GOT A GEAR QUESTION?
Ask the Expert!

Welcome back to *Gear Technology*'s Ask the Expert—our popular regular feature intended to help designers, specifiers, quality assurance and inspection personnel in addressing some of the more complex, troublesome gearing challenges that never cease to materialize—whether on the drafting table or the shop floor. Simply email your question—along with your name, job title and company name (if you wish to remain anonymous, no problem)—to: *jmcguinn@geartechnology.com;* or submit your question by visiting *geartechnology.com*.

QUESTION #1

Center Distance Variations for Internal Gears

(While) external involute gears are very tolerant of center distance variations, what are the center distance constraints/parameters for internal gears?

One of the beauties of the involute tooth form is its ability to operate smoothly on a relatively inaccurate center distance. This is a result of the tooth flank "unwinding" from the base circle. Conjugate tooth action can take place anywhere along the involute curve, so long as root interference is avoided and enough "profile overlap" remains to get the next tooth pair into action. Profile overlap ratios of as low as 1.20 have been successfully used, but I recommend a minimum of 1.40 to avoid the set feeling "toothy" during rotation.

This situation applies to both internal *and* external gears. To the casual observer it might appear that internal gear sets would have other constraints, but as far as the teeth are concerned, root interference is root interference. While it is common practice to reduce the operating addendum on internal gears as much as 5 percent to minimize the possibility of root interference with the mating external pinion or planets, it is not always required. The inside diameter of the internal gear—also known as the addendum circle—is sometimes enlarged to avoid trimming by the shaper cutter; but this is not a center distance issue.

No clear guidance exists on what is an appropriate "tolerance" for a given center distance; some companies have design practices that apply a fixed plus/minus value to all center distances—regardless of size. Others only apply a "plus" tolerance. It is very helpful for the gear designer to know the process capability of the machinery involved with making the housings the gears will be operating in.

This author's practice for industrial gearboxes is to vary the center distance tolerance by size. A plus/minus tolerance of .0010" is used for centers from 1.5 to 4.0 inches, with an additional .00025"/inch tolerance as the housing gets larger. Thus a 6.000 inch nominal center distance has a +/-.0015 tolerance, while a 12.000 inch nominal center distance has a +/-.0030" tolerance. These tolerances are used on both internal and external gears. The tolerance values are within the process capabilities of most well-maintained, computer-controlled milling machines.

Best regards,

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