



Determination of Clamping Forces

Table comparing attainable tensile load F_{Sp} of bolts with clamping forces of approx. cylinder equivalent. Material strength grade of bolts: 8.8 as per DIN 267, section 3. Tensile load of bolts at 33% yield stress.

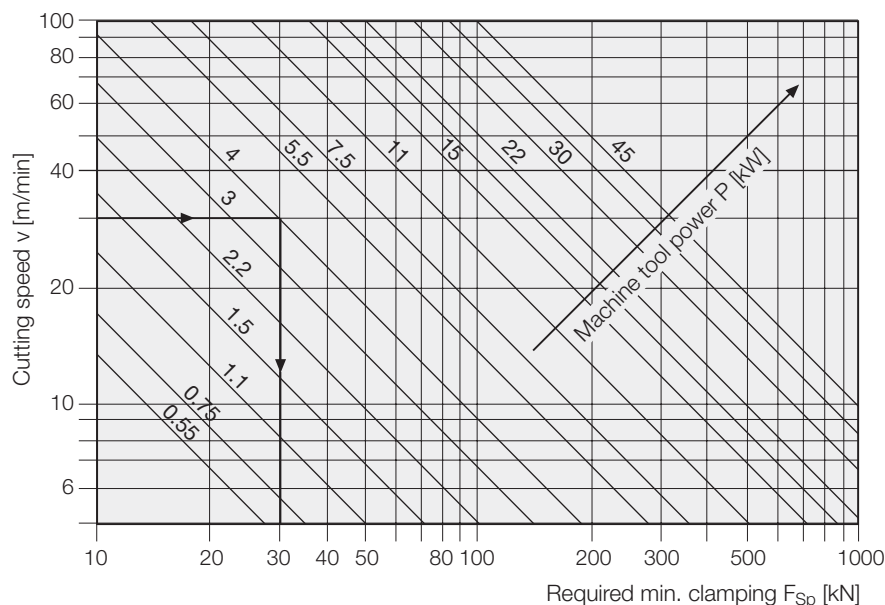
Bolt Ø	[mm]	M 5	M 6	M 8	M 10	M 12	M 16	M 20	M 24	M 27	M 30
Tensile load F_{Sp} at 0.33 yield	[kN]	3.1	4.4	8.0	12.6	18.5	34.5	53.6	77.3	100.5	123.0
Cylinder, piston Ø	[mm]	12	16	20	25	32	40	50	63	80	100
Force at 200 bar	[kN]	2.2	4.0	6.3	9.8	16.0	25.1	39.2	62.3	100.5	157.0
Cylinder, piston Ø	[mm]	8	10	12	16	20	25	32	40	50	63
Force at 500 bar	[kN]	2.5	3.9	5.6	10.0	15.6	24.5	40.0	62.8	98.5	156.0

Required min. clamping force F_{Sp} as a function of machine tool power P and cutting speed v .

The diagram applies under the conditions that the workpiece is retained on the machine tool table by frictional forces between the table and the workpiece, generated by the clamping force F_{Sp} acting on the workpiece normal to the machine tool table. The force F_{Sp} is just large enough to prevent slipping of the workpiece caused by cutting forces. Machine tool efficiency η is assumed to be 75% and the friction coefficient between table and workpiece $\mu = 0.2$. It is required to multiply the clamping force F_{Sp} with a correction coefficient

$$k = \frac{0.2}{\mu \cdot x}$$

for friction coefficients $\mu \cdot x$ other than 0.2.



Materials

Coefficients of static friction μ

	dry	lubricated
Cast iron on cast iron	0.30	0.19
Cast iron on steel	0.19	0.10
Steel on steel	0.15	0.12

The diagram solves the following equation

$$F_{Sp} = \frac{P \cdot \eta \cdot 60}{\mu \cdot v} \text{ [kN]}$$

Example

Machine tool power $P = 4 \text{ kW}$

Cutting speed $v = 30 \text{ m/min}$

Required min. clamping force $F_{Sp} = 30 \text{ kN}$