Sidney's Big Book of Water and Wastewater Math

Indigo Water Group

Unit Conversions to Know by Heart

1 inch = 2.54 centimeters
1 meter = 3.28 feet
1 mile = 5280 feet

1 acre = 43,560 ft^2
1 m^2 = 10.76 ft^2

1 gallon = 3.785 liters
1 ft^3 = 7.48 gallons
1 m^3 = 35.31 ft^3

1 ft water = 0.433 psi

1 gallon = 8.34 lbs when specific gravity is 1.0
1 kg = 2.2 lbs

1% = 10,000 mg/L
1 mg/L = 1 ppm
1 μg/L = 1 ppb

1 day = 1440 minutes
1 hp = 0.746 kW

1 gram = 15.43 grains
1 grain per gallon = 17.1 mg/L

Water Formulas

pounds per day = (concentration in mg/L)*(flow rate in mgd)*(8.34)

chlorine dose = demand + residual

$$\text{velocity} = \frac{\text{flow}}{\text{area}} \qquad V = \frac{Q}{A}$$

$$\text{flow rate} = \frac{\text{volume}}{\text{time}} \qquad Q = \frac{V}{t}$$

$$\text{overflow rate} = \frac{\text{flow rate}}{\text{area}}$$

$$\text{weir loading rate} = \frac{\text{flow rate}}{\text{feet of weir}}$$

(concentration 1)*(volume 1) = (concentration 2)*(volume 2) $C_1V_1 = C_2V_2$

(conc. 1)*(volume 1) + (conc. 2)*(volume 2) = (conc. 3)*(volume 3)

$$C_1V_1 + C_2V_2 = C_3V_3$$

$$\text{horsepower} = \frac{(\text{flow in gpm})*(\text{lift in feet})}{3960}$$

Miscellaneous

MISC.

1. How long must a grit chamber be to permit particle settling given the following: Flow velocity = 0.96 ft/sec, Water depth = 16", Particle settling rate = .075 ft/sec
 a) 17 ft.
 b) 22 ft.
 c) 18 ft.
 d) 19 ft.

2. Calculate the percent volatile solids. 100mL of sample, crucible weight = 19.985 g, crucible + dry solids = 20.050 g, crucible plus ash = 20.006 g
 a) 33%
 b) 50%
 c) 67%
 d) 74%

3. If the sewer rate is $5.50 for the first 500 cu ft and all wastewater generated over the minimum is billed at a rate of $0.25 per 100 cu ft, how much would a customer generating 1200 cu ft be billed?
 a) $5.25
 b) $6.25
 c) $6.75
 d) $7.25

4. Calculate the percent reduction in flows achieved by an industrial water conservation program if wastewater flows are reduced from 350 gpm to 220 gpm
 a) 31%
 b) 37%
 c) 44%
 d) 59%
 e) 63%

5. Determine the percent of dissolved oxygen saturation in the receiving waters of an effluent discharge when the actual dissolved oxygen concentration is 8.2 mg/l and the saturation concentration of dissolved oxygen is 9.4 mg/l.
 a) 82%
 b) 87%
 c) 94%
 d) 100%

?Operations Forum April 2001

6. A plant runs blowers for 24 hours at 100,000 ft3/min to aerate 100 mgd of flow containing 250 mg/l of BOD. Ninety percent of BOD was removed. How many cubic feet of air was required for each pound of BOD removed?
 a) 770
 b) 1200
 c) 595
 d) 1000

7. The secondary influent flow to a treatment plant consists of 100 mgd of primary effluent with 110 mg/l total suspended solids. What percentage of the suspended solids loading does a 1-mgd sidestream containing 1200 mg/l TSS represent?
 a) 8.5%
 b) 9.8%
 c) 10.5%

?Operations Forum May 1998

8. One hundred mgd of secondary influent to a treatment plant contains 110 mg/l of suspended solids. A side-stream from a 1-mgd dewatering plant with 1200 mg/l suspended solids is returned. What is the total suspended solids load on the secondary treatment plant, in pounds?
 a) 91,740 lb
 b) 101,750 lb
 c) 10,008 lb

?Operations Forum March 1998

9. A wet well level transmitter says 56% on a scale of 0% to 100%. The full depth of the wet well is 35 ft. How many feet of water are in the wet well?
 a) 15.2 ft
 b) 17.8 ft
 c) 19.6 ft
 d) 20.3 ft

?Operations Forum November 1997

10. Given the following, calculate the BOD5 of an unseeded sample: Initial DO = 9.0 mg/L, Final DO = 5.0 mg/L, Bottle volume = 300 mL, Sample volume = 6.0 mL
 a) 150
 b) 175
 c) 200
 d) 225

JOB Misc JOB NO. 121

SHEET NO. ____ OF ____

CALCULATED BY ____ DATE ____

CHECKED BY ____ DATE ____

SUBJECT ____

1. depth = 16 inches = 1.33 ft

$$1.33 \text{ feet depth} \left| \frac{1 \text{ second}}{0.075 \text{ ft depth}} \right| \frac{0.96 \text{ ft length}}{1 \text{ second}} \right| = 17 \text{ feet length}$$

2.
 20.050 grams crucible + solids
 − 19.985 grams crucible

 0.065 grams solids

 20.006 grams crucible + inert solids
 − 19.985 grams crucible

 0.021 grams inert solids

TS = TVS + Inert Solids
0.065 g = TVS + 0.021 g
0.044 g = TVS

$$\text{Percent} = \left[\frac{\text{PART}}{\text{WHOLE}}\right] * 100$$

$$\text{PERCENT} = \left[\frac{0.044 \text{ g}}{0.065 \text{ g}}\right] * 100$$

PERCENT = 67.7%

3.
 1200 cuft
 − 500 cuft
 ---
 700 cuft

$5.50 + (7)($0.25) = billed
$5.50 + $1.75 = billed
$7.25 = billed

4. $$\text{PERCENT} = \left[\frac{\text{PART}}{\text{WHOLE}}\right] * 100$$

JOB MISC JOB NO. 122
SHEET NO. ________ OF ________
CALCULATED BY ________ DATE ________
CHECKED BY ________ DATE ________
SUBJECT ________

4. (cont.)

$$\begin{array}{r} 350 \text{ gpm} \\ -220 \text{ gpm} \\ \hline 130 \text{ gpm SAVED} \end{array}$$

$$\text{PERCENT} = \left[\frac{130 \text{ gpm}}{350 \text{ gpm}}\right] * 100$$

PERCENT = 37%

5. $$\text{PERCENT} = \left[\frac{8.2 \text{ mg/L}}{9.4 \text{ mg/L}}\right] * 100$$

PERCENT = 87.2%

6. ppd = (mg/L)(Q, mgd)(8.34)
ppd = (250 mg/L)(100 mgd)(8.34)
ppd = 208,500

IF 90% REMOVED, THEN (208,500)(0.90) = 187,650 ppd BOD REMOVED

$$\frac{100,000 \text{ ft}^3}{\text{min}} \Big| \frac{1440 \text{ min}}{1 \text{ day}} = 144,000,000 \frac{\text{cf}}{\text{d}}$$

$$\frac{\text{air}}{\text{lb BOD}} = \frac{144,000,000 \text{ cf/d}}{187,650 \text{ ppd}}$$

$$\frac{\text{air}}{\text{lb BOD}} = 767 \text{ cf/lb}$$

JOB MISC JOB NO. 123

SHEET NO. ____ OF ____

CALCULATED BY ____ DATE ____

CHECKED BY ____ DATE ____

SUBJECT ____

7. ppd side = (mg/L)(Q, mgd)(8.34)
ppd side = (1200 mg/L)(1 mgd)(8.34)
ppd side = 10008

ppd main = (mg/L)(Q, mgd)(8.34)
ppd main = (110 mg/L)(100 mgd)(8.34)
ppd main = 91740

$$\text{PERCENT} = \left[\frac{\text{PART}}{\text{WHOLE}}\right] * 100$$

$$= \left[\frac{10008 \text{ ppd}}{10008 \text{ ppd} + 91740 \text{ ppd}}\right] * 100$$

$$= \left[\frac{10008}{101748}\right] * 100$$

$$= 9.8\%$$

8. TOTAL LOAD = 101,748 lbs * see #7

9. (35 ft)(0.56) = 19.6 ft full

10.
$$BOD = \frac{DO_{START} - DO_{END}}{(\text{SAMPLE VOLUME}/300 \text{ mL})}$$

$$BOD = \frac{9.0 - 5.0}{(6 \text{ mL}/300 \text{ mL})}$$

$$BOD = \frac{4 \text{ mg/L}}{0.02}$$

$$BOD = 200 \text{ mg/L}$$

104. A wet well level transmitter says 56% on a scale of 0% to 100%. The full depth of the wet well is 35 ft. How many feet of water are in the wet well?
a) 15.2 ft
b) 17.8 ft
c) 19.6 ft
d) 20.3 ft
Operations Forum November 1997

105. Of the $900 allotted for maintenance in the monthly budget, 15 percent was spent on pump repair. How much money was spent?
a) $135
b) $765
c) $450
d) $13.5

106. A water treatment plant treats 36,520,000 gallons during the month of July. The total water measured in various storage tanks is 28,710,000 gallons. What percentage of treated water is unaccounted for?
a) 78.6%
b) 21.4%
c) 27.2%
d) 63.0%

107. Scientific notation is a method by which any number can be expressed as a term multiplied by a power of ten, such as 8.75 x 10^-2. Express this number in decimal form.
a) 0.0875
b) 0.875
c) 875.00
d) 87.5

108. Express 7,960 in scientific notation.
a) 7.96 * 10^3
b) 7.96 * 10^-3
c) 7.96*10^5
None of these is correct.

109. Last month your Water System pumped 7,106,300 gallons of water into the distribution system. Your system was able to account for 5,264,800 gallons. What was your unaccounted for % of water for this month?

a) 47.1 %
b) 88 %
c) 2.95 %
d) 25.9 %
e) 74.1 %

110. You have replaced 3/4 of the water meters in your system. You have a total of 540. How many will you need to complete the task of replacing all the meters?

a) 195
b) 405
c) 135
d) 275
e) 54

111. Your plant's maximum capacity is 1.3 MGD. If you produced 67% of this capacity in one day how many gallons would this be ?

a) 1,100,201 gallons
b) 19,402 gallons
c) 194,020 gallons
d) 87,100 gallons
e) 871,000 gallons

104. $(35\ ft)(0.56) = level$

$19.6\ ft = level$

105. $(\$900)(0.15) = spent$

$\$135 = spent$

106.

$$\%\ MISSING = \left[\frac{36{,}520{,}000 - 28{,}710{,}000}{36{,}520{,}000}\right] * 100$$

$$\%\ MISSING = \left[\frac{7810000}{36520000}\right] * 100$$

$$\%\ MISSING = 21.4$$

107. $8.75 \times 10^{-2} = 0.0875$

-2 means move the decimal point 2 places to the left

108. $7{,}960 = 7.96 \times 10^{3}$

109. $$\%\ MISSING = \left[\frac{7{,}106{,}300 - 5{,}264{,}800}{7{,}106{,}300}\right] * 100$$

$$\%\ MISSING = 25.9$$

110. (540 meters)(3/4) = 405 replaced already

540 meters total
− 405 replaced
135 still need replacing

111. 1.3 MGD = 1300000 gallons/day

(1300000 gallons)(0.67) = production
871000 gallons = production