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Harshwardhan Gupta's Design Tips–2

Timing Belt Drives

We still see continuing use of gears and roller chains, where timing belts could do the job much more easily, cheaply and elegantly. Manufacturers' catalogues are easily available, and much information is available on the net too. Timing belts are also known as toothed belts.

Timing belts started with a trapezoidal shape of teeth, known as the Powergrip series. These then gave way to HTD belts, which can transmit much higher power for a given size. Many workshops with hobbing facilities also carry hobs for cutting standard timing belt teeth.

One reason for the limited popularity of the timing belt drives is that they are quite unforgiving, and they cannot easily be made and put together by uneducated fitters. Investing once in a scientific design and manufacturing will save more money than you can believe.

The advantages of timing belts over belts, gears and roller chains are:

1. Absolutely positive drive compared to flat, v or poly-v-belts (erroneously called toothed belts. Many variable-speed belts and toothed V-belts are also mistakenly called toothed belts). This enables exact speed ratios, impossible to achieve with belts.
2. Much lower cost compared to gears or silent chains. Almost same overall cost compared to a good v-belt drive or a high-speed chain drive.
3. Multi-stage reductions are easily possible. I have successfully designed and made backlash-free drives of 1:30 reduction – and incredibly cheap for a zero backlash drive.
4. No lubrication required whatsoever.
5. No idlers or tightening arrangement required. The drive can easily be designed with fixed center-distances, as unlike V-belts, timing belts DO NOT stretch during their lifetime. Some special grades of HTD belts do not stretch at all even during mounting – these are used in drives where position control is required within a micron.
6. Virtually noiseless and clean in operation. Good for food and pharma machines.
7. Backlash-free, so ideal for motions that go back and forth, like servo-drives, or even mechanical mechanisms.
8. Smaller bearings can be used, as the belt tension on the slack side is much lesser than plain belts.
9. Unlike for gears or high-speed chains, no drive housing required.
10. Replacement cost is low, as pulleys don't wear out. Belts have a long life and are quite cheap nowadays.

Keep in mind these points while designing timing belt drives:

1. Use HTD belts: the overall drive cost will be the least.
2. Shrouds are required only on the smaller pulley if the drive is between two horizontal shafts. Shrouds should be put on the larger pulley if the drive is between two vertical shafts. (Shrouds are the two side flanges to prevent the belt from running off the pulleys.
3. Belts are available only in selected whole numbers of pitches. Check with the supplier before designing the drive.

4. Make the pulleys (especially the larger one) in aluminium, maybe with a steel hub if the key load is more than what aluminium can take.
5. Center Distance should be calculated backwards by first fixing the belt-length, not by the usual flat-belt length from center-distance formula.
6. Follow the sizing procedure given in the manufacturers' manuals to the letter. Do not oversize the belt further.
7. The shroud OD should just be level with, or a little more than the outer surface of the belt.
8. The inside edge of the shroud MUST be well rounded.
9. Understand that unlike gears, the Pitch Circle Diameter of the timing pulley is MORE than the outer diameter.

Watch out for these points while making timing pulleys:

1. Depending on whether the available teeth-cutting hob is a topping hob or a non-topping hob, make the pulley blanks (respectively) more or equal to the exactly calculated outer diameter.
2. Do not try to somehow get that belt profile cut into the pulley - with a crude fly cutter on a milling machine, or a homemade hob, for example. Go to a workshop that has a proper hob, and get it hobbed by a skilled operator.
3. Do not over- or undercut the pulleys ever by fraction of a millimeter. Such pulleys will either not assemble right, or will chew up the belt in no time, and no one will be able to pinpoint the fault.
4. Bolt, glue, rivet or stake the shrouds onto the pulleys. For heavy belts and big pulleys, use fasteners, as one of the shrouds will have to be removed to put the belt onto the pulleys.
5. Do not plate or paint the teeth. Blackodise steel pulleys. Aluminium pulleys don't need any treatment. Self-anodizing can be done for longer life and aesthetic reasons. Never ever buff the teeth.

Take these precautions while assembling timing belt drives:

1. First of all, wrap the (HTD) belt on the pulley and check that no light is visible through the teeth. If there are gaps, something is seriously wrong. First check if the belt is not some special profile instead of the usual HTD. There are some low-cost-low-power special profiles available, which are not suitable for normal applications. If the belt is right, then the teeth are wrong – reject that pulley.
2. Keep those shafts parallel! And I mean parallel. The best way to ruin a timing belt is to not to have the two shafts parallel, so the belt rubs against one of the shrouds and soon starts to scuff.
3. If the CD is fixed, put the belt into the shrouded pulley first, then haul it into the other pulley by rotating the pulley with the belt partially wrapped around it. For heavy drives, remove one of the shrouds and then assemble same way. If the CD is variable, do not over-tighten the belt. The tension should just be sufficient to take up the slack. If the belt is whipping or vibrating sideways, it is too loose, and both belt and pulleys will be ruined very quickly.
4. Do provide proper guards as you would for any rotating machinery. Do not let oil drip onto the belt. It can severely damage the material. And obviously, don't let metal chips or foreign objects, sand or process material fall into the belts.
5. Timing belts have a great deal longer life than v-belts. If properly designed and mounted, they can actually outlive every other drive element – belts, chains, gears, bearings, except maybe the machine frame! So don't really bother to keep spares, except for mental satisfaction.

As I said, timing belt drives are unforgiving to careless users and corner-cutters. Look away for too long, maybe at your bank statement, and the timing belt will whip you. Time to tighten your belts!

Next Month: Saving Weight

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