EOCP Formulae, Conversions, and Abbreviations

Conversion Factors and Constants	Dimensions	Abbreviations
π (Pi) = 3.14 1 BTU = 1.055 kilojoule 1ft-lb = 1.356 joule 1 ha = 10,000 m^2 1 horsepower (electric) = 0.746 kw 1 joule = 0.738 foot pounds (ft-lb) 1 kilojoule = 0.9478 BTU 1 inch of water = 0.249 kpa 1 kpa = 4.015 inches of water 1 kpa = 0.145 PSI (or psi) 1psi = 6.895 kpa 1 kpa = 0.102 metre of water 1 meter of water = 9.807 kpa 1 litre of water = 1 kg 1 kw = 1.34 horsepower (electric) 1m^3 (cu m) = 1,000 litres (L)	A Area B Base (of a triangle) C Circumference (of a circle) D Depth H Height L Length P Perimeter W Width d Diameter r radius	BHP or bhP Brake horsepower BOD Biochemical oxygen demand BOD_E Biochemical oxygen demand of the effluent BOD_I Biochemical oxygen demand of the influent Conc Concentration (mg/L, %, or as decimal) Den Density (g/cm^3) DR (Dose) Dosing Concentration (expressed as mg/L) H Head (usually expressed in feet or metres) MLSS Mixed Liquor Suspended Solids $MLSS_F$ Mixed Liquor Suspended Solids (Final) $MLSS_I$ Mixed Liquor Suspended Solids (Initial) MLSS% MLSS expressed as percentage MLVSS Mixed Liquor Volatile Suspended Solids MHP or mhp Motor horsepower % Chem Percentage of active ingredient Q Flow rate Q_B Filter backwash flow Q_{Int} Internal flow within plant Q_W Sludge wastage flow RASS (RAS) Return Activated Suspended Solids SG Specific Gravity SSV or SV-30 Settled Sludge Volume (after 30 min) TSS Total Suspended Solids TSS_E Total Suspended Solids in effluent Vel Velocity Vol Volume V_{AT} Volume of Aeration Tank V_C Volume of Clarifier Vol_W Volume of Water WHP or whp Water horsepower WASS (WAS) Waste Activated Suspended Solids

Calcultion	Description	Formula
Length		
Circumference of a circle	π × diameter	$C = \pi \times d$ **or** $2 \times \pi \times r$
Perimeter of a rectangle or a square	2 × (length + width)	$P = 2 \times (L + W)$

Areas		
Area of a circle	π × radius × radius	$A = \pi \times r^2$ **or** $\pi \times d^2/4$
Area of a rectangle	length(L) × width(W)	$A = L \times W$
Area of a triangle	½ × base(B) × height(H)	$A = 0.5 \times B \times H$
Surface area of a sphere (an air bubble)		$A = 4 \times \pi \times r^2$ **or** $\pi \times d^2$

Volume		
Volume of a rectangular tank	length × width × height (or depth)	$Vol = L \times W \times H$
Volume of a cylindrical tank	area × height (or depth)	$Vol = \pi \times r^2 \times H$
Volume of a pipe	cross-sectional area × length	$Vol = \pi \times r^2 \times L$
Volume of a cone	1/3 × area × height	$Vol = 1/3 \times \pi \times r^2 \times H$
Volume of a lagoon	average of top and bottom areas × height	$Vol = ((L_T + L_B)/2) \times ((W_T + W_B)/2) \times D$
Volume of a sphere (an air bubble)		$Vol = 4/3 \times (\pi \times r^3)$ **or** $(\pi \times d^3)/6$

Rate of Flow (Q)	volume per unit of time	(usually expressed as L/sec or m^3/hr)
Flow in an open channel	width x depth x velocity	$Q = W \times D \times Vel$
Velocity in an open channel	flow rate per unit of area	$Vel = Q/(W \times D)$
Flow in a pipe	cross-sectional area x velocity	$Q = \pi \times r^2 \times Vel$
Velocity in a pipe	flow rate per unit of area	$Vel = Q/(\pi \times r^2)$

Detention Time (DT)	volume divided by flow	
Detention time in a pipe	area x length/flow	$(\pi \times r^2 \times L)/Q$
Detention time in a tank	area x depth/flow	$(L \times W \times H)/Q$ **or** $(\pi \times r^2 \times H)/Q$

Calculation	Description	Formula
Hydraulic Loading Rate	flow divided by volume or area	
Rotating Biological Contractor (RBC)	flow per unit of media surface area	$Q/(2 \times \pi \times r^2 \times N)$(N = No. of discs)
Aeration tank (AT)	flow per unit volume	$Q/(L \times W \times H)$ **or** $Q/(\pi \times r^2 \times D)$
Filter flow rate	forward flow per unit of surface area	$Q/(L \times W)$ **or** $Q/(\pi \times r^2)$ [units $(m^3/hr)/m^2$]*
Filter backwash flow	backwash flow per unit of surface area	$Q_B/(L \times W)$ **or** $Q/(\pi \times r^{2)}$ [units $(m^3/hr)/m^2$]* *also expressed as m/hr or L/sec/m^2

Hydraulic Overflow Rate		
Weir overflow rate	flow per unit of weir length	(Q/L)
Surface overflow rate	flow per unit of clarifier area	$Q/(L \times W)$ **or** $Q/(\pi \times r^2)$
Chemical Feed Rate [L/Day]	Rate of additional based on % active and density	(DR × Q / (Conc [decimal] × Den × 1000)

Chlorine or Chemical Feed Rate		$C_1 V_1 = C_2 V_2$
Chlorine Dosage	Amount of Cl_2 to be added/vol of water to be treated	(Conc [decimal] × Vol(if liquid)1,000 / Vol_w [m^3] **or** (Wt [kg] × 1000) / Vol_w [m^3]
Chemical Feed Rate [L/Day]	rate of additional based on % active and density	(DR × Q / (Conc [decimal] × Den × 1000)

Organic Loading	amount or weight added/volume or area to which it is added usually (flow x concentration)/volume or area	
Raw water or sewage TSS to Clarifier	flow x TSS per unit area of clarifier	$(Q \times TSS)/(L \times W)$ **or** $(Q \times TSS)/(\pi \times r^2)$
BOD to Aeration Tank (AT)	influent BOD per unit of AT volume	$(Q \times BOD)/ (L \times W \times H)$
BOD to RBC	influent BOD per unit area of media surface	$(Q \times BOD)/ (2 \times \pi \times r^2 \times N)$(N = No. of discs)
TSS to Filter	influent TSS per unit area of filter surface	$(Q \times TSS)/(L \times W)$ **or** $(Q \times TSS)/(\pi \times r^2)$
MLSS to Clarifier	internal flow x MLSS per unit area of clarifier	$(Q_{Int} \times TSS)/(L \times W)$ **or** $(Q_{Int} \times TSS)/(\pi \times r^2)$

Calculation	Description	Formula
Wastewater Sludge Calculations		
Sludge Volume Index (SVI)	volume occupied by 1g of dry sludge	SSV (or SV-30)x1000/MLSS
Sludge Density Index (SDI)	inverse of SVI	100/SVI
F/M (food to microorganism ratio)	BOD added to treatment system divided by amount of microorganisms in the systems	$(Q \times BOD)/(MLVSS \times (V_{AT} + V_C))$
Sludge Recycle rate	fraction of influent flow in sludge recycle	$Q_R = (Q \times MLSS)/(RASS - MLSS)$ **or** $Q_R = Q/((100/((MLSS\% \times SVI) - 1)$
Sludge Wasting rate	sludge to digestor to maintain desired MLSS	$Q_W = ((MLSS_I - MLSS_F) \times V_{AT})RASS$
Mean Cell Retention Time	aka Sludge Age	$MCRT = \dfrac{MLSS \times (V_{AT} + V_C)}{(Q \times TSS_E) + (Q_w \times WASS)}$

Calculation	Description	Formula
Horsepower		
Brake Horsepower, Imperial	hp required to drive a pump	$BHP[hp] = \dfrac{Q[USgpm \times H[ft] \times SG}{3960 \times \text{Pump Efficiency}}$
Brake Horsepower, Metric	hp required to drive a pump	$BHP[kw] = \dfrac{9.81Q\left[\frac{m^3}{sec}\right] \times H[m] \times SG}{\text{Pump Efficiency}}$

Calculation	Description	Formula
Efficiency		
Efficiency of treatment	input minus output as a percentage of input	$100 \times (BOD_I - BOD_E)/BOD_I$
Motor efficiency	motor output energy as a % of input electrical energy	(100 × bhp)/mhp
Pump efficiency	water output energy as a % of input motor energy	(100 × whp)/bhp
Overall efficiency	water output energy as a % of input electrical energy	(100 × whp)/mhp