



Introduction to gears

The standard STN ISO 701 (International gear notation – Symbols for geometrical data) aims to unify the symbols used in different countries into the international notation of gears following the basic geometric data.

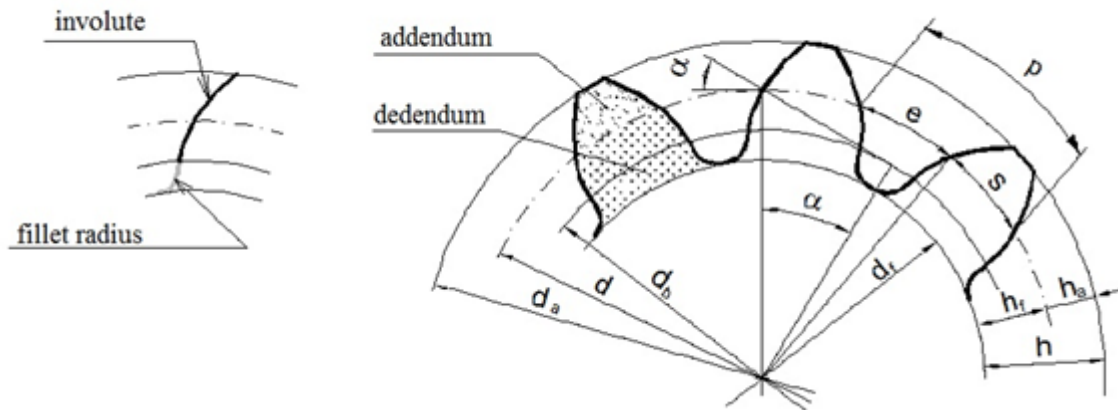


Fig. Basic parameters of a gear wheel

Meaning of basic indices

Index	Meaning of the Index
1, 3, 5, ...	driving wheel (pinion)
2, 4, 6, ...	driven gear (wheel)
a	addendum
b	basic
f	dedendum
n	normal
t	transverse section
x	axial
without index	pitch

Meaning of symbols

Symbol	Meaning of the Symbol
d	pitch diameter
d_a	outside diameter
d_f	root diameter
d_b	base diameter
h	whole depth
h_a	addendum
h_f	dedendum
p	circular pitch
s	tooth thickness
e	space width
α	pressure angle



Geometrical parameters of spur gear and helical gear

Geometric elements	Pinion	Wheel
Number of teeth	z_1	z_2
Gear ratio	$i = \frac{z_2}{z_1} = \frac{d_2}{d_1} = \frac{n_1}{n_2} = \frac{\omega_1}{\omega_2}$	
Normal module	m_n (standard module)	
Pressure angle	most commonly used $\alpha_n = 20^\circ$	
Helix angle	$\beta = 0^\circ$ - for spur gear $\beta = 8^\circ \div 25^\circ$ - for helical gear	
Transverse module	$m_t = \frac{m_n}{\cos \beta}$	
Transverse pressure angle	$\tan \alpha_t = \frac{\tan \alpha_n}{\cos \beta}$	
Helical angle on base circle	$\sin \beta_b = \sin \beta \cdot \cos \alpha_n$	
Normal circular pitch	$p_n = \pi \cdot m_n$	
Radial circular pitch	$p_t = \pi \cdot m_t$	
Addendum	$h_a = h_a^* \cdot m_n$ ($h_a^* = 1$)	
Dedendum	$h_f = (h_a^* + c_a^*) \cdot m_n$	
Pitch diameter	$d_1 = \frac{z_1 \cdot m_n}{\cos \beta}$	$d_2 = \frac{z_2 \cdot m_n}{\cos \beta}$
Outside diameter	$d_{a1} = d_1 + 2 \cdot h_a$	$d_{a2} = d_2 + 2 \cdot h_a$
Root diameter	$d_{f1} = d_1 - 2 \cdot h_f$	$d_{f2} = d_2 - 2 \cdot h_f$
Base diameter	$d_{b1} = d_1 \cdot \cos \alpha_t$	$d_{b2} = d_2 \cdot \cos \alpha_t$
Top clearance	$c_a = c_a^* \cdot m_n = 0,25 \cdot m_n$ ($c_a^* = 0,25$)	
Root radius	$r_f = r_f^* \cdot m_n = 0,38 \cdot m_n$ ($r_f^* = 0,38$)	
Face width coefficient	$\psi = 15 \text{ to } 25$	
Face width	$b_1 = b_2 + 2 \cdot m_n$	$b_2 = \psi \cdot m_n$
Center distance	$a = \frac{(z_1 + z_2) \cdot m_n}{2 \cdot \cos \beta}$	



Example of calculation of geometric dimensions of helical pinion without correction:

Number of pinion teeth $z_1 = 21$.

Number of meshing helical gear wheel $z_2 = 66$.

Gear ratio $u = \frac{z_2}{z_1} = \frac{66}{21}$

$$u = 3.143.$$

Normal module $m_n = 4 \text{ mm}$ (by standard).

Pressure angle $\alpha_n = 20^\circ$ (by standard).

Center distance $a = 180 \text{ mm}$.

Helix angle $\cos \beta = \frac{(z_1 + z_2) \cdot m_n}{2 \cdot a}; \left(a = \frac{(z_1 + z_2) \cdot m_n}{2 \cdot \cos \beta} \right)$

$$\cos \beta = \frac{(21 + 66) \cdot 4}{2 \cdot 180} \Rightarrow \beta = \arccos 0,9\bar{6}$$

$$\beta = 14.83511^\circ.$$

Transverse module $m_t = \frac{m_n}{\cos \beta} = \frac{4}{\cos 14,83511^\circ}$

$$m_t = 4.138 \text{ mm}.$$

Transverse pressure angle

$$\tan \alpha_t = \frac{\tan \alpha_n}{\cos \beta} = \frac{\tan 20}{\cos 14,83511^\circ} \Rightarrow \alpha_t = \arctan 0,37652$$

$$\alpha_t = 20.63241^\circ.$$

Normal circular pitch $p_n = \pi \cdot m_n = \pi \cdot 4 \Rightarrow p_n = 12.566 \text{ mm}.$

Addendum $h_a = h_a^* \cdot m_n = 1 \cdot 4 \Rightarrow h_a = 4 \text{ mm}.$

Dedendum $h_f = (h_a^* + c_a^*) \cdot m_n = (1 + 0,25) \cdot 4 \Rightarrow h_f = 5 \text{ mm}.$

Pitch diameter $d_1 = \frac{z_1 \cdot m_n}{\cos \beta} = \frac{21 \cdot 4}{\cos 14,83511}$

$$d_1 = 86.897 \text{ mm}.$$

Outside diameter $d_{a1} = d_1 + 2 \cdot h_a = 86,897 + 2 \cdot 4$

$$d_{a1} = 94.897 \text{ mm}.$$

Root diameter $d_{r1} = d_1 - 2 \cdot h_f = 86,897 - 2 \cdot 5$

$$d_{r1} = 76.897 \text{ mm}.$$

Base diameter $d_{b1} = d_1 \cdot \cos \alpha_t = 86,897 \cdot \cos 20,63241$

$$d_{b1} = 81.323 \text{ mm}.$$

Clearance $c_a = c_a^* \cdot m_n = 0,25 \cdot 4 \Rightarrow c_a = 1 \text{ mm}.$

Root radius $r_f = r_f^* \cdot m_n = 0,38 \cdot 4 \Rightarrow r_f = 1.52 \text{ mm}.$

Face width $b_1 = \psi \cdot m_n + 2 \cdot m_n = 18 \cdot 4 + 2 \cdot 4 \Rightarrow b_1 = 80 \text{ mm}.$