considered as significant as the pulley cable impact noise.

During the testing it was established that the contact zone between the cable belt strands and the pulley rim of the conveyor was very small. To increase the contact zone two options were considered, the first was to make the polyurethane rim of the pulley softer, and the second was to increase the pulley diameter.

The load bearing area can be increased by:

i. increasing the pulley diameter
ii. making the pulley rim softer
iii. using a cable with a soft external coating
iv. filling in the gap between the strands, so that no impacts can occur
v. a combination of the above

Items iii and iv were not considered in this investigation, as they were not practical options.

The following is a summary of the testing results

- Reducing the pulley hardness from Shaw hardness of 90A to 60 A results in up to a 15 dB noise reduction.
- Increasing the pulley size by 20 % resulted in a noise reduction of 6 dB.
- Reducing the pulley hardness from Shaw hardness of 90A to 60 A and increasing the pulley size by 20% results in up to a 20 dB noise reduction.

3. DEVELOPMENT OF A PREDICTION SYSTEM FOR CONVEYOR SPEED

As part of this review a literature review was undertaken, firstly of companies providing cable belt conveyor systems, and then in the scientific literature. The only relevant article that was found was two papers written by C.J. Wong from Xerox Corporation, "Timing Belt Noise of Office Machines", and "Timing Belt Noise of Office Machines II".

The primary observation made by both papers, which is relevant to noise emission from belts/cables, is that there is a power relationship between speed and the overall noise emission, ie.

$$SPL = CV^{x} \qquad (1)$$

SPL is the sound pressure level at a given distance from the conveyor, V is the velocity of the conveyor in m/s, C and x are indices.

To review the suitability of this relationship SVT undertook field testing of noise emission from the conveyor belt for various speeds at a given load. The testing procedure consisted of taking noise measurements at 7 and 75 metres from the conveyor. These measurements were taken at a number of positions along the conveyor belt. The octave band average sound pressure levels and the overall noise level versus speed is presented in Figures 1 and 2 for the 7 metre and 75 metre distant measurements respectively.

To predict the effects on the sound pressure level due to an increase in speed a power curve fit was used on the collected data at a distance of 7 metre and 75 metre so that the constants C and x from equation (1) can be reviewed. Figures 2 and 3 also present the power curve relationship applied to both the 7 metre and the 75 metre noise data.

The curve fit used for both the 7 metre and 75 metre measurements provides a good representation of the measured data between 40% and 100% belt speeds. Figures 1 and 2 also present the predicted noise levels for speeds between 100% and 140% using the curve fit power relationship developed.

Since it is not possible to increase the conveyor speed to beyond 100% it was not possible to verify the relationship above 100% speed. However, at speeds less than 100 % the relationship between the measured noise and the curve fitted data is very good.

References

C.J. Wong, "Timing Belt Noise of Office Machines", Noise Control Journal, Vol 35/No3, Nov-Dec 1990

"Timing Belt Noise of Office Machines II", Noise Control Journal, Vol 39/No2, Sep-Oct 1992