Blowdown Heat Recovery (Flash Vessel and Cooler)

Heat recovered from continuous blowdown by a flash vessel and a drain cooler heating make-up water, with the make-up temperature rise and the share recovered.

Method: IAPWS R7-97(2012) IF97

Input parameters

Unit system: SI

Parameter	Value	Unit
Blowdown flow	500.00	kg/h
Boiler drum pressure (absolute)	18.000	bar
Flash vessel pressure (absolute) Usually the deaerator pressure, where the flash steam is used.	1.5000	bar
Drain temperature leaving the cooler	40.000	°C
Make-up water flow through the cooler	5,000.0	kg/h
Make-up water inlet temperature	25.000	°C
Make-up water pressure (absolute)	3.0000	bar

Calculated results

Parameter	Value	Unit
Heat recovered	101.21	kW
Share of blowdown heat recovered	93.480	%
Make-up water outlet temperature	30.819	°C
Flash steam fraction	18.757	%
Flash steam flow	93.784	kg/h
Residual blowdown to the cooler	406.22	kg/h
Heat in the flash steam (above make-up temperature)	67.420	kW
Heat transferred in the drain cooler	33.785	kW
Heat in the blowdown (above make-up temperature)	108.26	kW
Flash vessel temperature	111.35	°C
Boiler water enthalpy	884.61	kJ/kg
Liquid enthalpy at flash pressure	467.08	kJ/kg
Flash steam enthalpy	2,693.1	kJ/kg
Drain enthalpy	167.67	kJ/kg

Formula and method

$$x = \frac{h_{f,b} - h_{f,f}}{h_{g,f} - h_{f,f}} \qquad \dot{m}_{fs} = x\,B \qquad \dot{m}_{l} = (1 - x)\,B$$

$$\dot{Q}_{fs} = \dot{m}_{fs}\,(h_{g,f} - h_{mu}) \qquad \dot{Q}_{hx} = \dot{m}_{l}\,(h_{f,f} - h_{d}) \qquad \dot{Q}_{rec} = \dot{Q}_{fs} + \dot{Q}_{hx}$$

$$\dot{Q}_{bd} = B\,(h_{f,b} - h_{mu}) \qquad \eta_{rec} = \frac{\dot{Q}_{rec}}{\dot{Q}_{bd}} \qquad h_{mu,2} = h_{mu} + \frac{\dot{Q}_{hx}}{\dot{m}_{mu}}$$

Variables

B	blowdown flow	kg/s
p_b	boiler drum absolute pressure	Pa
p_f	flash vessel absolute pressure	Pa
T_d	drain temperature leaving the cooler	K
$\dot{m}_{mu}$	make-up water flow through the cooler	kg/s
T_{mu}	make-up water inlet temperature	K
p_{mu}	make-up water absolute pressure	Pa
x	flash steam fraction	–
$\dot{m}_{fs}$	flash steam flow	kg/s
$\dot{m}_l$	residual blowdown to the cooler	kg/s
$\dot{Q}_{fs}$	heat in the flash steam above make-up temperature	W
$\dot{Q}_{hx}$	heat transferred in the drain cooler	W
$\dot{Q}_{rec}$	heat recovered	W
$\dot{Q}_{bd}$	heat in the blowdown above make-up temperature	W
η_{rec}	share of blowdown heat recovered	–
$T_{mu,2}$	make-up water outlet temperature (from $h_{mu,2}$)	K
T_f	flash vessel saturation temperature	K
$h_{f,b}$	saturated liquid enthalpy at drum pressure	J/kg
$h_{f,f}$	saturated liquid enthalpy at flash pressure	J/kg
$h_{g,f}$	saturated vapour enthalpy at flash pressure	J/kg
h_d	drain enthalpy, at T_d and flash vessel pressure	J/kg
h_{mu}	make-up water inlet enthalpy	J/kg

Method and standards

Energy balances on the flash vessel and the drain cooler with enthalpies from FireCAD's IAPWS-IF97 implementation. The make-up outlet temperature is found from its pressure and enthalpy (IF97 backward equation, refined on the forward equation).

Assumptions and limits

- Saturated blowdown at drum pressure; equilibrium flash; no carry-over of liquid with the flash steam.
- No heat loss from the vessel or cooler; the cooler is counter-flow when the make-up leaves hotter than the drain.
- The make-up water must leave the cooler colder than the blowdown enters it (the flash vessel temperature); a temperature cross is rejected.
- The flash steam is used where it condenses at the flash pressure (usually the deaerator); its heat is counted down to the make-up water temperature, which assumes the deaerator or another user can take all of it. If the deaerator already has enough heating steam, part of the flash steam is vented and the recovery is lower.

References

• IAPWS R7-97(2012) IF97

Report details

Report reference	FCC-9VVQ-KGQZ (the same inputs always give the same reference)
Generated	17 November 2026, 19:36 UTC
Calculator	Blowdown Heat Recovery (Flash Vessel and Cooler)
Method last reviewed	10 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/boilers-power-plant/boilers/blowdown-heat-recovery

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.