1. Convert 1000 ft^3 to cu. yards

   Solution:

   $1000\cancel{ft^3} * \frac{cu.yards}{27\cancel{ft^3}} = \boxed{37 cu.yards}$

2. Convert 10 gallons/min to ft^3/hr

   Solution:

   $\frac{10\cancel{gallons}}{\cancel{min}} * \frac{ft^3}{7.48\cancel{gallons}} * \frac{60\cancel{min}}{hr} = \boxed{\frac{80.2 ft^3}{hr}}$

   Solution:

3. Convert 100,000 ft^3 to acre-ft.

   Solution:

   $100,000 ft^3 * \frac{acre - ft}{43,560 ft^2 - ft} = \boxed{2.3 acre - ft}$

   Note: From the conversion table: acre (unit of area) = 43,560 ft^2

   Thus, acre-ft (unit of volume) = $43,560 ft^2 - ft$

4. Calculate the lbs/day of solids entering the plant given the influent flow is 5 MGD with an average solids concentration of 250 mg/l.

   Solution:

   Applying lbs formula:

   $\frac{lbs}{day} = 5MGD * 250\frac{mg}{l} * 8.34 = \boxed{10,425\frac{lbs}{day}}$

5. Calculate the lbs of solids in the primary sludge if the sludge flow is 7500 gallons and the solids concentration is 4.5%.

   Solution:

   Applying lbs formula:

   $lbs\ \ solids = \frac{7500}{1,000,000} MG * 4.5 * 10,000 * 8.34 = \boxed{2,815\ \ lbs\ \ solids}$

   Note:

   1) 7500 gallons was converted to MG by dividing by 1,000,000

   $7500\ \ gallons * \frac{1MG}{1,000,000\ \ gallon}$

2) 4.5% was converted to mg/l by multiplying by 10,000 as 1%=10,000mg/l

6. If the influent wastewater flow is 5 MGD and the BOD concentration is 240 mg/l what is the daily BOD loading in lbs/day?

   Solution:

   $$\frac{lbs\ \ BOD}{day} = 5MGD * 240mg/l * 8.34 = \boxed{\frac{10,000lbs}{day}}$$

7. What is the % removal efficiency if the influent concentration is 10 mg/L and the effluent concentration is 2.5 mg/L?

   $$Removal\ \ Rate(\%) = \frac{In - Out}{In} * 100 \implies \frac{10 - 2.5}{10} * 100 = \boxed{75\%}$$

8. How many lbs of solids are removed daily by a primary clarifier treating a 6 MGD flow if the average influent TSS concentration is 300 mg/l and the clarifier TSS removal efficiency is 67%?

   As the removal efficiency is 67%, 0.67 * 300 mg/l = 201 mg/l solids are removed.

   The total lbs removed can be calculated using the lbs formula.

   $$\frac{lbs\ \ solids}{day} = 6MGD * 201\frac{mg\ \ SS}{l} * 8.34 = \boxed{10,058\frac{lbs\ \ solids}{day}}$$

9. Calculate the primary clarifier influent solids concentration if its outlet concentration is 60 mg/l and the known clarifier removal efficiency is 75%?

   $$\frac{Actual\ \ inlet\ \ (X)}{Actual\ \ outlet} = \frac{100}{100 - Removal\ \ efficiency}$$
   $$\frac{Actual\ \ inlet\ \ (X)}{60} = \frac{100}{100 - 75} = 4$$
   $$\implies Actual\ \ inlet\ \ (X) = 4 * 60 = \boxed{240mg/l}$$

10. Calculate the outlet concentration if the inlet concentration is 80 mg/l and the process removal efficiency is 60%

    Solution:

    $$\frac{Actual\ \ Outlet(X)}{80} = \frac{100 - 60}{100}$$
    $$\implies \frac{Actual\ \ Outlet(X)}{80} = 0.4$$
    $$\implies Actual\ \ Outlet(X) = 0.4 * 80 = \boxed{32mg/l}$$

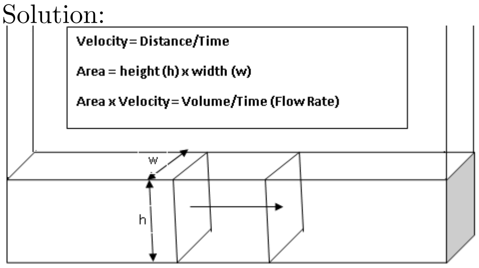
11. Calculate the inlet concentration if the outlet concentration is 80 mg/l and the process removal efficiency is 60%

$$\frac{Actual\ \ inlet\ \ (X)}{80} = \frac{100}{100-60}$$
$$\implies \frac{Actual\ \ inlet\ \ (X)}{80} = 2.5$$

Rearranging the equation: $Actual\ \ inlet(X) = 2.5 * 80 = \boxed{200mg/l}$

12. Calculate the flow, in gpd, that would pass through a grit chamber 2 feet wide, at a depth of 6 inches, with a velocity of 1 ft /sec

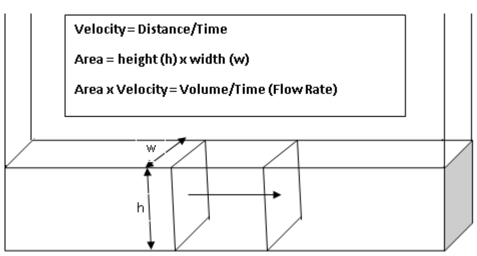
Solution:



$Q = V * A$

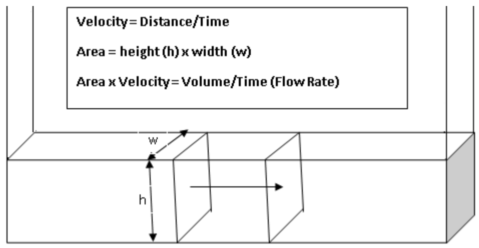
$$Q = 1\frac{ft}{s} * (2*0.5)ft^2 = 1\frac{ft^3}{s}$$
$$Q = 1\frac{\cancel{ft^3}}{\cancel{s}} * \frac{(1440*60)\cancel{s}}{day} * 7.48\frac{gal}{\cancel{ft^3}} = \boxed{646,272\frac{gal}{day}}$$

13. A wastewater channel is 3.25 feet wide and is conveying a wastewater flow of 3.5 MGD. The wastewater flow is 8 inches deep. Calculate the velocity of this flow.



$$Q = V * A \implies V = \frac{Q}{A}$$
$$\implies V\frac{ft}{s} = \frac{3.5\frac{\cancel{MG}}{\cancel{day}} * \frac{1000000\cancel{gal}}{\cancel{MG}} * \frac{ft^{\cancel{3}}}{7.48\cancel{gal}} * \frac{\cancel{day}}{(1440*60)s}}{(3.25*0.75)\cancel{ft^2}} = \boxed{2.2\frac{ft}{s}}$$

14. A wastewater flow of 3cu.ft/sec is flowing in a rectangular grit chamber. The chamber is 2 ft 8in wide. Wastewater is flowing 1 ft 3 in deep. Find the velocity of the flow in this grit chamber in ft/sec.



$$Q = V * A \implies V = \frac{Q}{A}$$

$$\implies V\frac{ft}{s} = \frac{3\frac{ft^{\cancel{3}}}{sec}}{(2+\frac{8}{12})\cancel{ft} * (1+\frac{3}{12}\cancel{ft})} = \boxed{\frac{0.9ft}{sec}}$$

15. How many times would the velocity increase for the same flow rate if the diameter of the pipe is reduced by half (assuming pipes are flowing full)?

    Solution:

    $$Q = V * A \implies V = \frac{Q}{A}$$

    $$\implies \frac{Velocity\ through\ the \frac{D}{2}\ pipe(V_{D/2})}{Velocity\ through\ the\ D\ pipe(V_D)} = \frac{\frac{\cancel{Q}}{(Area of D/2\ pipe)}}{\frac{\cancel{Q}}{(Area\ of\ D\ pipe)}} = \frac{Area\ of\ D\ pipe}{Area\ of\ D/2\ pipe} =$$

    $$\frac{\frac{\cancel{\pi}}{\cancel{4}}\cancel{D^2}}{\frac{\cancel{\pi}}{\cancel{4}}(\frac{\cancel{D}}{2})^2} = \boxed{4}$$ Note: $V \propto 1/A \implies V \propto 1/D^2.\ If\ D\ doubles,\ V\ will\ decrease\ 4X,\ if\ D\ triples,\ V\ will\ reduce$

16. A sewer line to a wastewater treatment plant is 12 miles long. If the wastewater is flowing at 2.2 fps, approximately. How long will it take for wastewater to reach the plant?

    Solution:

    $$time\ to\ reach\ plant\ (hrs) = \frac{\cancel{s}}{2.2\cancel{ft}} * \frac{5280\cancel{ft}}{\cancel{mile}} * 12\cancel{miles} * \frac{hrs}{(60*60)\cancel{s}} = \boxed{8hrs}$$

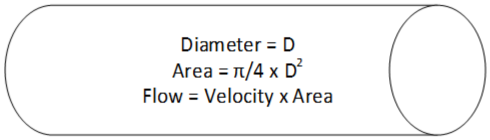
17. A plastic float is dropped into a wastewater channel and is found to travel 10 feet in 4.2 seconds. The channel is 2.4 feet wide and is flowing 1.8 feet deep. Calculate the flow rate of this wastewater in cubic feet per second.

    Solution:

    $$Q = V * A$$

    $$\implies Q\Big(\frac{ft^3}{s}\Big) = \frac{10ft}{4.2s} * (2.4 * 1.8)ft^2 = \boxed{10.3\frac{ft^3}{s}}$$

18. A 12 inch pipe conveys sewage at 2.6 feet per second. What is the flow expressed in MGD? Solution:



$Q = V * A$

$$Q = 2.6\frac{\cancel{ft}}{\cancel{s}} * 0.785 * 1^2 \cancel{ft^2} * 7.48\frac{\cancel{gal}}{ft^3} * \frac{MG}{1,000,000\cancel{gal}} * \frac{(1440*60)\cancel{s}}{day} = \boxed{\frac{1.3ft}{s}}$$

19. A circular clarifier receives a flow of 11 MGD. If the clarifier is 90 ft. in diameter and is 12 ft. deep, what is: a) the hydraulic/surface loading rate, b) weir overflow rate, and c) clarifier detention time in hours?

Solution:

a) Hydraulic/surface loading rate:

$$Clarifier\ hydraulic\ loading\ \left(\frac{gpd}{ft^2}\right) == \frac{\frac{11\cancel{MG}}{day} * \frac{10^6 gal}{\cancel{MG}}}{0.785 * 90^2 ft^2} = \boxed{1,730 gpd/ft^2}$$

b) Weir overflow rate:

$$Weir\ overflow\ rate\left(\frac{gpd}{ft}\right) = \frac{\frac{11\cancel{MG}}{day} * \frac{10^6 gal}{\cancel{MG}}}{3.14 * 90 ft} = \boxed{38,924 gpd/ft}$$

c) Clarifier detention time:

$$Clarifier\ detention\ time\ (hr) = \frac{Clarifier\ volume(cu.ft\ or\ gal)}{Influent\ flow\ (cu.ft\ or\ gal)/hr)}$$

$$Clarifier\ detention\ time\ (hr) = \frac{(0.785 * 90^2 * 15)\cancel{ft^3}}{\frac{11\cancel{MG}}{\cancel{day}} * \frac{10^6\cancel{gal}}{\cancel{MG}} * \frac{\cancel{ft^3}}{7.48\cancel{gal}} * \frac{\cancel{day}}{24hrs}} = \boxed{2hrs}$$

20. A clarifier has a TSS removal efficiency of 50%. If the influent TSS concentration is 220 mg/L, how many lbs/day of TSS are removed if the flow is 10 MGD. Also, how many cu. ft of sludge is pumped if the sludge has a TS concentration of 5%.

Solution:

$$lbs\ solids\ removed = (220 * 0.50) mg/l * 10 MGD * 8.34 = 9,174 lbs\ solids\ per\ day$$

$$\frac{ft^3\ sludge}{day} = \frac{9,174\ \cancel{lbs\ solids}}{day} * \frac{1\ \cancel{lb\ sludge}}{0.05\ \cancel{lbs\ solids}} * \frac{\cancel{gal\ sludge}}{8.34\cancel{lb\ sludge}} * \frac{ft^3\ sludge}{7.48\ \cancel{gal}} = \boxed{2,941\frac{ft^3\ sludge}{day}}$$