Boiler Blowdown Rate (TDS Balance)

Continuous blowdown needed to hold boiler water dissolved solids at a limit, with feedwater flow, cycles of concentration and the heat lost in the blowdown.

Method: IAPWS R7-97(2012) IF97; boiler-water limits from the boiler maker or a water-chemistry guideline (user input)

Input parameters

Unit system: SI

Parameter	Value	Unit
Steam generated	10,000	kg/h
Dissolved solids in feedwater TDS (or the controlling species, e.g. silica) by mass in the feedwater entering the drum.	150.00	ppm
Maximum dissolved solids in boiler water The limit for the boiler pressure from the boiler maker or the water-chemistry guideline.	3,000.0	ppm
Drum pressure (absolute) Absolute. Choose a gauge unit to enter gauge readings.	10.500	bar
Feedwater temperature	105.00	°C

Calculated results

Parameter	Value	Unit
Blowdown flow	526.32	kg/h
Blowdown as a share of steam	5.2632	%
Blowdown as a share of feedwater	5.0000	%
Feedwater flow	10,526	kg/h
Cycles of concentration	20.000	
Heat leaving with the blowdown (above feedwater)	48.422	kW
Boiler water enthalpy (saturated liquid)	772.10	kJ/kg
Feedwater enthalpy	440.90	kJ/kg

Formula and method

$$F c_{fw} = B c_{bd} \qquad F = S + B \quad \Rightarrow \quad B = \frac{S c_{fw}}{c_{bd} - c_{fw}}$$

$$N = \frac{c_{bd}}{c_{fw}} \qquad B/F = \frac{c_{fw}}{c_{bd}} \qquad \dot{Q}_{bd} = B\,(h_f - h_{fw})$$

Variables

S	steam generated	kg/s
c_{fw}	dissolved solids in feedwater (mass fraction)	–
c_{bd}	maximum dissolved solids in boiler water	–
p	drum absolute pressure	Pa
T_{fw}	feedwater temperature	K
B	blowdown flow	kg/s
B/S	blowdown as a share of steam	–
B/F	blowdown as a share of feedwater	–

F	feedwater flow	kg/s
N	cycles of concentration	–
$\dot{Q}_{bd}$	heat leaving with the blowdown, above feedwater	W
h_f	saturated liquid enthalpy at drum pressure	J/kg
h_{fw}	feedwater enthalpy	J/kg

Method and standards

Steady-state mass balance on dissolved solids, the standard basis for continuous blowdown control. Enthalpies from FireCAD's IAPWS-IF97 implementation. Boiler-water limits are the user's input, taken from the boiler maker or a recognised water-chemistry guideline for the drum pressure.

Assumptions and limits

- Steady state; no solids carried over with the steam and none removed by intermittent (bottom) blowdown. At high drum pressure silica volatilises into the steam, so for silica the balance overstates the blowdown needed; use the boiler maker's silica curve.
- A warning appears when the blowdown exceeds 10 % of the steam.
- Concentrations by mass (ppm = mg/kg); for dilute water mg/L is the same number.
- Feedwater enthalpy at drum pressure.

References

• IAPWS R7-97(2012) IF97
• boiler-water limits from the boiler maker or a water-chemistry guideline (user input)

Report details

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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/boilers-power-plant/boilers/boiler-blowdown-rate

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Reopens the calculator with the inputs of this report.