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 = 0.785 × D^2 (or π × r^2)

0.785 equals π/4, so you can use the diameter directly instead of converting to a radius.

Cylindrical tank volume = 0.785 × D^2 × 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 → answer 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 → minutes, gpd → days). For hours from gpd: × 24.

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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.