Just-Suspended Impeller Speed for Solids (Zwietering)

Impeller speed to just suspend all solids in a stirred tank (Zwietering) from particle size and density, liquid properties, loading and impeller size.

Method: Zwietering (1958); Chem. Eng. Sci. 8: 244; Perry's Chemical Engineers' Handbook; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Zwietering geometry constant	6.5000	
Liquid kinematic viscosity	1.0000	cSt
Particle size	200.00	µm
Solid density	2,650.0	kg/m³
Liquid density	1,000.0	kg/m³
Solids loading (mass solids per 100 mass liquid) Not wt % of slurry: a 10 wt % slurry is X = 100 × 10/90 = 11.1.	10.000	
Impeller diameter	1.0000	m

Calculated results

Parameter	Value	Unit
Just-suspended speed	84.202	rpm
Tip speed	4.4088	m/s

Notes for this case

- S depends on impeller type and clearance and tank-to-impeller ratio (about 4–8 for pitched-blade turbines at T/D = 3 with one-quarter clearance); take it from Zwietering's charts or tests. SI units throughout.

Formula and method

$$N_{js} = S\nu^{0.1}\left(\frac{g\Delta\rho}{\rho_L}\right)^{0.45} X^{0.13} d_p^{0.2} D^{-0.85}$$

Variables

S	Zwietering geometry constant	-
ν	Liquid kinematic viscosity	m²/s
d_p	Particle size	m
ρ_s	Solid density	kg/m³
ρ_L	Liquid density	kg/m³
X	Solids loading (mass solids per 100 mass liquid)	-
D	Impeller diameter	m
N_{js}	Just-suspended speed	1/s
$\pi D N_{js}$	Tip speed	m/s

Method and standards

Zwietering correlation (SI).

Assumptions and limits

- Standard baffled tanks.
- X is mass of solids per 100 mass of liquid, not wt % of slurry (10 wt % slurry is X = 11.1).

References

- Zwietering (1958)
- Chem. Eng. Sci. 8: 244; Perry's Chemical Engineers' Handbook
- 9th ed. (McGraw-Hill, 2019)
- sec. 18 (solids suspension)

Report details

Report reference	FCC-KFN9-8Z95 (the same inputs always give the same reference)
Generated	17 November 2026, 19:49 UTC
Calculator	Just-Suspended Impeller Speed for Solids (Zwietering)
Method last reviewed	13 November 2026
Software release	FireCAD Calc, release of 17 November 2026
Release checks	2 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/chemical/unit-operations/zwietering-suspension-speed

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.