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TIMING BELT DRIVE NOISE AND COMMON CAUSES

Most engineers in the power transmission field know that the main drawback of synchronous belts is that they are inherently noisy. This noise is quieter than chain but is annoying nevertheless. Timing belt noise is directly related to speed, width and pitch of the timing belt used.

Meshing frequency is assumed to be the primary frequency of noise generated by synchronous drives since the noise is generated from meshing interference and land impact during operation. Meshing frequency is defined as the number of belt teeth that enter and exit the sprocket grooves per unit of time. As the belt tooth enters and exits the pulleys tooth, air is compressed and forcibly evacuated, making a sound similar to air escaping from a balloon. Added to this is the impact between the belt teeth and pulley cause a slapping sound.

The most common unit of meshing frequency is # teeth/sec. This is equivalent to cycles/sec. Each sprocket may have its own meshing frequency, but the major noise generator tends to be the Drive(R) with the belt entering at its highest tension. This high tension combined with a tight fit of the belt and pulley teeth causes the tensioned belt to resonate like a plucked guitar string.

Meshing frequency can be calculated as follows:

(# Sprocket Grooves x rpm) / 60 = cycles/sec

DEFINING THE NOISE AND HOW IT IS GENERATED:

- Impact generated by collision of the belt tooth against the bottom land of the sprocket at the beginning of meshing
- Impact generated by collision of the sprocket tooth tip against the bottom land of the synchronous belt at the beginning of engagement
- Collision between the flanks of the two teeth at the beginning of meshing
- Transverse and torsional vibrations of the belt
- Vibrations of the pulleys
- Airflow between belt and pulley
- Friction due to the contact between belt fabric and pulley material.

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COMMON CAUSES:

- Drive misalignment

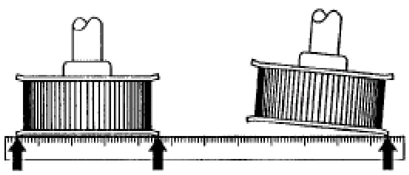

Fig. 25 Angular Misalignment

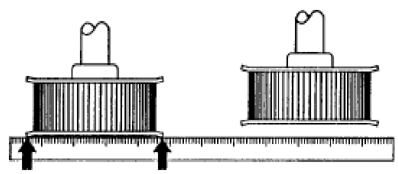

Fig. 26 Parallel Misalignment

- Improper tensioning

The noise created by a drive increases with belt speed. Thus, the problem is generally associated with high speed applications. If proper tensioning and alignment do not reduce the noise level, the next possible cause is improper pulley dimensions. Verify that all pulley dimensions are according to RMA or manufacturer's specifications.

ADDITIONAL ISSUES TO CONSIDER INCLUDE:

- Use of polyurethane (plastic) timing belts cause a higher belt noise level than rubber timing belts.
- Acoustics of drive enclosure. Often times the guarding in place around a belt drive amplify the sound resonating from the belt drive.
- Improper mixing of belt and sprocket tooth profiles.

DESIGNING DRIVES TO REDUCE NOISE

When designing synchronous drive systems, several general guidelines for noise reduction can be considered:

1. Minimize belt speeds. By slowing down the drive, the noise level is reduced and the frequency of any generated noise is lower. This often puts the frequency of the drive system into that unobjectionable area.

2. Minimize belt width. Using the narrowest belt that can handle the design loads at the design speed will help minimize noise levels.

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3. Maximize small sprocket diameter. By using the largest pitch diameter for the small sprocket, noise levels will be reduced. This will also lead to improved belt life.

   NOTE however that larger sprockets result in faster belt speeds (see statement #1) so some optimization is required.

4. Minimize vibration of equipment. Vibration causes air displacement, which causes noise. Dampening vibration of the equipment will lower noise from the system in general.

5. Minimize air transmission paths. By considering drive location and/or using acoustical guards, the air displacement path is blocked and effectively reduces noise.

When evaluating an existing drive that is generating objectionable noise, be thorough. Remember the belt drive may not be the only source for noise. Improperly maintained bearings or shafts, weak supporting structures and other rotating or sliding parts in the total system may also be a source for noise.

When checking the drive, evaluate carefully alignment and tension.

ALIGNMENT:
A drive with excessive misalignment, generally greater than 1/4 degree, will more likely generate noise than a properly aligned drive. Consider both parallel and angular misalignment. Also, properly aligned drives will yield improved belt life.

TENSION:
Improperly tensioned drives will more likely generate noise. Belt tension should not be too high or too low. Too low a tension can also lead to shortened belt life or ratcheting, while too high a tension will add undue stress to bearings, shafts and other related components.

PFEIFER INDUSTRIES
METRIC TIMING BELTS & PULLEYS

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OTHER NOISE REDUCTION SOLUTIONS

In addition to design considerations, there are several other accepted methods of reducing belt drive noise:

1. Split Width Belts. Although this method generally results in only very small reductions, approximately 4-5 dB, tests have shown it will help. When using wide belts, the drive can be split into two standard width belts, i.e., one 170 mm = two 85 mm wide belts.

2. Acoustical Noise Guard. The most effective method since it can result in noise reductions of from 10-25 dB. The actual level of noise reduction depends on the type of guard, i.e., partial or full guards.

3. New shapes for timing belt teeth. Goodyear has developed a double helix (similar to a tractor tire) pattern that significantly lowers the high pitched whine associated with timing belts. Goodyear's Eagle belt design has shown a 19 dB reduction in noise compared to equivalent timing belts.

4. Another new timing belt tooth shape RPP uses a dimple along the top of the tooth as an added escape channel for air, lessening its pressurization and exit velocity.

REFERENCES:

- Silviu Butnariu, Aurel Jula, "The Noise in the Synchronous Belts Drives"
- Gates Corporation
- Hechler, Todd and Anderson, Steve "The Noise about Synchronous Belts", Motion System Design, June 2000