Hopper Discharge Rate of Granular Solids (Beverloo)

Mass discharge rate of a free-flowing granular solid through a circular or slot outlet by the Beverloo correlation, from bulk density, outlet size and particle size.

Method: Beverloo; Leniger and van de Velde (1961); ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Outlet shape	Circular	
Outlet diameter or slot width	300.00	mm
Particle size	3.0000	mm
Bulk density	800.00	kg/m³
Beverloo constant	0.58000	
Particle shape constant	1.4000	

Calculated results

Parameter	Value	Unit
Discharge rate (per metre of slot length for a slot)	248.93	t/h
Effective outlet size	295.80	mm

Notes for this case

- For free-flowing coarse solids (above about 0.5 mm); cohesive solids need a mass-flow hopper design.

Formula and method

$$W = C\rho_b\sqrt{g}(D_0 - kd_p)^{2.5}\ \text{(circular)},\quad W_s = 1.03\,C\rho_b\sqrt{g}(D_0 - kd_p)^{1.5}\ \text{(slot, per metre of length)}$$

Variables

outlet	Outlet shape	-
D_0	Outlet diameter or slot width	m
d_p	Particle size	m
ρ_b	Bulk density	kg/m³
C	Beverloo constant	-
k	Particle shape constant	-
W	Discharge rate (circular outlet)	kg/s
W_s	Discharge rate per metre of slot length (slot outlet)	kg/(s·m)
$D_0 - kd_p$	Effective outlet size	m

Method and standards

Beverloo correlation.

Assumptions and limits

- Coarse free-flowing solids; particles below about 0.5 mm are flagged.
- For a slot outlet (width entered as D_0) the result W_s is per metre of slot length. The slot coefficient 1.03 is carried from the earlier FireCAD version; its printed source is not yet confirmed, so treat the slot result as an estimate.

References

- Beverloo
- Leniger and van de Velde (1961)
- Chem. Eng. Sci. 15: 260; Perry's Chemical Engineers' Handbook
- 9th ed. (McGraw-Hill, 2019)
- sec. 21

Report details

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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/mechanical/material-handling/beverloo-hopper-discharge

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.