Mixing Two Streams: Concentration and Temperature

Flow, concentration and temperature of the mixture of two liquid streams by mass and heat balance, and the flow of the second stream for a target concentration.

Method: Mass and energy balance

Input parameters

Unit system: SI

Parameter	Value	Unit
Flow of stream 1	1,000.0	kg/h
Concentration of stream 1 (mass fraction)	30.000	%
Temperature of stream 1	60.000	°C
Specific heat of stream 1	3.5000	kJ/(kg·K)
Flow of stream 2	2,000.0	kg/h
Concentration of stream 2 (mass fraction)	0	%
Temperature of stream 2	25.000	°C
Specific heat of stream 2	4.1800	kJ/(kg·K)
Target concentration for the stream 2 flow output (0 = none)	0	%

Calculated results

Parameter	Value	Unit
Mixture flow	3,000.0	kg/h
Mixture concentration	10.0000	%
Mixture temperature (no heat of mixing)	35.329	°C

Notes for this case

- Heat of mixing or dilution is not included: diluting strong acids and caustic releases heat and the mixture runs hotter.

Formula and method

$$\dot{m}_3 = \dot{m}_1 + \dot{m}_2, \quad x_3 = \frac{\dot{m}_1 x_1 + \dot{m}_2 x_2}{\dot{m}_3}$$

$$T_3 = \frac{\dot{m}_1 c_1 T_1 + \dot{m}_2 c_2 T_2}{\dot{m}_1 c_1 + \dot{m}_2 c_2}$$

$$\dot{m}_{2,t} = \dot{m}_1 \frac{x_1 - x_t}{x_t - x_2}$$

Variables

$\dot{m}_1$	flow of stream 1	kg/s
x_1	concentration of stream 1	-
T_1	temperature of stream 1	K
c_1	specific heat of stream 1	J/(kg·K)
$\dot{m}_2$	flow of stream 2	kg/s
x_2	concentration of stream 2	-
T_2	temperature of stream 2	K
c_2	specific heat of stream 2	J/(kg·K)

x_t	target concentration	-
$\dot{m}_3$	mixture flow	kg/s
x_3	mixture concentration	-
T_3	mixture temperature	K
$\dot{m}_{2,t}$	stream 2 flow for the target	kg/s

Method and standards

Steady mass balances on total flow and on the solute give the mixture concentration; an energy balance with constant specific heats gives the temperature.

Assumptions and limits

- Steady state; no reaction; no heat of mixing.
- A target concentration of 0 means "no target"; the stream 2 flow output appears only when a target is entered (the FAQ case uses 12 %).

References

- Mass and energy balance

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/chemical/mass-energy-balance/two-stream-mixing

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.