Rotary Dryer Volume from Volumetric Heat Transfer

Rotary dryer volume, diameter and length from the heat duty, a volumetric heat transfer coefficient and the log-mean temperature difference between gas and solids.

Method: Perry's Chemical Engineers' Handbook; 9th ed. (McGraw-Hill, 2019); ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Heat to the solids and water	1,500.0	kW
Volumetric heat transfer coefficient, W/(m³·K) Per kelvin: W/(m³·K), entered in W/m³ per K in every unit system. Convert Btu/(h·ft³·°F) by × 18.63. Perry's sec. 12 gives Ua from gas mass velocity and diameter.	150.00	W/m³
Gas in	400.00	°C
Gas out	110.00	°C
Solids in	25.000	°C
Solids out	90.000	°C
Flow arrangement	Co-current	
Length to diameter ratio	6.0000	

Calculated results

Parameter	Value	Unit
Log-mean temperature difference	121.11	K
Dryer volume	82.569	m³
Diameter	2.5973	m
Length	15.584	m

Formula and method

$$\Delta T_{lm} = \frac{\Delta T_1 - \Delta T_2}{\ln(\Delta T_1/\Delta T_2)},\quad \mathrm{co-current}:\ \Delta T_1 = T_{g1} - T_{s1},\ \Delta T_2 = T_{g2} - T_{s2};\quad \mathrm{counter-current}:\ \Delta T_1 = T_{g1} - T_{s2},\ \Delta T_2 = T_{g2} - T_{s1}$$

$$V = \frac{Q}{U_a\,\Delta T_{lm}},\quad D = \sqrt[3]{\frac{4V}{\pi(L/D)}}$$

Variables

Q	Heat to the solids and water	W
U_a	Volumetric heat transfer coefficient, W/(m³·K)	W/(m³·K)
T_{g1}	Gas in	K
T_{g2}	Gas out	K
T_{s1}	Solids in	K
T_{s2}	Solids out	K
flow	Flow arrangement	-
L/D	Length to diameter ratio	-
ΔT_{lm}	Log-mean temperature difference	K
V	Dryer volume	m³
D	Diameter	m
L	Length	m

Method and standards

Volumetric heat transfer design.

Assumptions and limits

- Uniform U_a; ΔT_lm between gas and solids.
- U_a is entered in W/(m³·K) in every unit system (no per-degree volumetric quantity exists for automatic conversion); 1 Btu/(h·ft³·°F) = 18.63 W/(m³·K).

References

- Perry's Chemical Engineers' Handbook
- 9th ed. (McGraw-Hill, 2019)
- sec. 12 (rotary dryers): Q = U_a V ΔT_lm

Report details

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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/rotary-dryer-volume

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.