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.

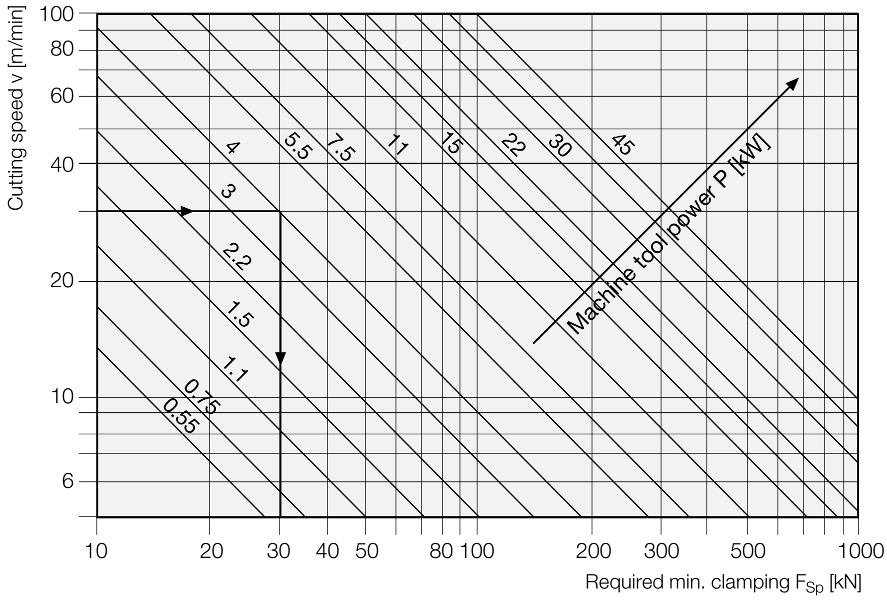
Bolt Ø	[mm]	M 5	M 6	M 8	M 10	M 12	M 16	M 20	M 24	M 27	M 30
Tensile load F_{Sp} at 0.33 yield	[kN]	3.1	4.4	8.0	12.6	18.5	34.5	53.6	77.3	100.5	123.0
Cylinder, piston Ø	[mm]	12	16	20	25	32	40	50	63	80	100
Force at 200 bar	[kN]	2.2	4.0	6.3	9.8	16.0	25.1	39.2	62.3	100.5	157.0
Cylinder, piston Ø	[mm]	8	10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

$$k = \frac{0,2}{\mu\ x}$$

for friction coefficients μ 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 kW
Cutting speed v = 30 m/min
Required min. clamping force F_{Sp} = 30 kN