Silo Wall Pressure by Janssen's Equation

Vertical and wall pressure in a silo at a depth by Janssen's equation from bulk density, wall friction, pressure ratio and diameter, with the deep-silo limit.

Method: Janssen (1895) equation; as given in Perry's Chemical Engineers' Handbook; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Silo diameter	8.0000	m
Depth below the material surface	20.000	m
Bulk density	800.00	kg/m³
Wall friction coefficient	0.40000	
Horizontal-to-vertical pressure ratio	0.45000	

Calculated results

Parameter	Value	Unit
Vertical pressure at depth z	72.761	kPa
Wall (horizontal) pressure	32.742	kPa
Wall friction stress	13.097	kPa
Asymptotic wall pressure (deep silo)	39.227	kPa
Hydrostatic pressure for comparison	156.91	kPa

Notes for this case

- Janssen gives filling (static) pressures. Discharge can raise wall pressure by 1.5–2.5 times locally; structural design uses the governing silo code's overpressure factors.

Formula and method

$$p_v = \frac{\rho g R_h}{\mu_w K}\left(1 - e^{-\mu_w K z / R_h}\right), \quad R_h = \frac{D}{4}, \quad p_h = K p_v$$

Variables

D	Silo diameter	m
z	Depth below the material surface	m
ρ_b	Bulk density	kg/m³
μ_w	Wall friction coefficient	-
K	Horizontal-to-vertical pressure ratio	-
p_v	Vertical pressure at depth z	Pa
p_h	Wall (horizontal) pressure	Pa
τ_w	Wall friction stress	Pa
$p_{h,\infty}$	Asymptotic wall pressure (deep silo)	Pa
$\rho g z$	Hydrostatic pressure for comparison	Pa

Method and standards

Janssen's equation.

Assumptions and limits

- Static filling; uniform material.

References

- Janssen (1895) equation
- as given in Perry's Chemical Engineers' Handbook
- 9th ed. (McGraw-Hill, 2019)
- sec. 21 (storage of solids)

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/mechanical/material-handling/janssen-silo-pressure

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.