Cooling Tower Cycles of Concentration Limited by Water Chemistry

Highest cycles of concentration before silica, hardness, chloride or TDS reach their limits, with the blowdown and make-up at those cycles.

Method: Cooling tower mass balances: N = C_circulating/C_make-up; B = E/(N − 1)

Input parameters

Unit system: SI

Parameter	Value	Unit
Heat rejected	35.000	MW
Silica in make-up (mg/L)	20.000	
Silica limit in circulating water (mg/L)	150.00	
Calcium hardness in make-up (mg/L as $CaCO_3$)	120.00	
Calcium hardness limit (mg/L as $CaCO_3$)	600.00	
Chloride in make-up (mg/L)	50.000	
Chloride limit (mg/L)	500.00	
TDS in make-up (mg/L)	400.00	
TDS limit (mg/L)	2,500.0	
Latent heat of evaporation	2,410.0	kJ/kg
Drift as a share of evaporation	0.20000	%

Calculated results

Parameter	Value	Unit
Allowed cycles of concentration	5.0000	
Limiting species (1 silica, 2 hardness, 3 chloride, 4 TDS)	2.0000	
Evaporation	52.282	t/h
Blowdown (including drift)	13.071	t/h
Make-up	65.353	t/h
Deliberate blowdown (total less drift)	12.966	t/h

Notes for this case

- Limited by calcium hardness. Limits depend on the treatment programme, pH and temperature; use the chemical supplier's values.

Formula and method

$$N = \min_i \frac{C_{i,max}}{C_{i,mu}}, \quad E = \frac{Q}{h_{fg}}, \quad B = \frac{E}{N-1}, \quad M = E + B, \quad B_d = B - d\,E$$

Variables

Q	Heat rejected	W
SiO_2	Silica in make-up (mg/L)	-
$SiO_{2,max}$	Silica limit in circulating water (mg/L)	-
CaH	Calcium hardness in make-up (mg/L as $CaCO_3$)	-
CaH_{max}	Calcium hardness limit (mg/L as $CaCO_3$)	-

Cl	Chloride in make-up (mg/L)	-
Cl_{max}	Chloride limit (mg/L)	-
TDS	TDS in make-up (mg/L)	-
TDS_{max}	TDS limit (mg/L)	-
h_{fg}	Latent heat of evaporation	J/kg
d	Drift as a share of evaporation	-
N	Allowed cycles of concentration	-
limit	Limiting species (1 silica, 2 hardness, 3 chloride, 4 TDS)	-
E	Evaporation	kg/s
B	Blowdown (including drift)	kg/s
M	Make-up	kg/s
B_d	deliberate blowdown, total solids-removing loss less drift	kg/s

Method and standards

Mass balance on dissolved solids.

Assumptions and limits

- Conservative species; all heat removed by evaporation, so evaporation, blowdown and make-up are higher (by about 18 % at the default) than in the cooling tower water balance calculator, which takes an evaporative share of 0.85.
- Drift here is a share of evaporation; the water balance calculator takes it as a share of circulating flow.
- The limiting species is shown as a number (1 silica, 2 hardness, 3 chloride, 4 TDS) and named in the note.

References

- Cooling tower mass balances: N = C_circulating/C_make-up
- B = E/(N − 1)

Report details

Report reference	FCC-WTD5-PJ9Y (the same inputs always give the same reference)
Generated	17 November 2026, 19:37 UTC
Calculator	Cooling Tower Cycles of Concentration Limited by Water Chemistry
Method last reviewed	13 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/condensers-cooling/cooling-tower-cycles-chemical-limits

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.