WASTEWATER OPERATOR MATH CHEAT SHEET

Formulas, conversions, and the "why" behind them, built by a licensed operator

CRITICAL CONVERSIONS

The conversions behind almost every loading, dosage, and flow problem on the exam. Memorize them cold.

1 ft^3	= 7.48 gallons	**1 cfs**	= 448.8 gpm
1 gallon (water)	= 8.34 lbs	**1 cfs**	= 0.6463 MGD
1 mg/L	= 1 ppm	**1 MGD**	= 694.4 gpm
1% concentration	= 10,000 mg/L	**1 MGD**	= 1.547 cfs
1 lb	= 453.6 grams	**1 gpm**	= 1,440 gpd
1 acre-foot	= 325,851 gallons	**1 hp**	= 33,000 ft·lb/min
1 ft (water column)	= 0.433 psi	**1 hp**	= 0.746 kW
1 cubic yard	= 27 ft^3	**π (pi)**	= ≈ 3.14

THE 8.34 RULE (most important number on the exam)

1 gallon of water weighs 8.34 lbs

This is the heart of the pounds-per-day formula. BOD loading, solids loading, and chemical dosing all run through it. If you forget every other conversion, remember this one.

GEOMETRY & VOLUME

Rectangle area = L × W Circle area = $\pi \times r^2$ (or $0.785 \times D^2$)

r is the **radius**, so halve the diameter first. 0.785 is the same thing in one step, because 0.785 = $\pi/4$, and it takes the diameter directly. Your exam sheet may print either one.

Cylindrical tank volume = $\pi \times r^2 \times$ height (or $0.785 \times D^2 \times$ height)

Round tanks, clarifiers, digesters, contact basins. Answer is in ft^3 when D and h are in feet.

Rectangular tank volume = L × W × H

All dimensions in feet, so the answer is in ft^3. Multiply by 7.48 to get gallons.

FLOW, VELOCITY & DETENTION TIME

Flow (Q) = Velocity × Area Velocity = Flow ÷ Area

Detention time = Volume ÷ Flow rate

Keep units consistent. If volume is in gallons, flow must be in the same time unit you want the answer in (gpm for minutes, gpd for days). For hours from gpd: × 24.

WASTEWATER OPERATOR MATH CHEAT SHEET

Formulas, conversions, and the "why" behind them, built by a licensed operator

LOADING, THE POUNDS FORMULA

Pounds per day = Concentration (mg/L) × Flow (MGD) × 8.34

The workhorse of wastewater math. Use it for BOD load, TSS/solids load, and chemical feed. Units must be mg/L and MGD. If flow is in gpm, divide by 694.4 first.

BOD loading (lb/day) = BOD (mg/L) × Flow (MGD) × 8.34

The organic load applied to the plant or the aeration basin, the numerator of the F/M ratio below.

ACTIVATED SLUDGE PROCESS CONTROL

F/M ratio = lb BOD applied per day ÷ lb MLVSS under aeration

Food-to-microorganism ratio. Conventional activated sludge typically runs ~0.2–0.5. Uses MLVSS, not MLSS.

MCRT / SRT (days) = lb MLSS in the system ÷ lb solids leaving per day

Mean cell residence time. Solids leaving = WAS solids + effluent solids per day. The master control variable.

Sludge age (days) = lb MLSS under aeration ÷ lb TSS entering per day

Gould sludge age, a simpler approximation than MCRT that ignores solids in the clarifier.

SVI (mL/g) = (30-min settled volume in mL/L × 1,000) ÷ MLSS (mg/L)

Sludge Volume Index. Good settling is roughly 80–120. High SVI signals bulking; very low can mean pin floc.

Return sludge rate (%) ≈ SSV_{30} ÷ (1,000 − SSV_{30}) × 100

Settleometer estimate of RAS rate as a percent of influent flow, where SSV_{30} is the 30-minute settled volume (mL/L).

SECONDARY CLARIFIER

Surface overflow rate (gpd/ft^2) = Flow (gpd) ÷ Surface area (ft^2)

Secondary clarifiers typically run ~400–800 gpd/ft^2. Too high carries solids over the weir.

Solids loading rate (lb/day/ft^2) = Solids applied (lb/day) ÷ Surface area (ft^2)

Includes MLSS carried in on the influent + RAS. Secondary clarifiers usually run ~20–30 lb/day/ft^2.

Weir overflow rate (gpd/ft) = Flow (gpd) ÷ Weir length (ft)

High weir loading drags floc over the launders.

DISINFECTION

Chlorine dose = Chlorine demand + Chlorine residual **CT = C (mg/L) × T (min)**

Dose is what you feed; residual is what's left after demand is satisfied. CT must meet your permit's target.

SOLIDS & DIGESTION

Dry solids (lb/day) = Sludge flow (MGD) × 8.34 × % solids (as a decimal × 100)

Quick form: lb/day = gallons × 8.34 × (% solids ÷ 100). 1% solids means 10,000 mg/L.

Volatile solids loading (lb VS/day/ft^3) = lb VS added per day ÷ digester volume (ft^3)

Standard-rate digesters run low (~0.04–0.1); high-rate digesters run higher (~0.1–0.3).

PERCENT REMOVAL (EFFICIENCY)

Percent removal = ((In − Out) ÷ In) × 100

Used for BOD and TSS removal efficiency. In and Out must be the same units (usually mg/L).

WASTEWATER MATH TIPS

- Underline what you're solving for (lb/day? gpd/ft^2? days?). Wrong unit = wrong answer.
- Convert flow to MGD before using the 8.34 formula. Always. If you have gpm, divide by 694.4.
- MLVSS for F/M; MLSS for SVI and MCRT, don't mix the two up.
- Estimate first, then round only at the very end. Mid-problem rounding compounds fast.