UASB Reactor Sizing: Volume, Area and Height

UASB anaerobic reactor volume from organic loading rate and retention time, area from upflow velocity, liquid height and methane from COD removed.

Method: Metcalf & Eddy; Wastewater Engineering: Treatment and Resource Recovery; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Wastewater flow	1,000.0	m³/d
Influent COD	6,000.0	mg/L
Design organic loading rate	10.000	kg/(m³·d)
Minimum hydraulic retention time	8.0000	h
Design upflow velocity	0.80000	m/h
COD removal	80.000	%

Calculated results

Parameter	Value	Unit
Volume by organic loading	600.00	m³
Volume by retention time	333.33	m³
Governing volume	600.00	m³
Area for the upflow velocity	52.083	m²
Reactor liquid height	11.520	m
Methane at 0.35 Nm³/kg COD removed	1,680.0	Nm³/d

Notes for this case

- The height is outside the usual 4–7 m: adjust the upflow velocity or split into more reactors.
- Lettinga's guidance: OLR 5–15 kg COD/(m³·d) at 30 °C for granular sludge, upflow 0.5–1 m/h, height 4.5–6 m; methane at 0.35 Nm³ per kg COD removed (theoretical, before sulfate reduction and growth).

Formula and method

$$V_{OLR} = \frac{Q\,COD}{OLR}, \quad V_{HRT} = Q\,HRT, \quad A = \frac{Q}{v_{up}}, \quad H = \frac{V}{A}$$

Variables

Q	Wastewater flow	m³/s
COD	Influent COD	kg/m³
OLR	Design organic loading rate	kg/(m³·s)
HRT_{min}	Minimum hydraulic retention time	s
v_{up}	Design upflow velocity	m/s
η	COD removal	-
V_{OLR}	Volume by organic loading	m³
V_{HRT}	Volume by retention time	m³
V	Governing volume	m³
A	Area for the upflow velocity	m²
H	Reactor liquid height	m
CH_4	Methane at 0.35 Nm³/kg COD removed	Nm³/s

Method and standards

Design definitions.

Assumptions and limits

- Granular sludge; mesophilic.

References

• Metcalf & Eddy
• Wastewater Engineering: Treatment and Resource Recovery
• 5th ed. (McGraw-Hill, 2014)
• ch. 10 (UASB design: organic loading, upflow velocity, height)
• Lettinga and Hulshoff Pol (1991)
• Water Sci. Technol. 24(8): 87

Report details

Report reference	FCC-1KS5-28CJ (the same inputs always give the same reference)
Generated	17 November 2026, 19:48 UTC
Calculator	UASB Reactor Sizing: Volume, Area and Height
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/environmental/wastewater/uasb-reactor-sizing

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.