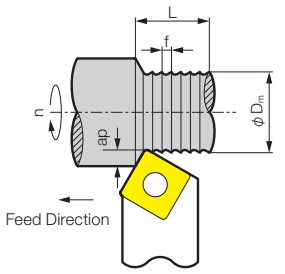
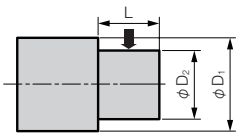
Formula for Turning

1. Cutting Time T [sec]

	T_C (Reference : n)	T_1 (Reference : vc)
External	$T_C = \frac{60 \times L}{f \times n}$	$T_1 = \frac{60 \times \pi \times L \times D_m}{1{,}000 \times f \times vc}$
Facing	$T_C = \frac{60 \times (D_1 - D_2) \times N}{2 \times f \times n}$	$T_1 = \frac{60 \times \pi \times (D_1 + D_2) \times (D_1 - D_2) \times N}{4{,}000 \times f \times vc}$
Grooving	$T_C = \frac{60 \times (D_1 - D_2)}{2 \times f \times n}$	$T_1 = \frac{60 \times \pi \times (D_1 + D_2) \times (D_1 - D_2)}{4{,}000 \times f \times vc}$
Cut-Off	$T_C = \frac{60 \times D_1}{2 \times f \times n}$	$T_1 = \frac{60 \times \pi \times (D_1 + D_3) \times (D_1 - D_3)}{4{,}000 \times f \times vc}$





f	: Feed Rate	[mm/rev]
n	: Spindle Speed	[min^{-1}]
L	: Length of Cut	[mm]
D_m	: Diameter	[mm]
D_1	: Max. Diameter	[mm]
D_2	: Min. Diameter	[mm]
D_3	: Diameter at n_{max}	[mm]
n_{max}	: Max. Spindle Speed	[min^{-1}]

※ $\pi \fallingdotseq 3.14$

Cut-Off — T_2 (Reference : vc, n_{max})

$$T_2 = T_1 + \frac{60 \times D_3}{2 \times f \times n_{max}}$$

2. Power Requirements P_C [kW]

$$P_C = \frac{vc \times f \times ap \times k_C}{60 \times 1{,}000 \times (\eta \div 100)}$$

P_C	: Power Requirements	[kW]
vc	: Cutting Speed	[m/min]
f	: Feed Rate	[mm/rev]
ap	: Depth of Cut	[mm]
k_C	: Specific Cutting Force	[MPa]
η	: Machine Efficiency	[%] (70 ~ 85)

Specific Cutting Force k_C

P	Un alloyed	1,500 MPa
	Low alloyed	2,000 MPa
	High alloyed	3,000 MPa
M	Austenitic	2,000 MPa
	Ferritic	2,500 MPa
K	Malleable	900 MPa
	Grey	1,200 MPa
	Ductile	1,500 MPa
N	Al based alloys	500 MPa
	Cu based alloys	900 MPa
S	Ti based alloys	1,400 MPa
	Fe based alloys	2,500 MPa
	Ni based alloys	2,800 MPa
	Co based alloys	3,000 MPa
H	Hardened steel 50-55	3,300 MPa
	Hardened steel 60-63	4,500 MPa
	Hardened cast iron	3,500 MPa

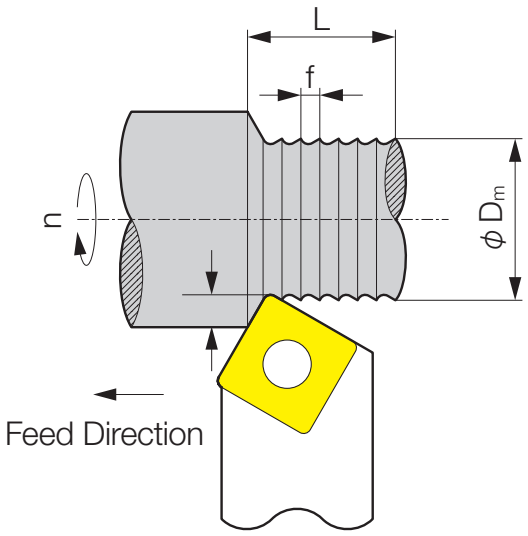
Formula for Turning

3. Cutting Speed vc [m/min]

$$vc = \frac{\pi \times D_m \times n}{1{,}000}$$

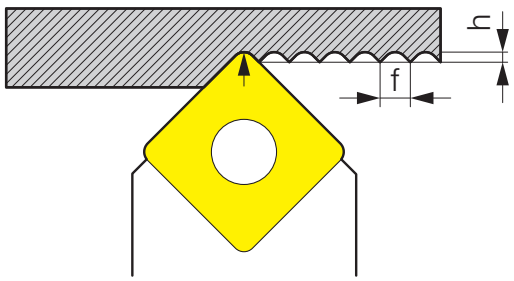
4. Spindle Speed n [min^{-1}]

$$n = \frac{vc \times 1{,}000}{\pi \times D_m}$$



5. Feed Rate f [mm/rev]

$$f = \frac{l \times \pi \times D_m}{vc \times 1{,}000} = \frac{l}{n}$$



6. Theoretical surface roughness h [μm]

$$h = \frac{f^2 \times 1{,}000}{8 \times RE}$$

7. Horsepower H [HP]

$$H = \frac{P_C}{0.75}$$

8. Material Removal Rate Q [cm^3/min]

$$Q = vc \times f \times ap$$

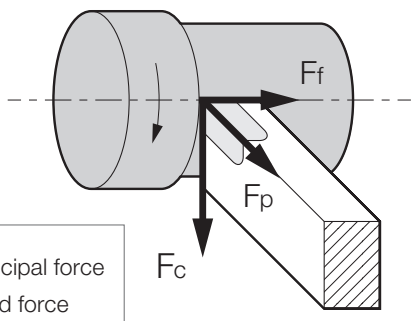
9. Cutting Force P [kN]

$$P = \frac{k_C \times f \times ap}{1{,}000}$$

vc	:	Cutting Speed	[m/min]
n	:	Spindle Speed	[min^{-1}]
D_m	:	Diameter	[mm]
f	:	Feed Rate	[mm/rev]
h	:	Theoretical surface roughness	[μm]
l	:	Length of Cut per minute	[mm]
RE	:	Nose R	[mm]
H	:	Horsepower	[HP]
P_C	:	Power Requirements	[kW]
ap	:	Depth of Cut ap	[mm]
k_C	:	Specific Cutting Force	[MPa]

※ π ≒ 3.14

Three cutting force components



F_c	:	Principal force
F_f	:	Feed force
F_p	:	Back force

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