Rotary Dryer Retention Time (Friedman–Marshall)

Retention time of solids in a flighted rotary dryer from length, diameter, slope and speed, corrected for gas drag in co-current or counter-current flow.

Method: Friedman–Marshall retention-time correlation

Input parameters

Unit system: SI

Parameter	Value	Unit
Dryer length	15.000	m
Shell diameter	1.8000	m
Slope (m per m)	3.0000	%
Rotational speed	4.0000	rpm
Mean particle size	500.00	µm
Gas mass velocity	1.5000	kg/(m²·s)
Feed rate of dry solids per unit cross-section	1.2000	kg/(m²·s)
Gas flow	Counter-current (slows the solids)	

Calculated results

Parameter	Value	Unit
Retention time from geometry alone	18.347	min
Correction for the gas flow	8.2532	min
Retention time	26.600	min
Particle-size constant B = 5 D_p^−0.5	0.22361	

Notes for this case

• Friedman and Marshall's correlation in its original units gives θ = 0.23 L/(S N^0.9 D) ± 0.6 B L G/F minutes, with L and D in ft, N in rpm, G and F in lb/(h·ft²), and B = 5 D_p^−0.5 with D_p in µm. The first term is the cascading of solids down the slope; the second is the drag of the gas, which holds solids back in counter-current flow and pushes them along in co-current flow. Inputs here are SI and converted internally. The correlation came from small pilot dryers: treat it as a first estimate and confirm with the maker.

Formula and method

$$\theta = \frac{0.23\,L}{S N^{0.9} D} \pm \frac{0.6\,BLG}{F}, \quad B = 5 D_p^{-0.5} \quad \text{(US units)}$$

Variables

L	Dryer length	m
D	Shell diameter	m
S	Slope (m per m)	-
N	Rotational speed	rad/s
D_p	Mean particle size	m
G	Gas mass velocity	kg/(m²·s)
F	Feed rate of dry solids per unit cross-section	kg/(m²·s)
flow	Gas flow	-
θ_0	Retention time from geometry alone	s
$\Delta\theta_G$	Correction for the gas flow	s

θ	Retention time	s
B	Particle-size constant B = 5 D_p^−0.5	-

Method and standards

Retention time.

Assumptions and limits

- Flighted dryer; correlation's units converted from SI.

References

Friedman–Marshall retention-time correlation

Report details

Report reference	FCC-JTDS-F0J8 (the same inputs always give the same reference)
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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/chemical/drying/rotary-dryer-retention-time

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.