

WATER OPERATOR EXAM FORMULA SHEET

9/1/15

1 minute (min) = 60 seconds (sec)
1 hour (hr) = 60 min
1 day = 24 hr = 1,440 min = 86,400 sec
1 inch (in) = 2.54 centimeters (cm)
1 ft = 12 in
1 ft = 0.433 pounds per square inch (psi)
1 psi = 2.31 ft
1 cubic foot (ft³) = 7.48 gallons (gal) = 62.38 pounds (lbs)
1 ft³ = 62.38 lbs
1 cubic yard = 27 ft³
1 gal = 8 pints
1 gal = 8.34 lbs
1 gal = 3.785 liters (L)
1 lb = 454 grams (g)
1 L = 1,000 milliliters (mL)
1 milligrams per liter (mg/L) = 1 part per million (ppm)
1 % = 10,000 ppm
1 cubic foot per second (cfs or ft³/sec) = 448 gallons per minute (gpm)
1 gpm = 1,440 gallons per day (gpd)
1 gpd = 2.63 mL/min
1 million gallons per day (MGD) = 694.4 gpm
1 grain per gallon (gpg) = 17.12 mg/L
1 ac-ft = 43,560 ft³
 π (pi) = 3.14
specific gravity (Sp Gr) of water = 1.00

ABBREVIATIONS

V = volume	A = area
v = velocity	D = diameter
Q = flow	r = radius
ft ² = square feet	C = circumference
W/W = weight/weight	W/V = weight/volume
DT = detention time	HP = horsepower

TEMPERATURE

Fahrenheit (°F) = (1.8 x °C) + 32

Celsius (°C) = (°F - 32) x 0.56

CIRCUMFERENCE, AREA & VOLUME

Circumference (C, ft) = π x D (ft)

Area of a rectangle (A, ft²) = length (ft) x width (ft)

Area of a circle (A, ft²) = 0.785 x D (ft)²

Area of a circle (A, ft²) = π x r (ft)²

Volume of a rectangle (V, ft³) = length (ft) x width (ft) x height (ft)

Volume of a rectangle (V, gal) = length (ft) x width (ft) x height (ft) x 7.48 (gal/ft³)

Volume of a cylinder (V, ft³) = 0.785 x D (ft)² x height (ft)

Volume of a cylinder (V, gal) = 0.785 x D (ft)² x height (ft) x 7.48 (gal/ft³)

DETENTION TIME

Detention time (DT, min) = volume (V, gal) ÷ flow (Q, gpm)

CHLORINATION

Chlorine dose (mg/L) = chlorine demand (mg/L) + chlorine residual (mg/L)

Total chlorine residual (mg/L) = free chlorine residual (mg/L) + combined chlorine residual (mg/L)

POUNDS, DOSAGE & FLOW

Dose (mg/L) = feed (lbs/day) ÷ flow (MGD) ÷ 8.34 (lbs/gal)

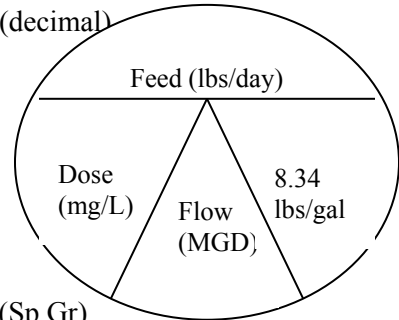
Feed (lbs/day) = dose (mg/L) x flow (MGD) x 8.34 (lbs/gal)

Feed (lbs/day) = dose (mg/L) x flow (MGD) x 8.34 (lbs/gal) ÷ % purity (decimal)

Flow (Q, gpm) = volume (V, gal) ÷ time (min)

Flow (Q, gpm) = velocity (v, fps) x area (A, ft²) x 7.48 (gal/ft³)

Flow (Q, cfs) = velocity (v, fps) x area (A, ft²)



COAGULATION AND FLOCCULATION

Polymer (lbs) = $\frac{\text{polymer solution (gal)} \times 8.34 \text{ (lbs/gal)} \times \text{polymer (\%)} \times \text{(Sp Gr)}}{100\%}$

FILTRATION

Filtration or backwash rate (gpm/ft²) = $\frac{\text{flow (Q, gpm)}}{\text{surface area (ft}^2\text{)}}$

Unit Filter Rate Volume (UFRV) (g/ft²) = filtration rate (gpm/ft²) x filter run (hr) x 60 (min/hr)

Backwash water (gal) = backwash flow (gpm) x backwash time (min)

Backwash (%) = $\frac{\text{backwash water (gal)} \times (100\%)}{\text{water filtered (gal)}}$

FLUORIDATION

Fluoride feed rate (lbs/day) = $\frac{\text{dose (mg/L)} \times \text{flow (MGD)} \times 8.34 \text{ (lbs/gal)}}{\text{Available Fluoride Ion (AFI)} \times \text{chemical purity (decimal)}}$

Fluoride feed rate (gpd) = $\frac{\text{dose (mg/L)} \times \text{flow (gpd)}}{18,000 \text{ mg/L}}$

Dose (mg/L) = $\frac{\text{fluoride feed rate (lbs/day)} \times \text{AFI} \times \text{chemical purity (decimal)}}{\text{flow (MGD)} \times 8.34 \text{ (lbs/gal)}}$

Dose (mg/L) = $\frac{\text{solution fed (gal)} \times 18,000 \text{ mg/L}}{\text{flow (gpd)}}$

Chemical	Formula	Available Fluoride Ion (AFI) Concentration	Chemical Purity
Sodium fluoride	NaF	0.453	98%
Sodium fluorosilicate	Na ₂ SiF ₆	0.607	98%
Fluorosilicic acid	H ₂ SiF ₆	0.792	23%

CHEMICAL DOSES

$$\text{Chemical feed setting (mL/min)} = \frac{\text{flow (MGD)} \times \text{alum dose (mg/L)} \times 3.785 \text{ (L/gal)} \times 1,000,000 \text{ (gal/MG)}}{\text{liquid alum (mg/mL)} \times 24 \text{ (hr/day)} \times 60 \text{ (min/hr)}}$$

$$\text{Dry chemical feeder (lbs/day)} = \frac{\text{chemical applied (lbs)}}{\text{length of application (day)}}$$

$$\text{Solution chemical feeder (lbs/day)} = \frac{\text{chem conc. (mg/L)} \times V \text{ pumped (mL)} \times 1,440 \text{ (min/day)}}{\text{time pumped (min)} \times 1,000 \text{ (mL/L)} \times 1,000 \text{ (mg/g)} \times 454 \text{ (g/lb)}}$$

$$\text{Average feed rate (lbs/day)} = \frac{\text{average feed rate (g/min)} \times 1,440 \text{ (min/day)}}{454 \text{ (g/lb)}}$$

DISINFECTION

$$\text{Hypochlorite flow (gpd)} = \frac{\text{container area (ft}^2\text{)} \times \text{drop (ft)} \times 7.48 \text{ (gal/ft}^3\text{)} \times 24 \text{ (hr/day)}}{\text{time (hr)}}$$

$$\text{Feed rate (gpd)} = \frac{\text{feed rate (lbs/day)} \times \text{feed dose (mg/L)}}{\text{feed solution (mg/L)}}$$

$$\text{Feed rate (lbs/day)} = \frac{\text{feeder setting (lbs/day)}}{24 \text{ (hr/day)}}$$

$$\text{CT (mg/L-min)} = \frac{V \text{ (gal)} \times (T_{10}) \times \text{free chlorine residual (mg/L)}}{\text{flow (gpm)}}$$

$$\text{Free chlorine residual (mg/L)} = \frac{\text{CT (mg/L-min)}}{T_{10} \text{ (min)}}$$

HORSEPOWER

$$Q \text{ (gpm)} = \frac{3,956 \text{ (HP)}}{\text{head (ft)} \times \text{Sp Gr}}$$

$$\text{HP} = \frac{\text{voltage} \times \text{current} \times \text{efficiency}}{746}$$

$$\text{Water (HP)} = \frac{\text{flow (gpm)} \times \text{lift (ft)} \times 8.34 \text{ (lbs/gal)}}{33,000 \text{ ft-lb/min-HP}}$$

$$\text{Power (kW-hr/day)} = \text{motor (HP)} \times 24 \text{ (hr/day)} \times 0.746 \text{ (kW/HP)}$$

MISC

$$\text{Percent (\%)} = \text{part} \div \text{whole} \times 100$$

$$\text{Part} = \text{whole} \times \text{percent} \div 100$$

$$\text{Average} = \frac{\text{sum of measurements}}{\text{number of measurements}}$$

$$\text{General ratio} \quad \frac{A1}{A2} = \frac{B1}{B2}$$

$$\text{Turnover or drawdown (ft)} = \text{pumping (ft)} - \text{static (ft)}$$

$$\text{Potassium permanganate dose (mg/L)} = (\text{Iron concentration mg/L}) + 2(\text{Manganese concentration mg/L})$$

$$\text{Alkalinity} = \frac{\text{mL of H}_2\text{SO}_4 \times 1,000}{\text{mL of sample}}$$

$$\text{Hardness} = \frac{\text{mL of EDTA} \times 1,000}{\text{mL of sample}}$$

$$\text{Reservoir Volume (V, gal)} = V \text{ (ac-ft)} \times 43,560 \text{ (ft}^3\text{/ac-ft)} \times 7.48 \text{ (gal/ft}^3\text{)}$$

$$\text{Feeder setting, \%} = \frac{\text{desired rate} \times 100\%}{\text{maximum rate}}$$

$$\text{Weight of substance (lbs/gal)} = \text{Sp Gr} \times 8.34 \text{ (lbs/gal)}$$

$$\text{Volume needed, } \mu\text{L} = \frac{\text{dose (mg/L)} \times \text{jar test beaker volume (L)}}{\text{Sp Gr} \times \text{Conc., \% (expressed as a decimal)}}$$

$$(\text{Volume, mL})_1 = \frac{(\text{concentration, mg/L})_2 (\text{volume, mL})_2}{(\text{concentration, mg/L})_1}$$