STATE WATER RESOURCES CONTROL BOARD
OPERATOR CERTIFICATION EXAMINATION
Equivalents and Formulae Sheet (Revised Jan 2014)

EQUIVALENTS

Note: conc = concentration, L = liter, mg = milligram, ppm = parts per million, psi = lbs/in^2

$27\ ft^3 = 1\ yard^3$ 1 acre = $43{,}560\ ft^2$ $1\ ft^3$ of water = 7.48 gallons 1 gallon of water = 8.34 lbs 365 days = 1 year	1 gram = 1,000 mg 1 ton = 2,000 lbs 1 mg/L = 1 ppm 1 % = 10,000 mg/L $\pi = 3.14$	60 min = 1 hour 24 hours = 1 day 1 day = 1,440 min = 86,400 sec 1 ft of H_2O = 0.43 psi $1\ lbs/in^2 = 2.31$ ft of H_2O
1 HP = 0.746 kW = 550 ft·lb/sec = 33,000 ft-lb/min		
1 Million Gallons/Day (MGD) = 694 Gallons/Minute (gpm) = $1.547\ ft^3/sec = 3.069$ acre·ft/day		

FORMULAS

Acronym: AST = Activated Sludge Tank, BOD = Biochemical Oxygen Demand, ET = Evapotranspiration, F/M = Food to Micro-organism Ratio, HP = Horsepower, kW = Kilo-Watt, MCRT = Mean Cell Residence Time, MG = Million Gallons, MLSS = Mixed Liquor Suspended Solids, MLVSS = Mixed Liquor Volatile Suspended Solids, Q = flow, RBC = Rotating Biological Contactor, SS = Suspended Solids, TDH = Total Dynamic Head, TF = Trickling Filter, VS = Volatile Solids, WAS = Waste Activated Sludge

Area of Rectangle, $\{ft^2\}$ = length, {ft} x width, {ft}
Area of Circle, $\{ft^2\} = \frac{\pi}{4} \times [\text{diameter, } \{ft\}]^2 = 0.785 \text{ x } [\text{diameter, } \{ft\}]^2$
Volume of Rectangular or circular tank of uniform depth, $\{ft^3\}$ = area, $\{ft\}^2$ x depth, {ft}
Volume of Cone, $\{ft^3\} = \left[\frac{\text{base area, } \{ft^2\} \text{ x depth, } \{ft\}}{3}\right]$
Circumference, {ft} = π x diameter, {ft}
Removal efficiency, $\{\%\} = \left[\frac{(in-out)}{in}\right] x100$
Velocity, $\{ft/sec\} = \left[\frac{\text{distance,}\{ft\}}{\text{time,}\{sec\}}\right]$
Detention time, $\{hr\} = \left[\frac{\text{tank volume, } \{ft^3\} \text{ X } 7.5\ \{\frac{\text{gallons}}{ft^3}\} \text{ X } 24\{\frac{hrs}{day}\}}{Q,\ \{gallons/day\}}\right]$
Q, $\{ft^3/sec\}$ = velocity {ft/sec} x area $\{ft^2\}$
BOD or SS, {lbs/day} = 8.34 {lbs·L/MG·mg} x Q,{MGD} x conc,{mg/L}
Hydraulic loading rate, $\{gal/day \cdot ft^2\} = \left[\frac{Q \text{ total, } \{gallons/day\}}{\text{area, } \{ft^2\}}\right]$
Digester (VS) loading rate, $\{lbsVS/day \cdot ft^3\} = \left[\frac{\text{VS added, } \{lbs/day\}}{\text{volume, } \{ft^3\}}\right]$
Weir overflow rate, $\{gal/day \cdot ft\} = \left[\frac{Q,\ \{gallons/day\}}{\text{weir length, } \{ft\}}\right]$
Solids loading rate, $\{lbs/day \cdot ft^2\} = \left[\frac{\text{solids applied, } \{lbs/day\}}{\text{surface area, } \{ft^2\}}\right]$
F/M, $\{\text{lbs BOD/day·lbs MLVSS}\} = \frac{\text{BOD applied } \{lbs/day\}}{\text{MLVSS, } \{lbs\}}$

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Q return, $\{MGD\} = \frac{Q\{MGD\} \times MLSS\left\{\frac{mg}{L}\right\}}{(RAS - MLSS)\left\{\frac{mg}{L}\right\}}$
Organic loading, $\left\{\frac{\{lbs\ BOD/day\}}{\{see\ Units\}}\right\} = \left[\frac{Q\ \{MGD\} \times BOD\ conc,\left\{\frac{mg}{l}\right\} \times 8.34\ \{lbs*L/MG*mg\}}{Volume,\{1{,}000\ ft^3\ (TF),\ \ 1{,}000\ ft^2\ (RBC)\ or\ acres\ (ponds)\}}\right]$
MCRT, $\{days\} = \frac{MLSS_{aeration\ tank(s)}\{lbs\} + MLSS_{clarifier}\{lbs\}}{SS_{effluent}\left\{\frac{lbs}{day}\right\} + SS_{WAS}\{lbs/day\}}$
SS_{WAS}, $\{lbs/day\} = \frac{MLSS_{aeration\ tank(s)}\{lbs\} + MLSS_{clarifier}\{lbs\}}{MCRT\ \{days\}} - SS_{effluent}\{lbs/day\}$
Sludge Volume Index $\{ml/gram\} = \left[\frac{settled\ sludge\ volume,\left\{\frac{ml}{L}\right\} X\ 1{,}000\ \left\{\frac{mg}{gram}\right\}}{MLSS,\ \left\{\frac{mg}{L}\right\}}\right]$
Pump efficiency, $\{\%\} = \left[\frac{Water\ HP}{Brake\ HP}\right] \times 100$
Brake HP $\{HP\} = \left[\frac{Motor\ Power,\{kW\} \times motor\ efficiency}{0.746\ \{kW/HP\}}\right]$
Water HP $\{HP\} = \frac{Q,\{gpm\} \times TDH,\{ft\}}{3{,}960\ \{gpm \cdot ft/HP\}}$
% VS reduction $\{\%\} = \left[\frac{VS\ in - VS\ out}{VSin - (VSin \times VSout)}\right] \times 100$
Chlorine demand, {mg/L} = dosage, {mg/L} – residual, {mg/L}
BOD, $\{mg/L\} = \frac{Initial\ DO\ \{mg/L\} - Final\ DO\ \{mg/L\}}{[Sample\ Size\ \{ml\}/Bottle\ Size\ \{ml\}]}$
Net Reservoir Flow, $\{inch/day\} = Q_{in} - Q_{out} = Q_{pond}\{inch/day\} + Q_{rain}\{inch/day\} - Q_{ET}\{inch/day\}$
Hydraulic Loading, Pond, $\{inch/day\} = \frac{Depth\ of\ pond,\{inches\}}{Detention\ time,\{days\}}$