Process Condenser Duty: Desuperheat, Condense, Sub-Cool

Duty of a process condenser that desuperheats, condenses and sub-cools a vapour, from flow, specific heats and latent heat, with the cooling water flow.

Method: Energy balance by zones: sensible; latent; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Vapour flow	3,000.0	kg/h
Vapour specific heat at constant pressure The constant-pressure specific heat c_p of the vapour (the symbol c_v here means vapour, not constant volume).	1.7000	kJ/(kg·K)
Superheat to remove	30.000	K
Latent heat at the condensing temperature	400.00	kJ/kg
Liquid specific heat	2.1000	kJ/(kg·K)
Sub-cooling	10.000	K
Cooling water specific heat	4.1800	kJ/(kg·K)
Cooling water temperature rise	8.0000	K

Calculated results

Parameter	Value	Unit
Desuperheating	42.500	kW
Condensing	333.33	kW
Sub-cooling	17.500	kW
Total duty	393.33	kW
Cooling water	42.344	t/h

Notes for this case

- Rate each zone separately: they have very different coefficients and temperature differences.

Formula and method

$$\dot{Q} = \dot{m}\left[c_v \Delta T_{sh} + \lambda + c_l \Delta T_{sc}\right], \quad \dot{m}_w = \frac{\dot{Q}}{c_w \Delta T_w}$$

Variables

$\dot{m}$	Vapour flow	kg/s
c_v	Vapour specific heat at constant pressure	J/(kg·K)
ΔT_{sh}	Superheat to remove	K
λ	Latent heat at the condensing temperature	J/kg
c_l	Liquid specific heat	J/(kg·K)
ΔT_{sc}	Sub-cooling	K
c_w	Cooling water specific heat	J/(kg·K)
ΔT_w	Cooling water temperature rise	K
$\dot{Q}_{sh}$	Desuperheating	W
$\dot{Q}_c$	Condensing	W
$\dot{Q}_{sc}$	Sub-cooling	W

$\dot{Q}$	Total duty	W
$\dot{m}_w$	Cooling water	kg/s

Method and standards

Energy balance.

Assumptions and limits

- Pure vapour.
- c_v is the vapour's constant-pressure specific heat (v for vapour).

References

- Energy balance by zones: sensible
- latent
- sensible

Report details

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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/chemical/process-heat-exchangers/process-condenser-duty

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.