Worm Gear Efficiency, Lead Angle and Self-Locking

Efficiency of a worm gear drive from lead angle, normal pressure angle and friction coefficient, with the lead angle from worm dimensions and a self-locking check.

Method: Shigley's Mechanical Engineering Design (Budynas and Nisbett); ch. 13 (η = (cos φn − f tan λ)/(cos φn + f cot λ); self-locking f ≥ cos φn tan λ)

Input parameters

Unit system: SI

Parameter	Value	Unit
Number of worm starts	2.0000	
Axial pitch of the worm	12.600	mm
Worm pitch diameter	50.000	mm
Normal pressure angle	20.000	°
Coefficient of friction Falls with sliding speed; from the maker or textbook charts.	0.050000	

Calculated results

Parameter	Value	Unit
Lead z_w p_x	25.200	mm
Lead angle	9.1142	°
Efficiency, worm driving	74.453	%
Self-locking (1 = yes, 0 = no)	0	

Notes for this case

- Bearing and churning losses lower the overall efficiency further. Self-locking is not a safe brake under vibration.

Formula and method

$$\tan\lambda = \frac{z_w p_x}{\pi d_w}, \quad \eta = \frac{\cos\phi_n - f\tan\lambda}{\cos\phi_n + f\cot\lambda}, \quad \text{self-locking if } f \geq \cos\phi_n \tan\lambda$$

Variables

z_w	Number of worm starts	-
p_x	Axial pitch of the worm	m
d_w	Worm pitch diameter	m
ϕ_n	Normal pressure angle	rad
f	Coefficient of friction	-
L	Lead z_w p_x	m
λ	Lead angle	rad
η	Efficiency, worm driving	-
locks	Self-locking (1 = yes, 0 = no)	-

Method and standards

Force analysis of the worm thread.

Assumptions and limits

- Worm driving; bearing losses excluded.

References

- Shigley's Mechanical Engineering Design (Budynas and Nisbett)
- ch. 13 (η = (cos φn − f tan λ)/(cos φn + f cot λ); self-locking f ≥ cos φn tan λ)

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/mechanical/machine-design/worm-gear-efficiency

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.