TOOTHTIPS

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Any gear manufacturer is clear on the need to inspect the end product, but there are more benefits than might initially be realized. Read on for a quick review.

THE ONE ESSENTIAL REQUIREMENT IN THE OPERATION OF EVERY GEAR is reliability, and that can only be achieved with systematic inspection methods. Inspections confirm that the finished gear is within the specified tolerances and will materially assist in warranting the gear's performance prior to it being placed in service. The final inspection procedures will also confirm the quality level of the gear before its assembly with a mating gear. Numerical quality systems are used to provide a common basis by which the accuracy of unassembled gears can be classified. The AGMA system and the ISO system have a common basis but are not directly interchangeable. In the past AGMA tolerance levels tightened as the number increased while the ISO quality levels decreased. In the current AGMA standard 2015-1-A01 a smaller grade number, as in the ISO system, denotes gears with higher precision. The accuracy levels are in steps based on √ 2 (approximately 1.4), providing a 40 percent change in tolerances from grade to grade. Gear inspection is the only was to prove that the required quality standard has been achieved.

Systematically applied inspections throughout the manufacturing process serve to control the gear in the most economical manner and prevent further work being done on gears that will have to be scrapped. Many quality control problems can be compounded during the manufacturing cycle. An eccentricity, for example, may start with the machining of the blank and, if undetected, will accumulate errors during all subsequent operations. To maximize the economies of inspection a combination of several methods should be utilized. Because inspection is a cost factor, there will always be the question of how detailed it needs to be. The answer will depend on the required tolerance level and the application. The cost of a single gear in a helicopter transmission may be equivalent to more than a hundred identical sized gears in an automobile engine, and inspection would have to be in accordance with the demands on the gear.

Two distinct methods of inspection, "elemental" and "composite," are available. The terms "analytical" and "functional" are also used to describe these two methods. The gear may require analytical inspection of all surfaces and include the checking of material, tooth form, surface finish, concentricity, tooth spacing, lead, and tooth thickness, etc. The principle advantage is providing immediate information in order that the necessary corrections can be made during the processing. The functional inspection determines how the mating gears will operate together, what the contact area will be after assembly, the amount of backlash, and smoothness of motion.

In earlier days the principal inspection method was to run two gears together. Even today basic rolling fixtures with master gears and dial indicators are prevalent on the shop floor next to the generators. Rolling the gear with a master gear on predetermined centers can reveal eccentricities and the backlash measured with feeler gages. It also provides what is known as the "total radial composite deviation" or, in other words, even though the gears have significant errors—in pitch and pressure angle, say—these errors are capable of canceling each other out and the gears will mesh effectively, as proven by the rolling fixture. When the gears are run together they are set up in a tight mesh that results in contact on both flanks, referred to as "double flank testing." When the gears are at their fixed operating center distance there is only one flank in contact, and a single flank gear test is conducted. These two inspections are not required for all gears.

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In practice, not all gears are inspected once an initial first off has been approved and the reliability of modern tooling is such that a consistent product will be produced within the required tolerances. When a large number of identical gears are produced it is normal practice to check only samples at a rate between 1 and 4 percent, or at a percentage pre-arranged with the buyer. Alignment and involute are checked more frequently than the pitch. A point of controversy in pitch measurement is frequently the direction of the measurement and the circle diameter to which the reading is tangent. AGMA 2015-!-A01 clearly defines the measurement parameters and avoids confusion.

ABOUT THE AUTHOR:

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