*CA-NV AWWA and CWEA*
*ADVANCED WATER TREATEMENT OPERATOR CERTIFICATION PROGRAM*
WITH APPRECIATION TO THE CA STATE OFFICE OF OPERATOR CERTIFICATION FOR USE OF THE AID

## Units and Conversion Factors

1 cubic foot of water weighs 62.3832 lb
1 gallon of water weighs 8.34 lb
1 liter of water weighs 1,000 gm
1 mg/L = 1 part per million (ppm)
1% = 10,000 ppm
$ft^2$ = square feet and $ft^3$ = cubic feet
1 mile = 5,280 feet (ft)
1 $yd^3$ = 27$ft^3$ and 1 yard = 3 feet
1 acre (a) = 43,560 square feet ($ft^2$)
1 acre foot = 325,829 gallons
1 cubic foot ($ft^3$) = 7.48 gallons (gal)
1 gal = 3.785 liters (L)
1 L = 1,000 milliliters (ml)
1 pound (lb) = 454 grams (gm)
1 lb = 7,000 grains (gr)
1 grain per gallon (gpg) = 17.1 mg/L
1 gm = 1,000 milligrams (mg)
1 day = 24 hr = 1,440 min = 86,400 sec
1,000,000 gal/day ÷ 86,400 sec/day ÷ 7.48 gal/cu ft = 1.55 cu ft/sec/MGD

## CHLORINATION

**Dosage, mg/l =** (Demand, mg/l) + (Residual, mg/l)

**(Gas) lbs =** Vol, MG x ppm or mg/L x 8.34 lbs/gal

**HTH Solid (lbs) =**
$$\frac{\text{(Vol, MG) x (ppm or mg/L) x 8.34 lbs/gal}}{\text{(\% Strength / 100)}}$$

**Liquid (gal) =**
$$\frac{\text{(Vol, MG) x (ppm or mg/L) x 8.34 lbs/gal}}{\text{(\% Strength /100) x Chemical Wt. (lbs/gal)}}$$

## PRESSURE

**PSI** = $\frac{\text{( Head, ft. )}}{\text{2.31ft./psi}}$ **PSI** = Head, ft. x 0. 433 PSI/ft.

**lbs Force** = (0.785) ( D, ft. )$^2$ x 144 in$^2$/ft$^2$ PSI.

## VOLUME

**Rectangular Basin = Volume, gal**
(Length, ft) x (Width, ft) x (Height, ft) x7.48 gal/cu.ft.

**Cylinder , Volume, gal =**
(0.785) x (Dia, ft)$^2$ x (Height, Depth, or Length in ft.) x 7.48 gal/ft$^3$

**Time, Hrs. =**
$$\frac{\text{Volume, gallons}}{\text{(Pumping Rate, GPM, x 60 Min/Hr )}}$$

**Supply, Hrs.=**
$$\frac{\text{Storage Volume, Gals}}{\text{( Flow In, GPM – Flow Out, GPM) x 60 min/hr.)}}$$

## SOLUTIONS

**Lbs/Gal** = $\frac{\text{(Solution \%)}}{100}$ x 8. 34 lbs/gal x Specific Gravity

**Lbs Chemical** =
Specific Gravity x 8.34 lbs/gallons x Solution(gal)

**Specific Gravity** = $\frac{\text{Chemical Wt. (lbs/gal)}}{\text{8. 34 (lbs/gal)}}$

**% of Chemical in Solution** = $\frac{\text{( Dry Chemical, Lbs) x 100}}{\text{(Dry Wt. Chemical, Lbs) + (Water, Lbs)}}$

**GPD** = $\frac{\text{(MGD) x (ppm or mg/L) x 8.34 lbs/gal}}{\text{( \% purity ) x Chemical Wt. (lbs/gal)}}$

**GPD** = $\frac{\text{( Feed, ml/min. x 1,440 min/day )}}{\text{( 1,000 ml/L x 3.785 L/Gal )}}$

**Two – Normal Equations:**
a) $C_1V_1 = C_2V_2$ $\quad \frac{Q_1}{V_1} = \frac{Q_2}{V_2}$

b) $C_1V_1 + C_2V_2 = C_3V_3$

C = Concentration, V = Volume, Q = Flow

## PUMPING

1 horsepower (Hp) = 746 watts = 0.746 kw = 3,960 gal/min/ft

**Water Hp** = $\frac{\text{( GPM ) x ( Total Head, ft )}}{\text{(3,960 gal/min/ft)}}$

**Brake Hp** = $\frac{\text{( GPM ) x ( Total Head, ft )}}{\text{( 3,960 ) x (Pump \% Efficiency )}}$

**Motor Hp** = $\frac{\text{( GPM ) x ( Total Head, ft )}}{\text{( 3,960 ) x Pump \% Eff. x Motor \% Eff.}}$

**"Wire to Water" Efficiency**
= ( Motor, % Efficiency x Pump % Efficiency )

**Cost, $** =
( Hp ) x ( 0.746 Kw/Hp ) x ( Operating Hrs. ) x cents/Kw-Hr

## Flow, velocity, area

Q = A x V Quantity = Area x Velocity

Flow ($ft^3$/sec) = Area($ft^2$) x Velocity (ft/sec)

$\frac{\text{MGD x 1.55 cu ft/sec/MGD}}{\text{.785 x pipe diameter ft x pipe diameter ft}} = \frac{\text{cu ft/sec}}{\text{sq ft}} = \text{ft/sec}$

## General

**($) Cost / day** = Lbs/day x ($) Cost/lb

**Removal, Percent** = $\frac{\text{(In - Out ) x 100}}{\text{In}}$

**Specific Capacity, GPM/ft.** = $\frac{\text{Well Yield, GPM}}{\text{Drawdown, ft.}}$

**Gals/Day =** (Population) x (Gals/Capita/Day)

**GPD =** $\frac{\text{(Meter Read 2 - Meter Read 1)}}{\text{(Number of Days)}}$

**Volume, Gals** = GPM x Time, minutes

## SCADA = 4 mA to 20 mA analog signal

$\frac{\text{( live signal mA - 4 mA off set ) x process unit and range}}{\text{( 16 mA span )}}$

4 mA = 0 20 mA full -range

## FILTRATION

**Filtration Rate (GPM/sq.ft)** = Filter Production (gallons per day) / (Filter area sq. ft.) x (1,440 min/day)

sq. ft. = square feet

**Membrane Filtration Flux Flux, gal/ft²/d (gfd)** = filtrate flow rate through membrane (gallons per day) / membrane surface area (sq. ft.)

**Loading Rate (GPM/ sq. ft.)** = ( Flow Rate, GPM ) / ( Filter Area, sq. ft. )

**Daily Filter Production (GPD)** = (Filter Area, sq. ft.) x (GPM/ sq. ft. x 1,440 min/day)

**Backwash Pumping Rate (GPM)** = (Filter Area, sq. ft.) x (Backwash Rate, GPM/ sq. ft.)

**Backwash Volume (Gallons)** = (Filter Area, sq. ft. ) x (Backwash Rate, gpm/ sq. ft. ) x (Time, min).

**Backwash Rate, GPM/ sq. ft.** = ( Backwash Volume, gallons) / ( Filter Area, sq. ft.) x (Time, min)

**Rate of Rise (inches per min.)** = (backwash rate gpm/sq.ft.) x 12 inches /ft / 7.48 gal/cu.ft.

**Unit Filter Run Volume, (UFRV)** = (gallons produced in a filter run) / (filter area sq. ft.)

## C• T CALCULATIONS

**C• t** = (Chlorine Residual, mg/L)x(Time, minutes)

**Time, minutes** = ( C• t ) / ( Chlorine Residual, mg/L )

**Chlorine Residual (mg/L)** = ( C• t ) / ( Time, minutes )

**Inactivation Ratio** = ( Actual System C• t ) / ( Table "E" C• t )

**C• t Calculated** = $T_{10}$ Value, minutes x Chlorine Residual, mg/L

**Log Removal** = 1.0 - (% Removal / 100) x Log key x ( -1 )

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**Empty Bed Contact Time Formula**

$$EBCT\ (\text{min}) = \frac{Bed\ Volume}{Flow\ Rate}$$

$$EBCT\ (\text{min}) = \frac{Bed\ Volume\ (ft^3) * \left(7.48\ \frac{gal}{ft^3}\right)}{Flow\ Rate\ (gpm)}$$

## SEDIMENTATION

**Surface Loading Rate, (GPD/ sq. ft.)** = ( Total Flow, GPD ) / ( Surface Area, sq.ft.)

**Detention Time** = Volume / flow

**Detention Time hours** = volume (cu ft) x 7.48 gal/cu ft x 24 hr/day / Gal/day

**Flow Rate** = Volume / Time

**Weir Overflow Rate, GPD/L.F.** = ( Flow, GPD) / ( Weir length, ft. )

## Chemical Dosage Calculations

Note (% purity) and (% commercial purity) used in decimal form

**Lbs/day gas feed dry** = MGD x (ppm or mg/L) x 8.34 lbs/gal

**Lbs/day (as solution)** = MGD x (ppm or mg/L) x 8.34 lbs/gal / % purity

**GPD** = MGD x (ppm or mg/L) x 8.34 lbs/gal / (% purity) x lbs/gal

**GPD** = MGD x (ppm or mg/L) x 8.34 lbs/gal / (commercial purity %) x (ion purity %) x (lbs/gal)

**ppm or mg/l** = lbs/day / MGD x 8.34 lbs/gal or gallons x % purity x lbs/gal / MG x 8.34 lbs/gal