Fermentation Heat and Cooling Water

Heat released by fermentation from the ethanol production rate and the heat per kg of ethanol, and the cooling-water flow for a temperature rise.

Method: Energy balance; heat of reaction from standard enthalpies of formation (NIST Chemistry WebBook) as a default

Input parameters

Unit system: SI

Parameter	Value	Unit
Ethanol produced (absolute)	100.00	kL/d
Heat released per kg of ethanol Standard enthalpies of formation give about 0.75 MJ/kg for glucose to ethanol and CO_2; add yeast growth and agitation from plant data.	750.00	kJ/kg
Cooling-water temperature rise	5.0000	K
Ethanol density at 20 °C	789.24	kg/m³

Calculated results

Parameter	Value	Unit
Ethanol by mass	3,288.5	kg/h
Heat to remove	685.10	kW
Cooling water	117.82	t/h

Notes for this case

- Batch fermenters peak at two to three times the average: size coolers on the peak.

Formula and method

$$\dot{m}_e = \dot{V}_e \rho_e, \quad \dot{Q} = \dot{m}_e \Delta h, \quad \dot{m}_w = \frac{\dot{Q}}{c_w \Delta T_w}$$

Variables

$\dot{V}_e$	Ethanol produced (absolute)	m³/s
Δh	Heat released per kg of ethanol	J/kg
ΔT_w	Cooling-water temperature rise	K
ρ_e	Ethanol density at 20 °C	kg/m³
$\dot{m}_e$	Ethanol by mass	kg/s
$\dot{Q}$	Heat to remove	W
$\dot{m}_w$	Cooling water	kg/s

Method and standards

Energy balance.

Assumptions and limits

- Steady average.
- c_w, the specific heat of the cooling water, is taken as 4.1868 kJ/(kg·K).
- The default heat per kg is the reaction enthalpy alone; heat from yeast growth and agitation, and the cooling by CO_2 carrying off vapour, are left to you through that input.

References

- Energy balance; heat of reaction from standard enthalpies of formation (NIST Chemistry WebBook) as a default

Report details

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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/sugar-ethanol/ethanol/fermentation-heat-cooling

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.