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TOOTH TIPS

Information you can use to prevent problems and prolong gear life.

When gears are worn, they lose their accuracy. Like an engine camshaft, gears need a smooth, accurate shape to carry their load. When the correct profile is lost to wear, the mating gear tends to bounce on the pits and rough spots, increasing the load and speeding up the wear process. The only cure is to get the gear back to its original accuracy.

If the gears aren't too badly worn, they can be re-cut to clean up the damage, leaving a fresh, accurate surface. This also produces increased backlash, but that can often be tolerated, particularly if the drive doesn't see load reversals in service.

If backlash must be controlled, it's often possible to re-cut the gear and make a new, thicker pinion to mate with the thinner gear at the same center distance and the original backlash. These oversize pinions are actually stronger than the originals and, in most cases, improve the capacity of the gear set.

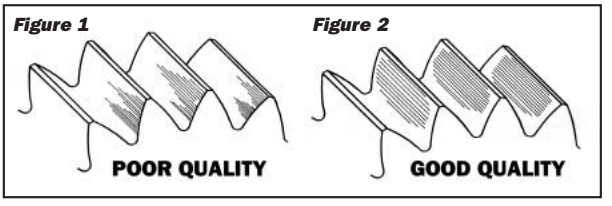
The cost of this repair is much less than replacing both gears, and the results are really better than the original.

Sometimes the use of oversize pinions should be avoided. When the pinion is driven by the gear, an oversize pinion requires careful profile modification to maintain good lubrication conditions. This is one of the "finer points" of gear design, and it should be approached with caution. As long as the pinion is the driving member, the oversize pinion design is easy, and highly recommended.

On a related note, what is gear quality? Think of each gear tooth as a cam, like those on an engine camshaft. They must be accurately spaced so that each is in the right place to pick up the load when the previous tooth rolls off its mate. That's a good picture of what happens 40,000 times a minute in a typical industrial input gear set. If those cams are the wrong shape or out of place by just .001", impact loads are added and gear life is shortened.

If the teeth aren't exactly parallel, the load is carried at one end, rather than across the whole face width. The overload at the high spots causes premature gear failure, either by pitting or tooth breakage.

The contact patterns in Figure 1 show all of these defects: overload at the ends (lead or helix error); non-uniform load from tip to root (profile or form error); and variation from tooth to tooth (spacing or index error). Figure 2 shows ideal contact, with the same centralized pattern on each tooth.



The AGMA classification system for gear quality has tolerances for tooth spacing, profile variation, and lead (tooth alignment or helix angle) variation, all organized by tooth size, gear size, and "quality number" (they run from five to 15, which are the best—and the most difficult—to make). There is an appropriate quality for every application, depending on speed, acceptable noise, reliability, and cost. Typical examples would be:

- Auto transmission: Q12
- Machine tool: Q10-12
- Paving machine: Q7
- Agricultural machines: Q7
- Industrial gearing: Q8-10

Here are some suggestions by pitch line speed (pitch diameter x 3.14 x RPM/12):

- 500 ft/min: Q7
- 1,000: Q8
- 2,000: Q9
- 4,000: Q10
- 7,000: Q11

Accurate gears carry more load than inaccurate ones, because the contact covers a larger portion of the gear teeth.

Using the AGMA system requires testing machines that are usually found in a gear shop, but not common elsewhere. A reasonable substitute for exact quality measurement is contact checking: examination of the pattern left when gears polish in, or the pattern made in marking compound as the gears are rolled together in the gear box or on true bench centers.

ABOUT THE AUTHOR:

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