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TOOTH TIPS

GEAR ACCURACY CHARTS — PART I

Understanding gear accuracy charts can be difficult, so here is the first in a three-part series—this one focusing on profile measurements—that will help clarify the process.

Gear accuracy charts can be confusing the first time you see one, so this is the first of three articles providing answers to some of the common questions I hear.

Gear accuracy is a complicated subject, and the AGMA classification system has been revised recently, so the reader is encouraged to consult current AGMA and ISO standards for more in-depth information. The three main parameters that are measured to assess the quality of spur and helical gears are profile, helix, and tooth spacing. These are usually measured on the same grinding machines that grind the teeth, or inspection equipment that is specially designed to measure gears.

Pinions and gears on shafts are usually mounted vertically between centers, with the bottom center attached to a rotating table. Gears are usually supported with the bore vertical on jacks mounted on the machine table. All gear charts should identify the part and include, as a minimum, the date, name of the operator, part number or description, and notes on how the part was mounted in the machine—specifying which are the right and left flanks. A single measuring probe is used for measuring profile and helix, and either single or dual probes are used for measuring tooth spacing. Figure 1 is a diagram of a typical single inspection probe against the left flank of an external tooth.

Profile measurements determine the accuracy of the involute tooth form. The probe is positioned against a tooth flank and slides along the tooth perpendicular to the axis of the part either from the root to the tip or tip to the root as the part rotates slightly (see Figure 1). Normally both flanks of three to four teeth equally spaced around the gear are measured and the results magnified and charted on a strip chart or printed out. The exact output varies by equipment manufacturer, but most are similar.

Figure 2 has been copied from Figure 17 of AGMA 915.1-A02 and is a sketch of a typical profile trace for one flank of a tooth. The scale in the horizontal direction has been expanded more than normal to help clarify the various items on the chart.

Figure 1

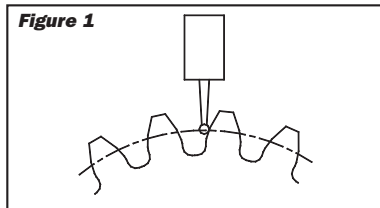
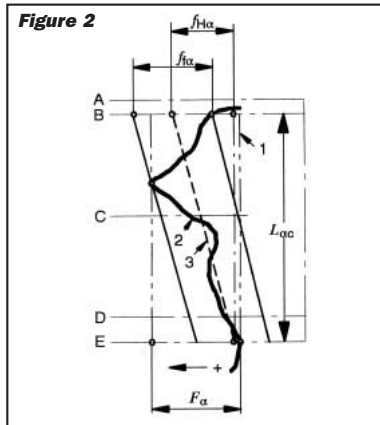


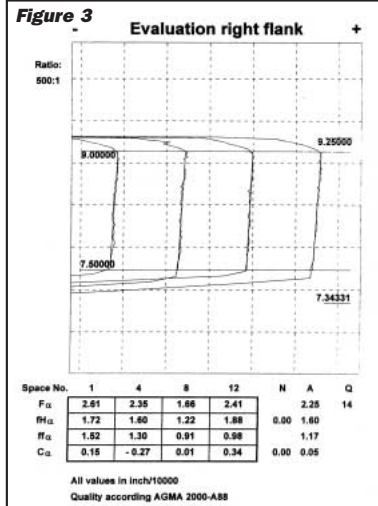
Figure 2



On charts for a specific gear, the numeric values at A, B, and E are usually printed out and represent diameters, distances from the base circle along the line of action or roll angles. Lac is the profile evaluation range and is the amount of profile used to classify the profile quality. Line 2 represents the actual trace of the profile. If the measured profile were a perfect involute without any intentional profile modifications, the trace would be a straight line as shown at line 1 on the chart.

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In addition to the actual profile traces, numerical values for the different profile parameters may be shown on the printed output. See Figure 2 for an explanation of what they represent.

Fα is the total profile deviation.
fHα is the profile slope deviation.
fα is the profile form deviation.

The maximum total profile deviation Fα of all the measured right flanks is used to determine the profile quality level of the right flanks, unless otherwise specified. The same procedure is used to classify the quality level of the left flanks.

Figure 3 is an example of actual profile measurements of the right flanks of a 15-tooth pinion with intentional profile modifications at the tips of the teeth. The OD of the part is 9.25" and the teeth have some tip relief from the OD down to 9.0". The profile evaluation range is from a diameter of 9.0" to 7.5". The values under the column labeled "A" are the averages for the four teeth measured. The 0.00261" value for the flank at space 1 was used to classify the quality as Q14 per AGMA 2000-A88.