Blend Time in a Turbulent Stirred Tank

Time to blend a stirred tank to 95 % uniformity in turbulent flow from impeller power number, speed and diameter ratio (Grenville), with power per volume.

Method: Grenville (1992) correlation; $\theta_{95}N = 5.20\ N_p^{-1/3}(T/D)^2$; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Impeller power number	1.2700	
Impeller speed	90.000	rpm
Impeller diameter	1.0000	m
Tank diameter	3.0000	m
Liquid density	1,000.0	kg/m³
Liquid viscosity	1.0000	cP

Calculated results

Parameter	Value	Unit
Impeller Reynolds number	1,500,000	
Blend time to 95 %	28.811	s
Power per volume (H = T)	0.20213	kW/m³

Notes for this case

- Grenville's correlation applies to H/T about 1 and fully turbulent flow; for taller tanks use multiple impellers.

Formula and method

$$\theta_{95} = \frac{5.20}{N N_p^{1/3}} \left(\frac{T}{D}\right)^2, \quad Re = \frac{\rho N D^2}{\mu}, \quad \frac{P}{V} = \frac{N_p \rho N^3 D^5}{\pi T^3/4}$$

Variables

N_p	Impeller power number	-
N	Impeller speed	1/s
D	Impeller diameter	m
T	Tank diameter	m
ρ	Liquid density	kg/m³
μ	Liquid viscosity	Pa·s
Re	Impeller Reynolds number	-
θ_{95}	Blend time to 95 %	s
P/V	Power per volume (H = T)	W/m³

Method and standards

Grenville's correlation.

Assumptions and limits

- H ≈ T (the volume for P/V is a cylinder with H = T); baffled; turbulent. The power number is taken as constant, which holds only in turbulent flow; below Re 10 000 the time is shown with a warning and is too short.
- Grenville fitted the correlation over a limited range of D/T; check yours against the Handbook of Industrial Mixing.

References

- Grenville (1992) correlation

- $\theta_{95}N = 5.20\ N_p^{(-1/3)}(T/D)^2$
- in Paul
- Atiemo-Obeng and Kresta
- Handbook of Industrial Mixing (Wiley, 2004)
- ch. 9

Report details

Report reference	FCC-3P70-Q2QH (the same inputs always give the same reference)
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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/blend-time-stirred-tank

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.