WATEROP · WATER TREATMENT OPERATOR

The Ultimate Water Treatment Formula Cheat Sheet

Tape this to the inside of the control room door.

1 Core Treatment Formulas

Detention time, the pounds formula and velocity carry the majority of the exam maths between them.

QUANTITY	FORMULA
Velocity	v = distance / time
Flow rate	Q = v x A
Detention time	DT = V / Q
Pounds	lbs = 8.34 lbs/gal x mg/L x MG
Chlorine demand	Demand = Dose - Residual
CT value	CT = Residual x Contact time

2 Chemical Feed & Solution Strength

What to feed when the product is not pure chemical, which on a real plant it never is.

QUANTITY	FORMULA
Chemical %	(dry chemical lbs x 100) / (dry chemical + water lbs)
Feed rate (lbs/day)	Q x dose x 8.34 × 100 × 100 / (solution % x purity %)
Feed rate (gal/day)	feed rate lbs/day / chemical solution lbs/gal
Scale setting %	(desired feed rate x 100) / maximum feed rate
Ion purity %	(mol. wt of ion x 100) / mol. wt of compound

3 Pumping & Horsepower

Water horsepower is what reaches the water. Everything else is loss.

QUANTITY	FORMULA
Water horsepower	WHP = (gpm x head ft) / 3,960
Brake horsepower	BHP = WHP / pump efficiency
Motor horsepower	MHP = BHP / motor efficiency
Wire-to-water efficiency	pump efficiency x motor efficiency
Power (kW)	motor hp x 746 / 1,000

4 Loading Rates

Clarifier and basin loading, straight off the sheet.

QUANTITY	FORMULA
Weir overflow rate	Q / length of weir
Surface loading (gpd/sq ft)	Q / surface area
Rise rate (ft/min)	surface loading (gpm/sq ft) / 7.48

5 Softening & Demineralisation

Hardness, lime demand and membrane performance.

QUANTITY	FORMULA
Non-carbonate hardness	Total hardness - Total alkalinity (zero when alkalinity is equal or greater)
Lime demand (mg/L)	((2.27 x CO2) + Total Alk + (4.12 x Mg)) x 0.56
Water treated (gal)	exchange capacity grains / hardness gpg
Bypass flow (gpd)	(total flow x finished hardness) / raw hardness
Salt required (lbs)	salt lbs per 1,000 grains x grains removed / 1,000
Mineral rejection %	(1 - product TDS / feed TDS) x 100
Recovery %	(product flow / feed flow) x 100
Soda ash	non-carbonate hardness x (106 / 100)

6 Filtration Formulas

Backwash and filter-run performance.

QUANTITY	FORMULA
Backwash pumping rate (gpm)	filter area x backwash rate
Backwash rise (in/min)	(backwash rate gpm/sq ft x 12) / 7.48
Backwash %	(backwash water gal x 100) / water filtered gal
UFRV (gal/sq ft)	volume filtered / filter surface area

7 Area & Volume Formulas

Every tank question starts with one of these.

SHAPE	FORMULA
Rectangle area	A = L x W
Triangle area	A = 1/2 x B x H
Circle area	A = 3.14 x R^2
Rectangular volume	V = L x W x H
Cylinder volume	V = 3.14 x R^2 x H
Cone volume	V = 1/3 × 3.14 x R^2 x H

8 Weight & Pressure Conversions

8.34 lbs/gal is the single most important number on the exam.

FROM	EQUALS
8.34 lbs	1 gallon of water
62.4 lbs	1 cu ft of water
2.31 ft of water	1 psi
1 ft of water	0.433 psi
454 gm	1 lb
1,000 mg	1 gm
1,000 gm	1 kg
746 watts	1 horsepower

9 Concentration & Time Conversions

Where most unit-conversion marks are won and lost.

FROM	EQUALS
1 grain/gal	17.1 mg/L
10,000 mg/L	1 %
1,000 mL	1 litre
60 sec	1 min
60 min	1 hour
1,440 min	1 day

> **8.34 is weight, 7.48 is volume: pounds use 8.34 lbs per gallon, gallons use 7.48 per cubic foot. CT uses the residual at the end of the contact time, never the dose applied.**

Doing this by hand on shift?

- Detention time, the pounds formula, CT and eight more, each worked step by step
- A daily chemical log that checks the pounds fed against the dose and prints the month
- 464 operator practice questions, free in your browser, and it works offline once opened

xernaitech.com/waterop

A study and plant aid. Your state's operator rules, your plant's procedures and the formula sheet your exam hands you govern; check them before you rely on any figure here.