Minimum Bubbling Velocity and Maximum Stable Bubble

Minimum bubbling velocity of Group A powders (Abrahamsen and Geldart) and the maximum stable bubble size from the terminal velocity of 2.7 × mean size.

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

Input parameters

Unit system: SI

Parameter	Value	Unit
Mean particle diameter (surface-volume)	0.30000	mm
Particle density	2,500.0	kg/m³
Gas density	0.31600	kg/m³
Gas viscosity	0.045000	cP
Mass fraction finer than 45 µm	10.000	%
Minimum fluidisation velocity Measured, or from the minimum fluidisation velocity calculator for the same particle and gas. A note compares it with Wen and Yu.	0.030000	m/s
Terminal velocity of particles 2.7 × mean size	1.5000	m/s

Calculated results

Parameter	Value	Unit
Ratio U_mb/U_mf	0.59568	
Minimum bubbling velocity	0.030000	m/s
Maximum stable bubble size	0.45887	m

Notes for this case

- For Group B and D solids (most boiler beds) bubbles form at U_mf, so U_mb = U_mf: the ratio is shown, but U_mb is never taken below U_mf.

Formula and method

$$\frac{U_{mb}}{U_{mf}} = \frac{2300\mu^{0.523}\rho_g^{0.126}e^{0.716F}}{d_p^{0.8}g^{0.934}(\rho_p-\rho_g)^{0.934}}, \quad U_{mb} = \max\left(\frac{U_{mb}}{U_{mf}}, 1\right)U_{mf}, \quad D_{b,max} = \frac{2U_t^{*2}}{g}$$

Variables

d_p	Mean particle diameter (surface-volume)	m
ρ_p	Particle density	kg/m³
ρ_g	Gas density	kg/m³
μ	Gas viscosity	Pa·s
F	Mass fraction finer than 45 µm	-
U_{mf}	Minimum fluidisation velocity	m/s
U_t^*	Terminal velocity of particles 2.7 × mean size	m/s
U_{mb}/U_{mf}	Ratio U_mb/U_mf	-
U_{mb}	Minimum bubbling velocity	m/s
$D_{b,max}$	Maximum stable bubble size	m
g	standard gravity, 9.80665	m/s²

Method and standards

Basu's Eqs. (2.4) and (2.5). U_mf is your input; a note compares it with the Wen and Yu (1966) value for the same particle and gas.

Assumptions and limits

- SI units throughout.
- The Abrahamsen and Geldart ratio applies to Group A powders; for Group B and D solids the ratio comes out below 1 and U_mb is taken equal to U_mf. The Geldart group is not checked.
- U_mb is only as good as the U_mf entered.

References

- Basu
- Circulating Fluidized Bed Boilers: Design
- Operation and Maintenance (Springer, 2015)
- ch. 2
- Eqs. (2.4) (Abrahamsen and Geldart 1980) and (2.5) (Grace 1982)

Report details

Report reference	FCC-TFJG-X8GA (the same inputs always give the same reference)
Generated	17 November 2026, 19:49 UTC
Calculator	Minimum Bubbling Velocity and Maximum Stable Bubble
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/minimum-bubbling-velocity

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.