Boiler Water Recovery after a Contamination Upset

Concentration in boiler water over time after an upset as blowdown dilutes it toward the normal level (first-order mixing), and the time to reach a target.

Method: Completely mixed tank with blowdown: c(t) = c_ss + (c₀ − c_ss) e^{−t ṁ_b/M}

Input parameters

Unit system: SI

Parameter	Value	Unit
Boiler water hold-up	40.000	t
Blowdown flow (raised during recovery)	2,000.0	kg/h
Concentration after the upset Any units: mg/L TDS, ppb Na, µS/cm.	800.00	
Normal steady level at this blowdown	150.00	
Target level	300.00	
Time for a check value	6.0000	h

Calculated results

Parameter	Value	Unit
Time constant M/ṁ_b	20.000	h
Concentration at the check time	631.53	
Time to reach the target	29.327	h

Formula and method

$$\tau = \frac{M}{\dot{m}_b}, \quad c(t) = c_{ss} + (c_0 - c_{ss})e^{-t/\tau}, \quad t_t = \tau \ln \frac{c_0 - c_{ss}}{c_t - c_{ss}}$$

Variables

M	Boiler water hold-up	kg
$\dot{m}_b$	Blowdown flow (raised during recovery)	kg/s
c_0	Concentration after the upset	-
c_{ss}	Normal steady level at this blowdown	-
c_t	Target level	-
t	Time for a check value	s
τ	Time constant M/ṁ_b	s
$c(t)$	Concentration at the check time	-
t_t	Time to reach the target	s

Method and standards

First-order mixing.

Assumptions and limits

- Fully mixed boiler water.
- The steady level must be the level that the raised blowdown rate gives (it is lower than at normal blowdown); it is your input and is not checked against the flow.
- When the target is not between the upset and steady levels, the time to it is not shown and a note says why.

References

- Completely mixed tank with blowdown: c(t) = c_ss + (c₀ − c_ss) e^{−t ṁ_b/M}

Report details

Report reference	FCC-QENY-NSXY (the same inputs always give the same reference)
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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/boilers-power-plant/water-treatment/boiler-water-upset-recovery

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.