Choking Velocity and Voidage (Yang) for a Fast Bed

Choking velocity and voidage marking the transition to fast fluidisation for a solids circulation rate, by solving Yang's correlation (Basu Eqs. 2.12–2.13).

Method: Basu; Circulating Fluidized Bed Boilers: Design; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Solids circulation rate	30.000	kg/(m²·s)
Particle terminal velocity	2.7220	m/s
Particle density	2,500.0	kg/m³
Gas density	0.31600	kg/m³
Equivalent column diameter	0.20300	m

Calculated results

Parameter	Value	Unit
Voidage at choking	99.760	%
Slip at choking	5.0015	m/s
Choking velocity	7.7050	m/s

Formula and method

$$\frac{U_{ch}}{\varepsilon_c} - U_t = \left[\frac{2gD(\varepsilon_c^{-4.7}-1)}{6.81\times10^5}\left(\frac{\rho_p}{\rho_g}\right)^{2.2}\right]^{0.5}, \quad G_s = \left(\frac{U_{ch}}{\varepsilon_c} - U_t\right)(1-\varepsilon_c)\rho_p$$

Variables

G_s	Solids circulation rate	kg/(m²·s)
U_t	Particle terminal velocity	m/s
ρ_p	Particle density	kg/m³
ρ_g	Gas density	kg/m³
D	Equivalent column diameter	m
ε_c	Voidage at choking	-
$U_{ch}/\varepsilon_c - U_t$	Slip at choking	m/s
U_{ch}	Choking velocity	m/s

Method and standards

Yang's correlation solved by bisection on ε_c between 0.5 and 1; a choking voidage below 0.5 is reported as no solution. Standard gravity 9.80665 m/s².

Assumptions and limits

- Group A data base from columns under 0.3 m; first approximation for boilers (a warning appears above 0.3 m, where U_{ch} is extrapolated with $\sqrt{D}$).

References

• Basu
• Circulating Fluidized Bed Boilers: Design
• Operation and Maintenance (Springer, 2015)
• ch. 2
• Eqs. (2.12) and (2.13) (Yang 1983) and the worked example of section 2.2

Report details

Report reference	FCC-QBFG-V0S7 (the same inputs always give the same reference)
Generated	17 November 2026, 19:46 UTC
Calculator	Choking Velocity and Voidage (Yang) for a Fast Bed
Method last reviewed	13 November 2026
Software release	FireCAD Calc, release of 17 November 2026
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/boilers-power-plant/fluidised-bed/choking-velocity-yang

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.