UDC 621.833.1 February 1986

Basic rack tooth profiles

for involute teeth of cylindrical gears
for general engineering and heavy engineering

DIN 867

Bezugsprofile für Evolventenverzahnungen an Stirnrädern (Zylinderrädern) für den allgemeinen Maschinenbau und den Schwermaschinenbau

Supersedes September 1974 edition.

In keeping with current practice in standards published by the International Organization for Standardization (ISO), a comma has been used throughout as the decimal marker.

See Explanatory notes for connection with International Standard ISO 53-1974 published by the International Organization for Standardization (ISO).

1 Scope and field of application

This standard lays down rules for the basic rack tooth profile to be preferred for involute teeth of cylindrical gears for general and heavy engineering. It shall be used predominantly for cylindrical gears as specified in DIN 3960 with module m_n from 1 mm to 70 mm.

The basic rack tooth profile as specified in DIN 58 400 shall preferably be used for teeth in precision engineering (0,1 mm to 1 mm module).

2 Symbols, quantities, units

Consistent with the provisions of DIN 3960 (June 1984 draft), the following symbols and quantities are used in the present standard.

Symbol	Quantity	Unit
c_P	Bottom clearance between basic rack tooth profile and counterpart tooth profile	mm
c_P^*	Bottom clearance coefficient	–
e_P	Space width of basic rack tooth profile	mm
h_{aP}	Addendum of basic rack tooth profile	mm
h_{aP}^*	Addendum coefficient	–
h_{fP}	Dedendum of basic rack tooth profile	mm
h_{fP}^*	Dedendum coefficient	–
h_{wP}	Common tooth depth of basic rack and counterpart rack tooth profiles	mm
h_{wP}^*	Common tooth depth coefficient	–
h_{FfP}	Root form depth of basic rack tooth profile	mm
h_P	Tooth depth of basic rack tooth profile	mm
h_P^*	Tooth depth coefficient	–
m	Module	mm
p	Pitch	mm
s_P	Tooth thickness of basic rack tooth profile	mm
α_P	Pressure angle	°
	Angle given in formulae	rad
ϱ_{aP0}	Tip rounding radius of tool basic rack tooth profile	mm
ϱ_{fP}	Fillet radius of basic rack tooth profile	mm
ϱ_{fP}^*	Fillet radius coefficient	–

3 Basic rack tooth profiles

3.1 Basic rack tooth profile of a cylindrical gear

The basic rack tooth profile for the involute teeth of a cylindrical gear has straight flanks, which extend up to the addendum line and down to the fillet radius and tooth root (see figure 1).

3.2 Datum line (PP), addendum line, dedendum line

The datum line is that straight line on which the tooth thickness is equal to the space width or half the pitch:

$$s_P = e_P = p/2 \quad (1)$$

The basic rack tooth profile is enclosed by the addendum line which runs parallel with the datum line and the dedendum line which runs parallel with the latter.

The basic rack tooth profiles of the cutting tool have been derived from the basic rack tooth profile of the teeth (see DIN 3972).

3.3 Basic rack tooth profile of the mating gear (counterpart rack tooth profile)

The basic rack tooth profile of the mating gear (counterpart rack tooth profile) is equal to the cylindrical gear basic rack tooth profile folded through 180° around the datum line and displaced by half a pitch along this line. The counterpart rack tooth profile shall engage with its teeth in the tooth spaces in the basic rack tooth profile of the cylindrical gear.

The teeth of the gear and mating gear as specified in this standard thus have the same basic rack tooth profile.

4 Features of the basic rack tooth profile

The dimensions of the basic rack tooth profile shall be nominal dimensions.

4.1 Module, pitch

The module, m, is a length which determines the size of the basic rack tooth profile and thus of the associated cylindrical gear teeth.

All linear sizes of the basic rack tooth profile can also be specified as a multiple of the module; the corresponding factors are additionally identified by an asterisk (*).

The basic rack tooth profile of module m has the pitch

$$p = \pi \cdot m. \quad (2)$$

4.2 Pressure angle

The pressure angle, α_P, is formed by the straight flanks and a line perpendicular to the datum line.

The two flanks of a tooth are symmetrical about the midline of the tooth.

α_P is equal to 20° for a basic rack tooth profile as specified in this standard.

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4.3 Tooth depth, addendum, dedendum, bottom clearance, common tooth depth

The tooth depth, h_P, of the basic rack tooth profile is subdivided by the datum line into the addendum, h_{aP}, and dedendum, h_{fP}.

The bottom clearance, c_P, is the difference between the dedendum of the basic rack tooth profile and the addendum of the counterpart rack tooth profile.

The common tooth depth, h_{wP}, of the basic rack and counterpart rack tooth profiles is the total of the two tooth tip depths.

For calculating a basic rack tooth profile as specified in this standard, the following formulae shall be used:

$$h_P = h_P^* \cdot m = 2 \cdot m + c_P \quad (3)$$

$$h_{aP} = h_{aP}^* \cdot m = 1 \cdot m \quad (4)$$

$$h_{fP} = h_{fP}^* \cdot m = 1 \cdot m + c_P \quad (5)$$

$$h_{wP} = h_{wP}^* \cdot m = 2 \cdot h_{aP} = 2 \cdot m \quad (6)$$

4.4 Bottom clearance, bottom clearance coefficient

Generally, the bottom clearance, c_P, is equal to $c_P^* \cdot m = 0{,}1 \cdot m$ to $0{,}4 \cdot m$. The bottom clearance to be used depends on the requirements to be met by the gear, and the gear manufacturing facilities. It limits the fillet radius of the basic rack tooth profile of the cylindrical gear and thus the tip rounding radius of the tool basic rack tooth profile.

4.5 Fillet radius

The fillet radius, ϱ_{fP}, shall start on or below the common tooth depth. It is then defined by:

$$\varrho_{fP} \leq \frac{c_P}{1 - \sin \alpha_P} \quad (7)$$

The fillet radius shall not exceed the value obtained when the left flank and right flank of a space on a basic rack tooth profile merge with the fillet without forming a tooth root surface. With h_{fP} as specified in equation (5), ϱ_{fP} is to be calculated using the following formula:

$$\varrho_{fP} \leq \frac{1 + \sin \alpha_P}{\cos \alpha_P} \cdot \left[m \cdot \left(\frac{\pi}{4} - \tan \alpha_P \right) - c_P \cdot \tan \alpha_P \right] \quad (8)$$

The following shall apply to a basic rack tooth profile as specified in this standard (with $\alpha_P = 20°$ and $h_{fP} = 1 \cdot m + c_P$): formula (7) shall be used for c_P not exceeding $0{,}295 \cdot m$ and formula (8) for c_P exceeding $0{,}295 \cdot m$ or h_{fP} exceeding $1{,}295 \cdot m$. The notation associated with formulae (7) and (8) is given in figure 2. Only one pair of values, $c_P = 0{,}25 \cdot m$ and $\varrho_{fP} = 0{,}38 \cdot m$, has been specified in ISO 53.

Note. The fillet radius of the cylindrical gear basic rack tooth profile determines the tip rounding radius of the tool basic rack tooth profile. The radii of curvature of the fillet produced on the cylindrical gear shall be equal to or greater than the tip rounding radius of the tool according to the numbers of teeth and profile displacements of the generating gear.

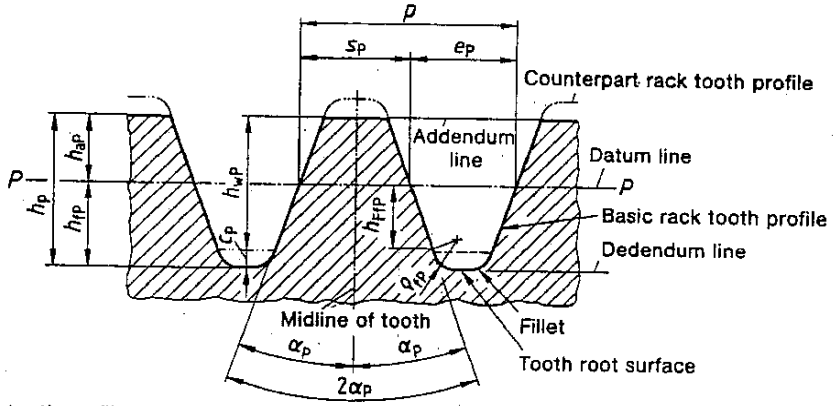

Figure 1. Basic rack tooth profile (with counterpart rack tooth profile)

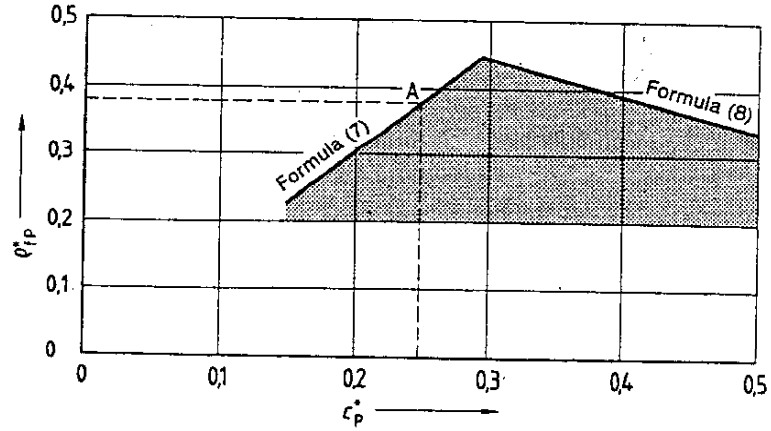

Figure 2. Relationship between bottom clearance coefficient and fillet radius coefficient according to formulae (7) and (8) for $\alpha_P = 20°$ and $h_{fP} = 1 \cdot m + c_P$.

The part of the diagram shaded grey shows the area including possible pairs of values for the cases in which the tooth flanks merge with the fillet. The pairs of values outside the shaded area are associated with basic racks the tooth flanks of which are undercut.

Point A: pair of values specified in ISO 53.

4.6 Usable flanks, root form depth

The straight parts of the tooth flanks form the usable flanks. Where the flanks merge with the fillet without forming a tooth root surface, the root form depth of the basic rack tooth profile is defined by:

$$h_{FfP} = h_{fP} - \varrho_{fP} \cdot (1 - \sin \alpha_P) \qquad (9)$$

4.7 Root undercut

Basic rack tooth profiles for cylindrical gears with root undercut are not covered by this standard. See DIN 3960, Appendix A, for information and explanatory notes.

5 Flank form corrections

Flank form corrections are not dealt with in this standard. They are specified using the cylindrical gear teeth, not the cylindrical gear basic rack tooth profile. See DIN 3960 and DIN 3972.

Standards referred to

DIN 3960	(at present at the stage of draft) Concepts and parameters associated with cylindrical gears and cylindrical gear pairs with involute teeth
DIN 3972	Reference profiles of gear-cutting tools for involute tooth systems as specified in DIN 867
DIN 58400	Basic rack tooth profiles for involute teeth of cylindrical gears for precision mechanics
ISO 53-1974	Cylindrical gears for general and heavy engineering; basic rack

Previous editions

DIN 867: 07.27, 09.63, 09.74.

Amendments

The following amendments have been made in comparison with the September 1974 edition.

a) Formulae for calculating the fillet radius have been included.

b) The root form height, h_{FfP}, has been introduced as a parameter for the first time.

c) The standard has been restructured and editorially revised.

d) Coefficients c_P^*, h_{aP}^*, h_{fP}^*, h_{wP}^*, h_P^* and ϱ_{fP}^* have been introduced for the first time.

e) Notes on root undercut and flank form corrections have been added.

Explanatory notes

This standard corresponds to International Standard ISO 53 in its material content, but differs from the latter in the following points.

1. The symbols denoting the linear sizes (pitch, tooth depth, addendum, dedendum, bottom clearance and fillet radius) have been entered in the illustration of the basic rack tooth profile, whereas ISO 53 specifies the factors by which the module is to be multiplied. In addition, the counterpart rack tooth profile is shown in the present standard.
2. ISO 53 specifies the tip relief and its maximum value. This specification has not been adopted in DIN 867, because the requirements which make a rack relief necessary in specific cases vary so widely that they cannot be allowed for in a standard.
3. ISO 53-1974 specifies only a single basic rack tooth profile with a dedendum of $1{,}25 \cdot m$ and a fillet radius of $0{,}38 \cdot m$. The following table gives some values of the maximum possible fillet radius coefficient, $\varrho_{fP\,max}^*$, as a function of the bottom clearance coefficient c_P^* (see also figure 2).

c_P^*	0,17	0,25	0,3	0,4
$\varrho_{fP\,max}^*$	0,25	0,38	0,45	0,39

4. As a departure from ISO 53, the present standard makes it possible to use basic rack tooth profiles with a pressure angle other than 20°.
5. As a departure from ISO 53, the present standard makes it possible to use basic rack tooth profiles with larger addenda and dedenda (extra-depth gearing) or smaller addenda and dedenda (stub gearing).

International Patent Classification

F 16 H 55/08