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PLASTIC SPINDLE NUTS

The competitive edge through engineered components made of plastic

1. Plastic as a material for spindle nuts

Spindle nuts, in combination with a threaded spindle, transform a turning motion into a linear motion. Good stability of the nut material, a large thread bearing area and high surface quality are advantages for power transmission. A trapezoidal screw thread design according to DIN 103 is advantageous and practical.
Loading of the thread flanks is the same as on a sliding element which means that in regard to choosing a suitable material for the spindle nut, the main considerations are sliding and wear properties. The stability of the chosen material is decisive for safe power transmission.
It should be noted that glass fibre reinforced plastics are unsuitable for the manufacture of spindle nuts. Compared to other thermoplastics, they exhibit inferior sliding and wear values. In addition, the glass fibres can cause increased wear in the mating component. The relatively high modulus of elasticity of these materials also hinders deformation of the thread during load peaks, so that the load can distribute evenly over all the threads. This results in tears in the thread and a much shorter service life compared to plastics that are not reinforced.

1.1 Materials

For the manufacture of spindle nuts, cast polyamides with and without sliding additives, as well as POM, PET and PET with sliding additives have proven their worth.
In regard to service life, like all other sliding applications, the use of materials with built-in lubrication (such as **LiNNOTAM***GLiDE*, **LiNNOTAM***GLiDE PRO* and PET-GL) is an advantage. Compared to other plastics, they exhibit less wear and thus achieve a longer service life.

1.2 Lubrication

As with all other slide applications, lubrication is not absolutely necessary, but among other things it does considerably prolong the service life of the components. It also counteracts the danger of stick-slip occurring.
Initial installation lubrication is practical, as recommended for friction bearings and sliding pads, with a subsequent empirical lubrication. This especially applies to highly loaded spindle nuts where attention has to be paid that the friction heat is dissipated.
However, graphite should not be used as a lubricant in combination with polyamide spindle nuts, as stick-slip becomes more likely with this combination.

2. Manufacture and design

The threads of spindle nuts can be machined on suitable machine tools. We recommend that they be produced on a lathe with the use of a thread turning tool. In this way, it can be ensured that there is enough play on the flanks of the thread to balance out the effects of heat expansion and moisture absorption.
Generally the spindle nut and housing are connected via a feather key. The load bearing capacity of plastic nuts in this case is oriented to the admissible compression in the feather key groove.
To fully utilise the load bearing capacity of the plastic thread, a form-fit connection between the outer steel housing and the plastic nut is required.

3. Calculating the load bearing capacity

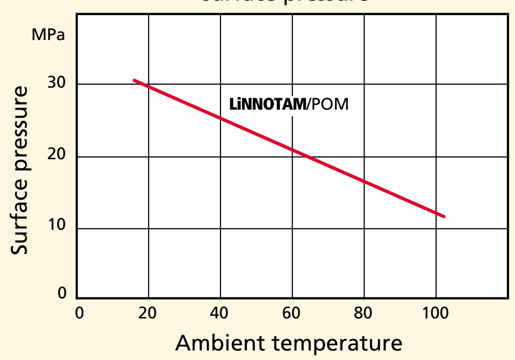
3.1 Surface pressure in the key groove

For a feather key connection, the side of the key groove must be checked to ensure that it does not exceed the permissible surface pressure:

$$P_F = \frac{M_d \cdot 10^3}{i \cdot r_m \cdot h \cdot b} \qquad [\text{MPa}]$$

where
M_d = transmitted torque in Nm
i = number of groove flanks
r_m = radius from the middle of the shaft to the middle of the bearing flank in mm
h = height of the bearing flank in mm
b = width of the bearing flank in mm

Diagram 1: Guiding values for permissible surface pressure



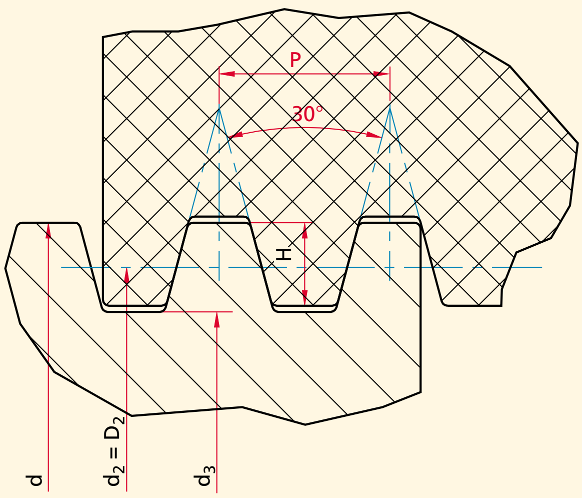
The value from the calculation is compared with Diagram 1 and may not exceed the maximum value.

3.2 Surface pressure on the thread flank

If we assume that all thread flanks bear the load equally, the surface pressure on the flanks is:

$$p = \frac{F}{z \cdot H \cdot \sqrt{\left(d_2 \cdot \pi \cdot \frac{l}{P}\right)^2 + l^2}} \qquad [\text{MPa}]$$

where
F = axial load of the spindle in N
P = lead in mm
d_2 = flank diameter in mm
l = length of nut in mm
H = depth for ISO metric trapezoidal screw thread in mm according to Table 1
z = number of screw flights (in case of multiple-flights)



In the case of static loading for spindle nuts made from PA, POM or PET, at 20 °C approx. 12 MPa and at 80 °C approx. 8 MPa can be permitted as the maximum compression.

Table 1: ISO metric trapezoidal screw thread according to DIN 103

Thread diameter d	P	H = 0.5 · P	d_2 = d - H	Thread diameter d	P	H = 0.5 · P	d_2 = d - H	Thread diameter d	P	H = 0.5 · P	d_2 = d - H
8	1.5	0.75	7.25	36	6	3	33	75	10	5	70
10	2	1	9	40	7	3.5	36.5	80	10	5	75
12	3	1.5	10.5	44	7	13.5	40.5	85	12	6	79
16	4	2	14	48	8	4	44	90	12	6	84
20	4	2	18	52	8	4	48	95	12	6	89
24	5	2.5	21.5	60	9	4.5	55.5	100	12	6	94
28	5	2.5	21.5	65	10	25	60	110	12	6	104
32	6	3	29	70	10	5	65	120	14	7	113

3.3 Sliding friction on the thread flank

As the thread flanks can be considered as a sliding element, the pv value can also be used as a guiding value for sliding friction loads for spindle nuts. For the thread flank this is

$$pv = p \cdot \frac{n \cdot \sqrt{(d_2 \cdot \pi)^2 + s^2}}{60{,}000} \qquad [\mathrm{MPa} \cdot \mathrm{m/s}]$$

where

n = number of strokes in $1/\mathrm{min}^{-1}$

d_2 = flank diameter in mm

s = stroke length in mm

As with friction bearings, the question regarding the permissible sliding friction load is a problem caused by the heat that occurs due to friction. If it can be ensured that the plastic nuts have sufficient time to cool down in intermittent operation, higher values can be permitted than in the case of continuous operation.

However, the determined values may not exceed the maximum values given in Table 2.

Table 2: pv – limiting values for spindle nuts

	Continuous operation					Intermittent operation				
	LiNNOTAM	LiNNOTAMGLiDE	POM-C	PET	PET- GL	LiNNOTAM	LiNNOTAMGLiDE	POM-C	PET	PET- GL
Dry running	0.06	0.12	0.06	0.06	0.13	0.08	0.12	0.08	0.08	0.37
Continuous lubrication	0.30	0.30	0.30	0.30	0.50	0.45	0.45	0.45	0.45	0.50

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