Gearbox Synchroniser Torque, Synchronising Time and Energy

Friction torque of a cone synchroniser from shift force, cone radius, angle, friction and number of cones, and the time and energy to match speeds of an inertia.

Method: Cone synchroniser mechanics

Input parameters

Unit system: SI

Parameter	Value	Unit
Axial shift force at the synchroniser	600.00	N
Mean cone radius	40.000	mm
Cone half-angle	6.5000	°
Cone friction coefficient	0.10000	
Number of cones	1.0000	
Inertia to synchronise	0.015000	kg·m²
Speed difference	1,200.0	rpm

Calculated results

Parameter	Value	Unit
Synchronising torque	21.201	N·m
Synchronising time	88.910	ms
Friction energy per shift	118.44	J

Notes for this case

• T_s = n_cμF_ar_c/sinα: a small cone angle multiplies the axial force (but below about 6° the cone may stick). t = JΔω/T_s; drag torque from oil and bearings, neglected here, helps on upshifts and hinders on downshifts. Multi-cone synchronisers cut shift force for heavy, low-gear inertias.

Formula and method

$$T_s = \frac{n_c \mu F_a r_c}{\sin \alpha}, \quad t_s = \frac{J \Delta \omega}{T_s}, \quad E = \frac{1}{2} J \Delta \omega^2$$

Variables

F_a	Axial shift force at the synchroniser	N
r_c	Mean cone radius	m
α	Cone half-angle	rad
μ	Cone friction coefficient	-
n_c	Number of cones	-
J	Inertia to synchronise	kg·m²
Δn	Speed difference	rad/s
T_s	Synchronising torque	N·m
t_s	Synchronising time	s
E	Friction energy per shift	J

Method and standards

Synchroniser.

Assumptions and limits

- Constant friction; no drag torque.

References
Cone synchroniser mechanics

Report details

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Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online
https://calc.firecad.com/automotive/transmission/synchroniser-cone-time

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Reopens the calculator with the inputs of this report.