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Tolerances for Cylindrical Gear Teeth

Bases

DIN
3961

Toleranzen für Stirnradverzahnungen; Grundlagen

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1 General

1.1 Symbols and designations

a	Centre distance
a_d	Reference centre distance
a''	Two-flank working distance
b	Facewidth
d	Reference diameter
f_f	Profile form deviation
f'_i	Single-flank working error
f''_i	Two-flank working error
f_p	Individual pitch deviation
f_{pe}	Normal base pitch deviation
f_u	Pitch error
$f_{H\alpha}$	Profile angle deviation
$f_{H\beta}$	Tooth trace angle deviation
$f_{\beta t}$	Tooth trace form deviation
$f_{\beta w}$	Tooth trace waviness
m	Module
m_n	Normal module
m_t	Transverse module
s_n	Normal tooth thickness on the reference cylinder
s_t	Transverse tooth thickness on the reference cylinder
z	Number of teeth
z_1	Number of teeth of pinion
z_2	Number of teeth of gear
A^*	Allowance factor

A, B, C	Test groups
C_b	Tooth trace relief with longitudinal crowning
F_f	Total profile deviation
F'_i	Single-flank working deviation
F''_i	Two-flank working deviation
F_p	Total pitch deviation
F_{pk}	Pitch-span deviation over k pitches
$F_{pz/8}$	Pitch-span deviation over $1/8$ of gear periphery
F_r	Concentricity deviation
F_E	Generator total deviation
F_β	Tooth trace total deviation
G, L, N, T	Function groups
L	Arc length on reference circle
R_s	Tooth thickness fluctuation
R_t	Peak-to-valley height
R_{Md}	Fluctuation of diametral two-ball or two-roller dimension
R_w	Base tangent length fluctuation
TRA	Bearing surface
T_s	Tooth thickness tolerance
α	Pressure angle
α_n	Normal pressure angle
α_t	Transverse pressure angle
α_{wt}	Working pressure angle
α''	Pressure angle with two-flank working test with master gear
β	Helix angle
φ	Tolerance increment from gear tooth quality to gear tooth quality

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1.2 Gear tooth tolerances, system of gear fits

To make sure at all times that, apart from the interchangeability of the gears of gear transmission units which is governed by the mating dimensions, the respective functional requirements such as quiet running, true-angle transmission, lubrication facilities, loading capability, are upheld, it is essential for the deviations of certain parameters of the gear teeth as well as the mounting dimensions in the gear housing to be held within certain limits.

The system of gear fits resembles the system for cylindrical fits. For each of the gears of a gear pair all form deviations, pitch deviations etc. lie within the dimensions of two notional, error-free, concentric gears, the tooth centres of which do not need to coincide with those of the working gears, and the tooth thicknesses of which differ from the nominal dimension by the amount of the upper allowance in the case of one of the gears, and by the amount of the lower allowance in the case of the other gear. The backlash results not only from appropriately chosen allowances of tooth thickness, but also from the allowance of the centre distance and other individual deviations. The magnitude and scaling of the tooth thickness allowances are thus in a given ratio to the magnitude and scaling of the centre distance allowances.

Just as with ISO cylindrical fits there are two systems of fits, the hole basis and the shaft basis, so also are there two systems of gear fits, namely the centre distance basis and the tooth thickness basis. With the former, only one tolerance zone of the centre distance is used and the magnitude of the clearance is established by different tolerance zones of the tooth thickness. With the tooth thickness basis system the opposite applies.

The sizes of the gear tooth tolerances are developed on the same principles as the tolerances for cylindrical fits. Thus, just as the latter are designed for accuracies which exceeded the requirements existing at the time of their origin, and are still in advance of their time, so also are the gear tooth tolerances arranged such that in all probability more exacting requirements and improved measuring methods available in the future are catered for.

DIN 3962 Part 1 to Part 3 contain the tolerances for deviations of individual parameters of cylindrical gear teeth.

DIN 3963 contains the tolerances for working deviations.

DIN 3964 contains the centre distance allowances and shaft position tolerances for housings for cylindrical gear transmissions.

DIN 3967 contains the system of gear fits with data on backlash, tooth thickness allowances and tooth thickness tolerances.

The basis specified for the system of gear fits is that of the centre distance. For this purpose it is necessary so to arrange the centre distance allowances that when using gear transmissions with external and internal teeth the centre distance allowances are indicated in the same way, and in gear transmissions with many pairs of gears no unacceptably large deviations from the nominal dimension arise in the distance from the first to the last transmission shaft. The limiting allowances are thus disposed symmetrically relative to the zero line. The kind of gear tooth fit is determined through the choice of

the upper allowance and the tolerance on tooth thickness in DIN 3967 and through the choice of zone for the centre distance allowances in DIN 3964.

1.3 Scope

DIN 3962 Part 1 to Part 3 and DIN 3963 contain tolerances for gear teeth on cylindrical gears of module 1 to 70 mm and with reference circle diameters d up to 10 000 mm, graded in 12 gear tooth qualities. The tolerances apply regardless of the pressure angle. For checking tooth thickness and determining backlash, the working pressure angles and helix angles have to be taken into account, see DIN 3967. For d exceeding 10 000 mm tolerances can be agreed which can be calculated by using the formulae given in Section 3.5.1 and in Section 3.5.2.

In the case of racks, the tolerances for their teeth shall not exceed those for the teeth of the mating gear. If the manufacturer has no knowledge of the mating gear, he may make the rack length equal to the mating gear circumference.

2 Other relevant Standards

- DIN 3960 Definitions and parameters for cylindrical gears and cylindrical gear pairs with involute teeth
- DIN 3962 Part 1 Tolerances for cylindrical gear teeth; tolerances for deviations of individual parameters
- DIN 3962 Part 2 Tolerances for cylindrical gear teeth; tolerances for tooth trace deviations
- DIN 3962 Part 3 Tolerances for cylindrical gear teeth; tolerances for pitch-span deviations
- DIN 3963 Tolerances for cylindrical gear teeth; tolerances for working deviations
- DIN 3964 Centre distance allowances and shaft position tolerances of housings for cylindrical gear transmissions
- DIN 3967 System of gear fits, backlash, tooth thickness allowances and tooth thickness tolerances; bases, calculation of tooth thickness allowances, conversion of allowances for the different measuring methods

3 Structure of the tolerance system

3.1 Tolerance relationships

The DIN gear tooth tolerance system has been derived from long experience in gear production. The aim has been as far as possible so to coordinate the various tolerances with one another that in a given gear tooth quality they correspond approximately to the average relationships in which the deviations occur in production. The bases of the tolerance system are thus production-oriented; the way in which this system can also be used for tolerancing to suit different functional requirements is described in Section 4.

The numerical equations for the tolerances and the values calculated from them in DIN 3962 Part 1, DIN 3963, DIN 3964 and DIN 3967 have also been extrapolated to ranges in which they can no longer be meaningful applied in all cases; for example, in gear tooth quality 12 it is only very rarely that there will be any point in making