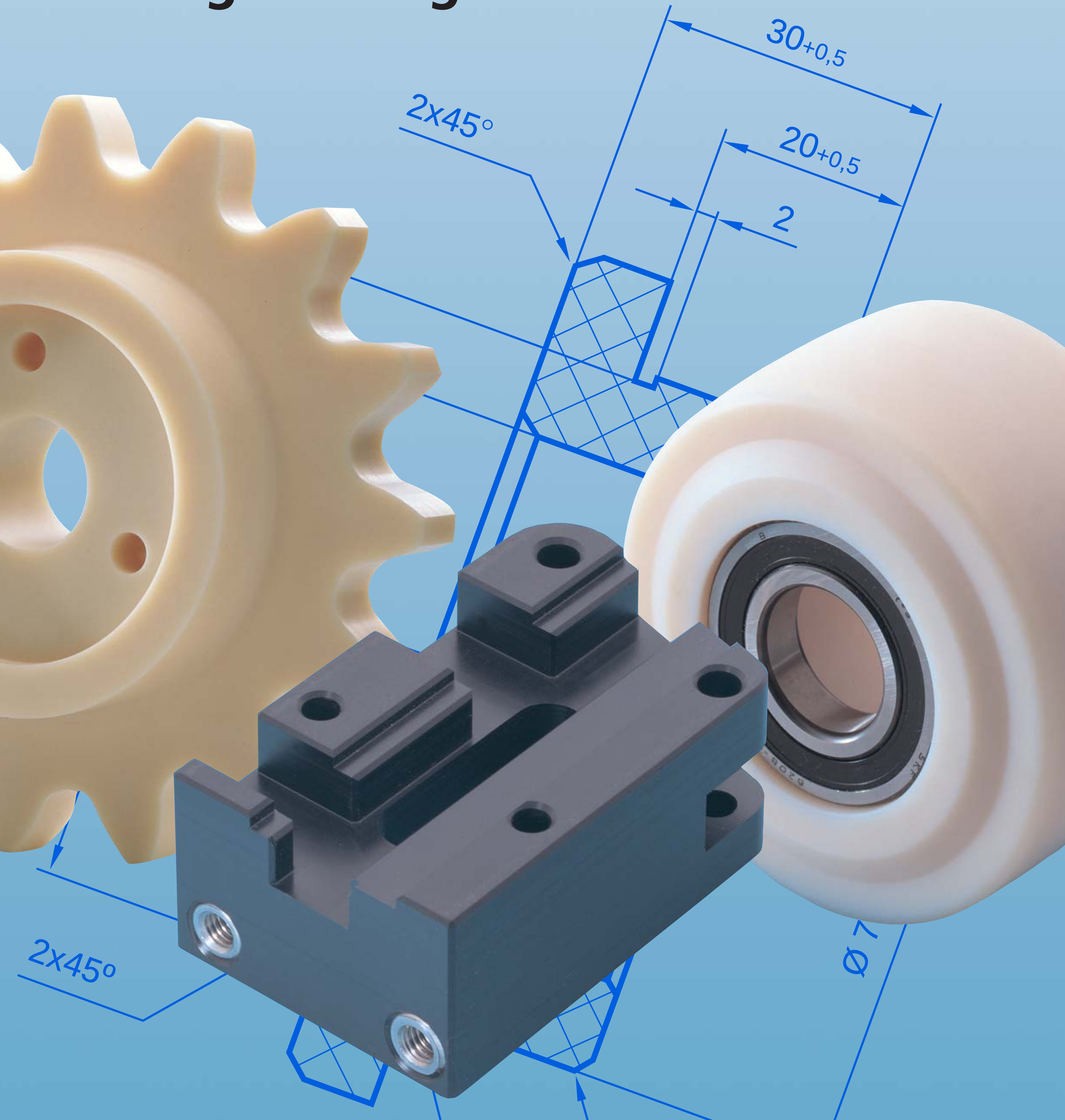
Licharz
engineering plastics

# Designing with engineering Plastics



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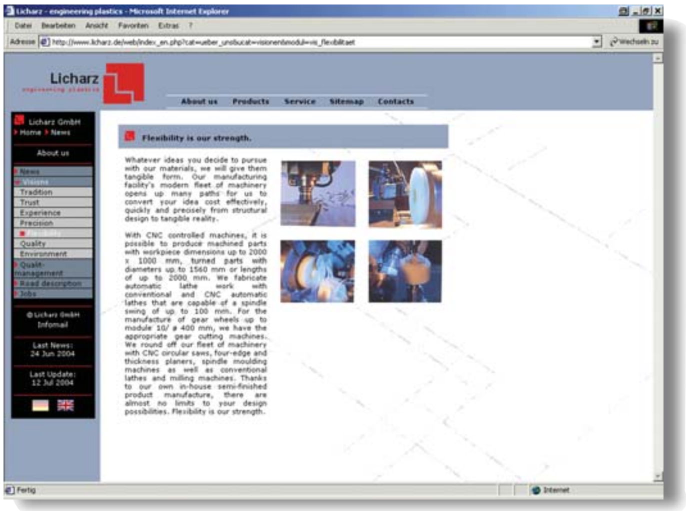



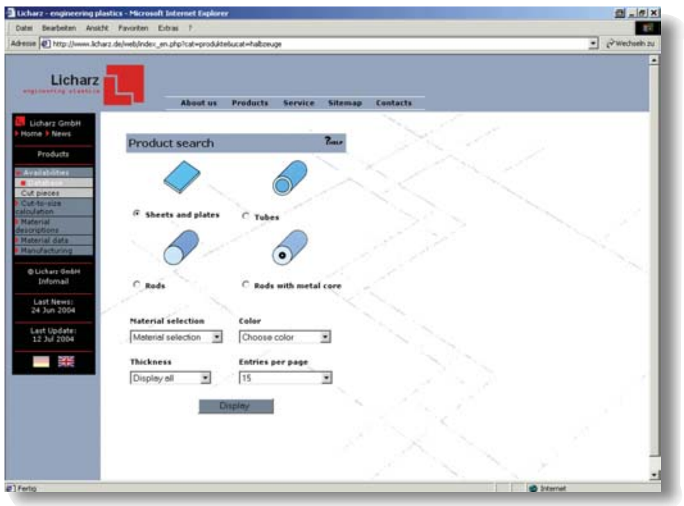


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# Plastic spindle nuts

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## 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 stress 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 Oilamid 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.
An initial installation lubrication is practical, as recommended for friction bearings and sliding pads, with a subsequent empirical lubrication. This especially applies to highly stressed 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 with this combination stick-slip becomes more likely.

## 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 lathe thread chisel. 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

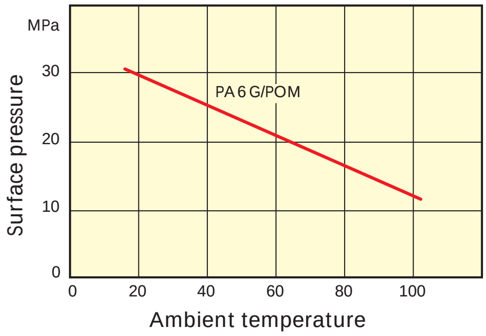
### 3.1 Surface pressure in the key groove

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.
The surface pressure is

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

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



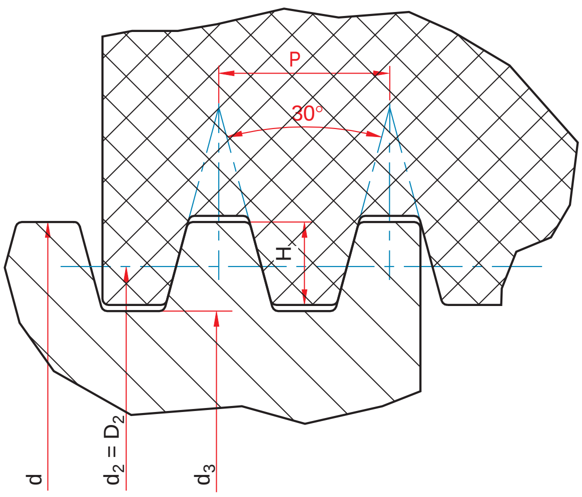

The value from the calculation is compared with Diagram 1 and may not exceed the maximum value.

### 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 | 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 | 3,5 | 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 | 25,5 | 65 | 10 | 5 | 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

$$pv = p \cdot \frac{n \cdot \sqrt{(d_2 \cdot \pi)^2 + s^2}}{60000} \qquad [MPa \cdot m/s]$$

where
$n$ = number of strokes in $1/min^{-1}$
$d_2$ = 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 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | PA 6 G | Oilamid | POM – C | PET | PET – GL | PA 6 G | Oilamid | POM – C | PET | PET – GL |
| Dry running | 0,15 | 0,23 | 0,15 | 0,15 | 0,25 | 0,23 | 0,34 | 0,23 | 0,23 | 0,37 |
| Continuous lubrication | 0,30 | 0,30 | 0,30 | 0,30 | 0,50 | 0,45 | 0,45 | 0,45 | 0,45 | 0,50 |

**Our machining capabilities:**

- CNC milling machines, workpiece capacity up to max. 2000 x 1000mm
- 5-axis CNC milling machines
- CNC lathes, chucking capacity up to max. 1560 mm diameter and 2000 mm long
- Screw machine lathes up to 100mm diameter spindle swing
- CNC automatic lathes up to 100mm diameter spindle swing
- Gear cutting machines for gears starting at Module 0,5
- Profile milling (shaping and molding)
- Circular saws up to 170mm cutting thickness and 3100mm cutting length
- Four-sided planers up to 125mm thickness and 225mm width
- Thickness planers up to 230mm thickness and 1000mm width

**We process:**

| | |
|---|---|
| • Polyamide | PA |
| • Polyacetal | POM |
| • Polyethylene terephthalate | PET |
| • Polyethylene 1000 | PE-UHMW |
| • Polyethylene 500 | PE-HMW |
| • Polyethylene 300 | PE-HD |
| • Polypropylene | PP-H |
| • Polyvinyl chloride (hard) | PVC-U |
| • Polyvinylidene fluoride | PVDF |
| • Polytetrafluoroethylene | PTFE |
| • Polyetheretherketone | PEEK |
| • Polysulphone | PSU |
| • Polyether imide | PEI |

**Examples of parts:**

- Rope sheaves and castors
- Guide rollers
- Deflection sheaves
- Friction bearings
- Slider pads
- Guide rails
- Gear wheels
- Sprocket wheels
- Spindle nuts
- Curved feed tables
- Feed tables
- Feed screws
- Curved guides
- Metering disks
- Curved disks
- Threaded joints
- Seals
- Inspection glasses
- Valve seats
- Equipment casings
- Bobbins
- Vacuum rails/panels
- Stripper rails
- Punch supports

## Information on how to use this documentation

All calculations, designs and technical details are only intended as information and advice and do not replace tests by the users in regard to the suitability of the materials for specific applications. No legally binding assurance of properties and/or results from the calculations can be deduced from this document. The material parameters stated here are not binding minimum values, rather they should be regarded as guiding values. If not otherwise stated, they were determined with standardised samples at room temperature and 50% relative humidity. The user is responsible for the decision as to which material is used for which application and for the parts manufactured from the material. Hence, we recommend that practical tests are carried out to determine the suitability before producing any parts in series.

We expressly reserve the right to make changes to this document. Errors excepted.
You can download the latest version containing all changes and supplements as a pdf file at www.licharz.de.



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**For further information, detailed catalogs are available:**

- Information on Licharz machining capabilities of component parts
- Brochure „Material Guiding Values / chemical Resistance“
- Product information on semi-finished products of PA, POM und PET
- Delivery programme

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