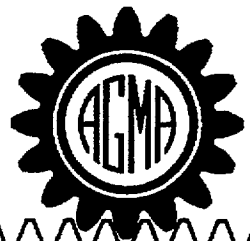


Topological Tolerancing of Worm–Gear Tooth surfaces

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Topological Tolerancing of Worm-Gear Tooth Surfaces

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Abstract

A method is proposed for the determination of surface deviations of the worm-gear tooth resulting from the cutting edge deviations of the hob used to cut the gear. Using this method, tolerance tables for worm-gear tooth profiles can be obtained from the tolerance tables for the corresponding worm threads and hob cutting edges. Such tables can be an important first step towards a worm-gear inspection standard that takes into account topological, and not only functional and elementary dimensional, metrology methods for the tooth profiles.

Introduction

The common quality control practice for worm-gear drives today is to apply dimensional metrology to worms to check lead, profile and pitch, but to check the worm-gear only using subjective methods. The only analytical tests considered for worm-gears are index and runout, while the ultimate measure of the tooth profile quality is usually obtained with a contact pattern check. The results of this test are often open to the engineer's interpretation, and it is therefore difficult to develop proper standards and tolerances for such a test.

Another option currently under development at the leading gear inspection equipment vendors is the analytical inspection of the worm-gear tooth profile. The worm-gear tooth surface topology is then inspected using a contact probe at a number of points on the tooth, and the results may be presented using a topographic map of the error surface. We do not consider this procedure

to be a substitute for a contact pattern check, but proper correlation between the two can be established. At present, topographic maps are used for spiral bevel and hypoid gears (Litvin et al, 1989b), and here, just like in the case of worm-gear drives, one of the ultimate quality criteria is a contact pattern roll check.

One additional benefit of analytical worm-gear tooth surface inspection is the fact that proper tolerance bands can be established for given quality classes, much like the bands currently used for the profiles of cylindrical gears and worms. Bands of rectangular and K-shape are the ones used most commonly, but some gear shops use bands of curves interpolated over of up to eight or more points. Once a tolerance band for the worm profile is agreed upon, a corresponding band for the worm-gear tooth surface can be constructed using the Theory of Conjugate Surfaces (see (Litvin, 1989a)). The important property of these bands would be that if a worm-gear is generated by a worm-like hob, and if the hob profile is held within a given worm tolerance band, the resulting worm-gear tooth surface will be held within the corresponding worm-gear band.

The computations of such conjugate worm-gear tooth surface tolerance bands will be our main focus.