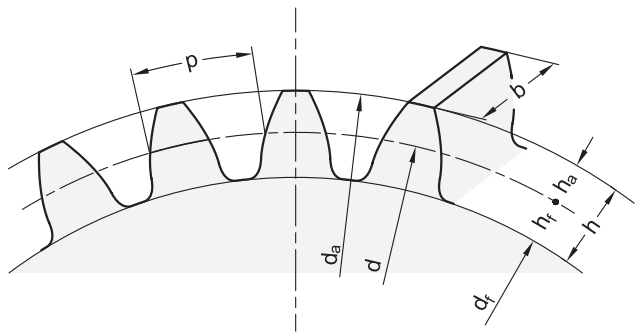
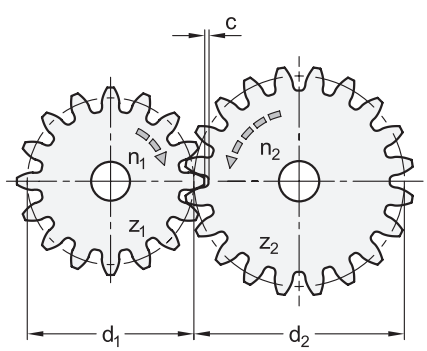
Gear Calculation

The following are the generally applicable formulas for the design of spur gears.

Formulas



Module **m** in mm	$m = \frac{p}{\pi}$	Pitch **p** in mm	$p = \pi \cdot m$
Tooth count **z**	$z = \frac{d}{m} = \frac{d_a - 2 \cdot m}{m}$	Tooth height **h** in mm	$h = 2 \cdot m + c$
Pitch circle Ø **d** in mm	$d = m \cdot z$	Addendum $\mathbf{h_a}$ in mm	$h_a = m$
Addendum circle Ø $\mathbf{d_a}$ in mm	$d_a = d + 2 \cdot m = m \cdot (z + 2)$	Dedendum $\mathbf{h_f}$ in mm	$h_f = m + c$
Root circle Ø $\mathbf{d_f}$ in mm	$d_f = d - 2 \cdot (m + c)$	Crest clearance **c** in mm	$c = 0{,}1 \cdot m \ldots 0{,}3 \cdot m$



Gear ratio **i**	$i = \frac{z_2}{z_1} = \frac{n_1}{n_2}$
Reference center distance $\mathbf{a_d}$ in mm	$a_d = \frac{d_1 + d_2}{2} = \frac{m \cdot (z_1 + z_2)}{2}$
Center distance **a** in mm	$a = \frac{d_1 + d_2}{2} + t$

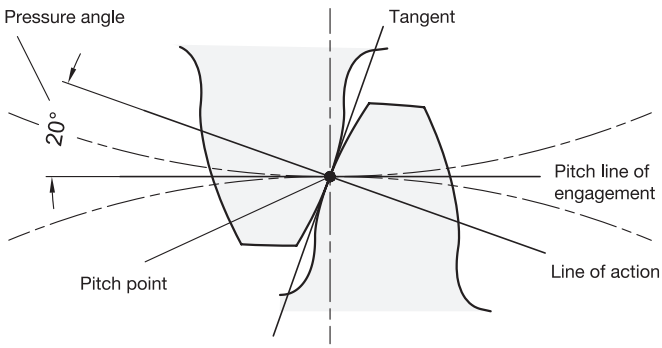
The following tolerances **t** must be taken into account for the center distance **a**:
t = +0,03 / +0,1 with module 0,5 / 1 / 1,5
t = +0,08 / +0,3 with module 2 / 2,5 / 3

Tooth Profile

The spur gears GN 7802 have involute toothing with a pressure angle of 20°. Only gears with the same module and pressure angle can be paired with each other.

The following relationship applies to the involute toothing:

Involute Toothing

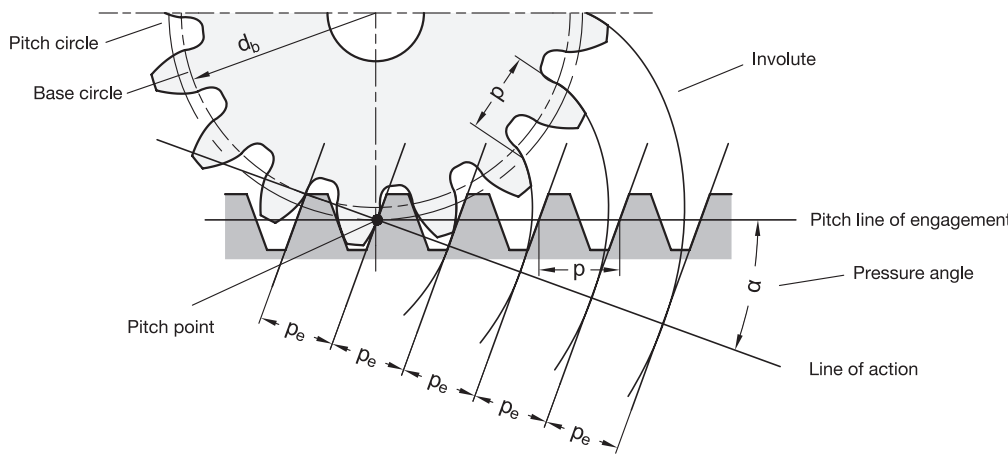


The tooth flanks of the gears are shaped as involutes.

The tangent that is perpendicular to the line of action runs through the contact point between the two tooth flanks (involutes). The line of action is at a 20° angle to the pitch line of engagement.

The pitch point is located on the line of engagement at the intersection between the line of action and the center line of the gear axes.

For each gear, a counter gear with an infinitely large pitch diameter can be designed, which has a trapezoidal tooth profile. This reference profile then corresponds precisely to the profile of the rack.



Base circle diameter $\mathbf{d_b}$	$d_b = d \cdot \cos\alpha = z \cdot m \cdot \cos\alpha$	The pitch **p** on the pitch circle corresponds to the pitch **p** on the line of engagement.
Base pitch $\mathbf{p_b}$	$p_b = \frac{d_b \cdot \pi}{z} = p \cdot \cos\alpha$	The base pitch $\mathbf{p_b}$ corresponds to the contact pitch $\mathbf{p_e}$.
Contact pitch $\mathbf{p_e}$	$p_e \triangleq p_b = p \cdot \cos\alpha = \pi \cdot m \cdot \cos\alpha$	The contact pitch $\mathbf{p_e}$ is determined by the pitch **p** and the size of the pressure angle **α**.

Material-specific Advantages

The gears GN 7802 are made of polyamide and offer the following material-specific advantages:

- Weight reduction compared with metal gears
- Noise reduction
- Low coefficient of friction, meaning that lubrication is not absolutely required
- High corrosion resistance
- Higher torque transmission compared with other plastics, such as polyacetal (POM) / polyketone (PK)

In addition, gears of steel are frequently overdimensioned for their application. In such cases, polyamide gears are a cost-effective alternative. The spur gears GN 7802 of polyamide are frequently used in the following applications:

- Packaging and conveyor machines
- Industrial cleaning machines
- Glass and ceramic processing machines
- Agricultural machinery
- Chemical and pharmaceutical industry
- Household appliances

Lubrication / Maintenance

One of the main advantages of the spur gears GN 7802 of plastic is the possibility of using them without lubrication. If lubrication is still required to decrease friction and wear or to increase the lifespan of the gear, lithium-saponified grease with a mineral oil base is recommended.

Gear Pairing – Metal and Plastic

The spur gears GN 7802 of plastic can also be used in combination with metal gears.

With this pairing, the smallest gear (pinion) should be of metal and the larger gear of plastic since the wear on the larger gear is distributed over more teeth, resulting in a longer lifespan.

The combination of metal and plastic gears offers additional advantages since metal has a higher thermal conductivity, leading to better heat dissipation during operation and an associated decrease in wear on the plastic gear.

Hub Machining of Plastic Gears

The following points must be observed when making a bore or keyway:

- The clamping jaws used must be precisely matched to the addendum circle of the gear.
- The clamping surface must be as wide as possible. For module 3, for example, it is necessary to clamp at least 3 - 4 teeth and for module 1 at least 7 teeth.
- Cutting parameters and forward feed rates suitable for polyamide must be selected based on the machining method. Cooling or lubrication must be used during machining, if necessary.

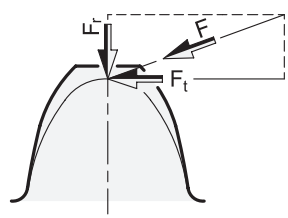
Torque

The torque specifications in the table of the respective standard sheet have been determined through a combination of theoretical calculations and laboratory tests. The empirically determined data has been verified with suitable software, taking into account the VDI 2736 guideline for the design of thermoplastic gears.

The test series were carried out in continous operation at a speed of 100-150 rpm without lubrication in order to test the most severe conditions.

The following assumptions were used for the theoretical calculation:

- The tooth force F is decomposed into the tangential force F_t and radial force F_r.
- The radial force F_r is considered negligible. As a result, the tooth force F can be simply assumed to have the same value as the tangential force F_t on the pitch circle.
- The least favorable case is assumed, in which only one tooth is engaged.



The tangential force F_t is then correlated with the torque via the pitch circle diameter. The following formula applies to the nominal torque:

$$M = F_t \cdot \frac{d}{2}$$

The torques given in the standard sheet should be considered guide values and may vary based on the specific application situation. Operating conditions such as speed, temperature, pairing of gears of different materials, lubricated or dry operation, etc. have a major influence on the load capacity.