Chemical Blending: Static Mixer or Pipe Length for a Target COV

Intensity of segregation for a chemical dose, the mixer length-to-diameter ratio needed for a target coefficient of variation, blending time and head loss.

Input parameters

Unit system: SI

Parameter	Value	Unit
Chemical dose	2.0000	mg/L
Strength of the chemical feed	120.00	g/L
Target coefficient of variation	5.0000	%
Mixing device (Godfrey)	Kenics static mixer (0.63, 2.0)	
Mixer or pipe diameter	600.00	mm
Water flow	24,000	L/min
Length of one mixer insert in diameters (0 for continuous length)	1.5000	

Calculated results

Parameter	Value	Unit
Volume fraction of the feed	1.6666e-05	
Required uniformity ratio	2.0412e-04	
Intensity of segregation	4.1667e-08	
Length-to-diameter ratio required	18.390	
Number of inserts	13.000	
Length-to-diameter ratio provided	19.500	
Mixer length	11.700	m
Velocity	1.4147	m/s
Blending time	8.2702	s
Head loss	3.9797	m

Notes for this case

• (σ_b/σ_u) after L/D = (σ_b/σ_u at L/D = 1)^(L/D) with Godfrey's values; head loss = N_VH × (L/D) velocity heads. To move a sample point in a channel with a measured COV, use the empty-pipe value with σ_b/σ_u = COV_new/COV_old and the depth as D.

Formula and method

$$X_A = \frac{C_{dose}}{C_A + C_{dose}}, \quad \frac{\sigma_b}{\sigma_u} = \frac{COV \cdot X_A}{\sqrt{X_A(1-X_A)}}, \quad I_s = \left(\frac{\sigma_b}{\sigma_u}\right)^2$$

$$\frac{L}{D} = \frac{\ln(\sigma_b/\sigma_u)}{\ln(\sigma_b/\sigma_u)_{AR=1}}, \quad H_L = N_{VH}\frac{L}{D}\frac{v^2}{2g}, \quad t_b = \frac{L}{v}$$

Variables

C_{dose}	Chemical dose	kg/m³

C_A	Strength of the chemical feed	kg/m³
COV	Target coefficient of variation	-
device	Mixing device (Godfrey)	-
D	Mixer or pipe diameter	m
Q	Water flow	m³/s
L_{ins}/D	Length of one mixer insert in diameters (0 for continuous length)	-
X_A	Volume fraction of the feed	-
(σ_b/σ_u)	Required uniformity ratio	-
I_s	Intensity of segregation	-
L/D	Length-to-diameter ratio required	-
n	Number of inserts	-
L/D_{used}	Length-to-diameter ratio provided	-
L	Mixer length	m
v	Velocity	m/s
t_b	Blending time	s
H_L	Head loss	m

Method and standards

Godfrey's exponential decay of segregation with mixer length.

Assumptions and limits

- Turbulent flow; Godfrey's device constants.

Report details

Report reference	FCC-KCPV-D8J3 (the same inputs always give the same reference)
Generated	23 November 2026, 17:34 UTC
Calculator	Chemical Blending: Static Mixer or Pipe Length for a Target COV
Method last reviewed	17 November 2026
Software release	FireCAD Calc, release of 22 November 2026
Release checks	3 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/drinking-water/static-mixer-blending

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Reopens the calculator with the inputs of this report.