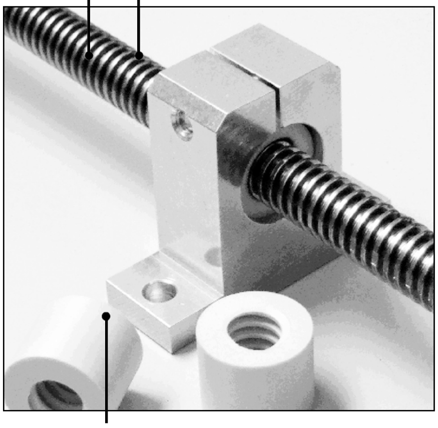
LINEAR MOTION

Trapezoidal Leadscrew Nuts

iglidur® Self Lubricating : DIN 103, ISO 2903

Advantages

- Self lubricating
- Resistant to dirt
- Maintenance free
- Best resistance to galling
- Corrosion free
- Quiet operation
- Temperature resistant up to +90°C
- Trapezoidal lead screws manufactured from Steel, Stainless and anodised Aluminium on request.
- Left-handed leadscrew nuts on request.



Until now, there have been two types of trapezoidal lead screw nuts on the market; lubricated metallic nuts (Steel, Bronze, Brass etc.) without emergency running properties, and maintenance free versions made of plastic such as PA 6.6 or POM with very restricted load capacity. iglidur® maintenance free trapezoidal lead screw nuts are now closing the gap - they are fully maintenance free and take high loads.

The new Trapezoidal lead screw nuts add to the range of the maintenance free and dry running products for linear technology.

The iglidur® lead screw nuts offer considerable advantages over nuts which require maintenance and lubrication especially in applications using detergents such as those of the packaging industry or in areas with high dust contamination (textile machines).

The iglidur® lead screw nuts are manufactured to DIN 103.

Calculations of the trapezoidal thread loads

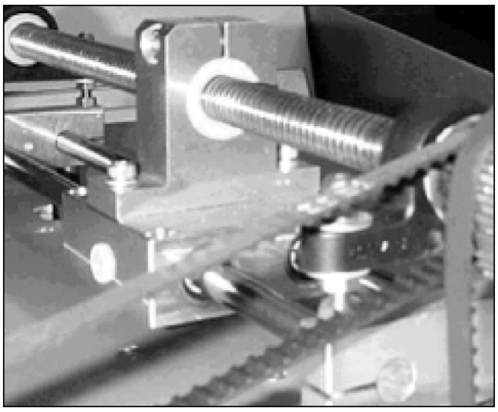
The load capacity of the trapezoidal lead screw nuts made of high performance polymers depends on the surface pressure, the speed and the resulting temperature.

The temperature ratio will be affected by the frequency as well as by the lead screw material and its thermal properties.

The surface pressure of the iglidur® trapezoidal lead screw nut should not permanently exceed 5 MPa.

p x v Value$_{max}$ 0.08 MPa x m/s

The permissible feeds and speeds can be determined for each thread size with the pxv value and the running surfaces given in the dimension table.



Required (running surface):

$A_e = F_{axial} / p_{permissible}$ (mm^2)

Selection of the thread size and determination of the effective surface pressure:

$p_{eff} = F_{axial} / A_{e\ eff}$ (MPa)

Permissible sliding speed:

$V_{slide} = p \times v_{max} / p_{eff}$ (m/s)

Maximum permissible RPM:

$N = V_{slide} \times 1.000 \times 60 / (\pi \times d1)$ (1/mm)

Feed Speed:

$V_{feed} = n \times P / 60.000$ (m/s)

F_{axial}	Axial force
$p_{permissible}$	Max. permissible surface pressure 5 MPa
p_{eff}	Effective surface pressure on a specific thread size
$A_{E\ eff}$	Effective supporting surface of the selected trapezoidal lead screw nut
P	Pitch
d1	Effective diameter

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Trapezoidal Leadscrews

Dimensions of Screw and Nut

The screw has to withstand the applied torque and also carry the load. The length of engagement between the nut and screw must be sufficient to avoid shearing and too rapid wear. In practice, it is nearly always the latter which determines the length of nut. The screw, if in compression, will also have to be considered as a column, and the J B Johnson or Euler formula applied. Since the torque is a function of the pitch diameter, which itself cannot be calculated until the minor diameter is known, the screw diameter must be selected by a trial and error solution. Therefore a trial solution for the minor diameter area is made considering only the **normal** stress. Use the following equation;

$$Ai = \frac{W \times fs}{Sy}$$

Then a nominal thread is selected having a minor diameter equal to, or exceeding that calculated. It is now possible to ascertain the tangent of the helix angle;

$$\tan\lambda = \frac{P}{\pi d}$$

With this information the torque can be calculated;

$$T = \frac{Wd}{2}\left(\frac{\cos\alpha \tan\lambda + \mu}{\cos\alpha - \mu\tan\lambda}\right)$$

The next step is to find the torsional shear stress;

$$Ss = \frac{16T}{\pi di^3}$$

And the normal stress on the minor diameter section for screws in **tension**;

$$S = \frac{W}{Ai}$$

For screws in **compression**, we must take into account the bending stresses, since the screw is acting as a column, and J B Johnson or Euler formula will apply.
Use the following equation to determine which formula is applicable;

$$a)\ \frac{L}{K} < \sqrt{\frac{2C\pi^2 E}{Sy}} \qquad b)\ \frac{L}{K} > \sqrt{\frac{2C\pi^2 E}{Sy}}$$

If a) applies, then the screw conforms to the Johnson formula;

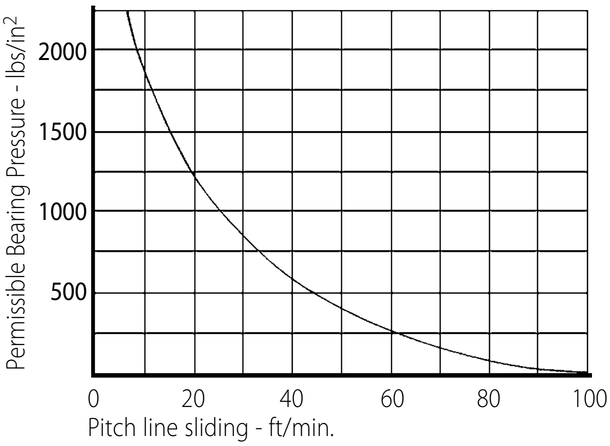
$$S = \frac{W}{Ai}\ \frac{1}{1 - \left[\frac{Sy\,(L/K)^2}{4C\pi^2 E}\right]}$$

If b) applies, then the screw conforms to the Euler formula;

$$S = \frac{W}{Ai}\ \frac{Sy\,(L/K)^2}{C\pi^2 E}$$

Having obtained a value for 'S' from one of the above equations a solution can be made for the factor of safety, taking into account all the stresses.

Graph of Speed/Allowable Pressure
Steel screws and bronze or cast iron nuts only



$$fs = \frac{Sy/2}{\sqrt{\left(\frac{S}{2}\right)^2 + \left(Ss\right)^2}}$$

This is then compared with the originally selected design value, and a decision can be made as to whether this is adequate, or whether another solution must be calculated.

It is advisable to check at this stage the length of the nut necessary to give acceptable bearing pressure on the thread flanks to ensure a satisfactory service life;

$$Le = \frac{4Wp}{\pi B\,(do^2 - di^2)}$$

The length of the nut should not exceed 3d, or manufacturing difficulties will arise, and if the nut length is found to be excessive, then re-calculation will be necessary using a larger screw diameter and alternative pitch. A multiple start thread will reduce the pitch-line sliding speed, and this alone may solve the problem of excessive bearing pressure. Finally, a check should be made on the factor of safety provided by the screw threads in shear;

$$\text{Screw } fs = \frac{Le\,\pi\,di\,ti\,Ssy}{Wp} \qquad \text{Nut } fs = \frac{Le\,\pi\,do\,to\,Ssy}{Wp}$$

Efficiency of a Screw Thread

$$e = \tan\lambda\left(\frac{\cos\alpha - \mu\tan\lambda}{\cos\alpha\tan\lambda + \mu}\right)$$

Self Locking Threads

A screw will be self-sustaining if μ exceeds cos μ tan λ.

Symbols Used in Equations

Ai = Area of screw minor diameter
B = Allowable bearing pressure (see graph)
C = End fixity coefficient (C = 2 for fixed ends)
d = Effective diameter of thread
di = Minor diameter of thread
do = Major diameter of thread
E = Modulus of elasticity of material
fs = Factor of safety
I = Second moment of inertia
K = $\sqrt{\frac{I}{Ai}}$ = radius of gyration of cross-section
L = Length of shaft, unsupported
Le = Length of engagement = length of nut
p = Pitch of thread
P = Lead of thread (pitch x No. of starts)
SS = Torsional shear stress
SSy = Shear stress yield point of material
T = Torque
ti = Thread thickness, minor diameter
to = Thread thickness, major diameter
W = Axial load
λ = Helix angle
α = Flank angle (15° Trapezoidal)
μ = Coefficient of friction (can be taken as 0.15)

TECHNICAL

LINEAR MOTION

Trapezoidal Leadscrews

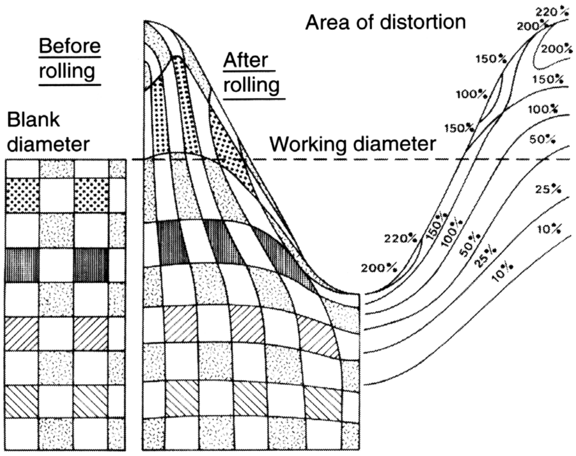
Load v Speed (Steel screws with Bronze nuts) (May need correction for nut length (lg)

Linear speed (mm/min):		125	250	375	500	625	750	875	1000	1250	1500	1750	2000
Tr 12 x 3	Rpm:	42	83	125	167	208	250	292	333	417	500	583	667
25lg	Load Kg:	700	560	475	400	330	280	240	200	150	100	60	60
Tr 16 x 4	Rpm:	30	70	100	125	150	200	250	300	350	400	450	500
29lg	Load Kg:	1,050	860	680	610	520	380	280	220	170	120	90	68
Tr 20 x 4	Rpm:	31	62	94	125	156	187	219	250	312	375	437	500
32lg	Load Kg:	1,330	1,080	875	700	580	470	380	300	170	100	60	60
Tr 24 x 5	Rpm:	25	50	75	100	125	150	175	200	250	300	350	400
45lg	Load Kg:	2,360	1,900	1,500	1,220	1,020	850	680	530	300	170	100	75
Tr 32 x 6	Rpm:	21	42	63	83	104	125	146	167	208	250	292	333
60lg	Load Kg:	4,100	3,230	2,530	2,050	1,670	1,600	1,020	770	420	230	150	115
Tr 40 x 6	Rpm:	21	42	63	83	104	125	146	167	208	250	292	333
60lg	Load Kg:	4,950	3,630	2,730	2,150	1,580	1,470	740	500	250	150	-	-
Tr 50 x 8	Rpm:	16	31	47	63	78	94	109	125	156	188	219	250
90lg	Load Kg:	9,300	6,950	5,300	4,100	3,200	2,380	1,700	1,150	550	380	-	-
Tr 60 x 9	Rpm:	13	25	38	50	63	75	88	100	125	150	175	200
115lg	Load Kg:	14,300	10,800	8,250	6,600	5,200	3,950	2,800	2,000	1,050	600	415	-

To select the correct screw for your application you will find it helpful to refer to the chart. This shows the screw required for various loads and linear speeds. It takes into account flank loads to give satisfactory life. If in compression consideration must also be given to the screw as a column. When used in tension the figures given will normally allow an adequate safety factor (steel screw with bronze nuts), use lowest figure from either table.

Bucking Load v Screw Length

Thread Dimensions	Perm-tensile Force (Kg)	Screw Length (m) 0.15	0.20	0.30	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	3.00	4.00	5.00
Tr 10 x 3	330	136	75	33	12	5	3	-	-	-	-	-	-	-	-	-
Tr 12 x 3	570	393	221	98	35	15	8	5	3	-	-	-	-	-	-	-
Tr 14 x 4	710	612	345	153	55	24	13	8	6	4	3	2	-	-	-	-
Tr 16 x 4	1,040	-	740	329	118	45	29	19	13	9	7	5	4	3	1	-
Tr 20 x 4	1,890	-	-	1,085	391	173	97	62	43	31	24	19	15	10	6	3
Tr 24 x 5	2,690	-	-	2,202	794	353	198	127	88	64	49	39	31	22	12	7
Tr 28 x 5	3,980	-	-	-	1,732	770	433	277	192	141	108	85	69	48	27	17
Tr 30 x 6	4,340	-	-	-	2,062	918	517	330	229	168	129	102	82	57	32	20
Tr 32 x 6	5,110	-	-	-	2,860	1,271	715	458	318	233	178	141	114	79	44	28
Tr 36 x 6	6,830	-	-	-	5,120	2,280	1,280	820	569	418	320	253	205	142	80	51
Tr 40 x 7	8,300	Bucking Load (kg)			7,560	3,360	1,890	1,210	840	617	472	377	302	210	118	75
Tr 44 x 7	10,460				-	5,330	3,000	1,920	1,332	980	750	593	480	333	187	120
Tr 48 x 8	12,510				-	7,350	3,950	2,610	1,860	1,370	1,020	850	670	460	245	175
Tr 50 x 8	13,530				-	8,940	5,020	3,218	2,230	1,640	1,255	993	804	558	314	201
Tr 52 x 8	14,550	-	-	-	-	10,530	6,045	3,815	2,610	1,925	1,485	1,150	940	660	375	230
Tr 60 x 9	20,030	-	-	-	-	19,570	11000	7,050	4,890	3,595	2,750	2,178	1,761	1,222	688	440
Tr 70 x 10	27,810	-	-	-	-	-	21,200	13,570	9,420	6,920	5,300	4,180	3,390	2,352	1,325	848



Improvement of the Mechanical Properties: Gain reaching 30% on hardness and 12% on breaking strength, in fact the fibres of the material are formed but not cut as in the case of cutting.

The Process

Cold-formed threading, more commonly called rolling, implies the cold forming of a metal bar by pressing during rotation with tools called dies, in order to obtain a thread or a knurling. Thanks to this performing process, we manufacture amongst others metric, trapezoidal threads and ball screws, using different materials such as current and special steels, stainless steel, brass and numerous alloys.

Economic Efficiency

The process of rolling allows a high production and an important saving in material as the diameter used is below nominal and unlike cutting it has no chips, thus no material loss.

Comparisons

The roller finishing on the surface considerably increases the life time of the screw or of the nut, improves fatigue strength and eliminates the starting points of the fracture.