1. Calculate the MCRT of an activated sludge plant given the following information.
   Plant flow- 4.25 MGD
   WAS conc-7980 mg/l
   Waste flow- 0.055 MGD
   RAS conc.- 7980 mg/l
   Aeration tank vol-1MG
   Clarifier vol- 0.25 MG
   Final eff TSS conc. - 21.2 mg/l
   MLSS conc.- 2050 mg/l

   Solution:

   $$MCRT(days) = \frac{MLSS\ in\ aeration\ tank\ (lbs) + MLSS\ in\ clarifier\ (lbs)}{SS\ effluent\ (lbs/day) + SS\ WAS\ (lbs/day)}$$

   $$MLSS\ in\ aeration\ tank\ (lbs) = 1 * 2050 * 8.34 = 17097 lbs$$

   $$MLSS\ in\ clarifier\ (lbs) = 0.25 * 2050 * 8.34 = 4274.3 lbs$$

   $$SS\ effluent\ (lbs/day) = 4.25 MGD * 21.2 mg/l * 8.34 = 751.4 lbs/day$$

   $$SS\ WAS\ (lbs/day) = 0.055 MGD * 7980 mg/l * 8.34 = 3660.4 lbs/day$$

   Plugging in the values calculated above: $MCRT(days) = \frac{17097.6 + 4274.3}{751.4 + 3660.4} = 4.8 = \boxed{5 days}$

2. Calculate the MCRT given the following.

   Plant flow - 1.8 MGD

   MLSS conc - 2800 mg/l

   WAS flow - 0.04 MGD

   MLVSS conc. - 2190 mg/l

   Aerator vol - 0.3 MG

   Reactor vol. - 0.2 MG

   RAS conc. - 8150 mg/l

   Effluent SS conc.-18 mg/l

   Solution:

   $$MCRT(days) = \frac{MLSS\ in\ aeration\ tank\ (lbs) + MLSS\ in\ clarifier\ (lbs)}{SS\ effluent\ (lbs/day) + SS\ WAS\ (lbs/day)}$$

   $$MLSS\ in\ aeration\ tank\ (lbs) = 0.3 * 2800 * 8.34 = 7005.6lbs$$

   $$MLSS\ in\ clarifier\ (lbs) = 0.2 * 2800 * 8.34 = 4670.4lbs$$

   $$SS\ effluent\ (lbs/day) = 1.8MGD * 18mg/l * 8.34 = 270.2lbs/day$$

   $$SS\ WAS\ (lbs/day) = 0.04MGD * 8150mg/l * 8.34 = 2718.8lbs/day$$

   Plugging in the values calculated above: $MCRT(days) = \frac{7005.6 + 4670.4}{270.2 + 2718.8} = 3.9 = \boxed{4days}$

3. Calculate F/M ratio based on the following data:
   Secondary influent BOD - 156 mg/l
   Four (4) aeration basins - 30 ft x 70 ft x 10 ft. deep
   Influent flow - 0.65 MGD
   MLSS - 3600 mg/l
   MLSS average % volatile - 72%
   Solution:

$$F:M = \frac{(lbs/day)\ primary\ effluent\ BOD\ entering\ the\ aeration\ tank}{(lbs)\ MLVSS\ in\ the\ aeration\ tank}$$

$$F:M = \frac{156 * 0.65 * 8.34}{3600 * 0.72 * 4 * (30 * 70 * 10)ft^3 * \frac{7.48gal}{ft^3} * \frac{MG}{1000000gal} * 8.34} = \boxed{0.06}$$

4. In an aeration tank, the MLSS is 2650 mg/l and recorded 30-minute settling test indicates 221 ml/L. What is the sludge volume index?

   Solution:
   SVI (ml/g)= $\frac{Settled\ sludge\ volume\ in\ ml/l\ after\ 30\ min}{MLSS\ mg/l} * 1000\frac{mg}{g}$

   SVI= $\frac{221ml/l}{2650mg/l} * 1000\frac{mg}{g} = \boxed{83ml/g}$

5. The desired F/M ratio is .35 lbs BOD/day/lb MLVSS. If 2,100 lbs of BOD enter the aerator daily, how many lbs of MLVSS should be maintained in the aeration tank?
   Solution:

$$F:M = \frac{(lbs/day)\ primary\ effluent\ BOD\ entering\ the\ aeration\ tank}{(lbs)\ MLVSS\ in\ the\ aeration\ tank}$$

$$\implies 0.35 = \frac{2100}{x} \implies x = \boxed{130,100lbs\ MLVSS}$$

6. Calculate F/M ratio based on the following data:
   Secondary influent BOD - 156 mg/l
   Four (4) aeration basins - 30 ft x 70 ft x 10 ft. deep
   Influent flow - 0.65 MGD
   MLSS - 3600 mg/l
   MLSS average % volatile - 72%
   Solution:

$$F:M = \frac{(lbs/day)\ primary\ effluent\ BOD\ entering\ the\ aeration\ tank}{(lbs)\ MLVSS\ in\ the\ aeration\ tank}$$

$$F:M = \frac{156 * 0.65 * 8.34}{3600 * 0.72 * 4 * (30 * 70 * 10)ft^3 * \frac{7.48gal}{ft^3} * \frac{MG}{1000000gal} * 8.34} = \boxed{0.06}$$

7. Operational data is given below for a conventional activated sludge treatment plant:
   Influent flow: 2.5 mgd
   Influent BOD: 220 mg/L
   Influent TSS: 240 mg/L
   Primary BOD removal efficiency: 30%
   Aeration tank volume: 1.8 MG
   Secondary clarifier volume: 0.8 MG
   MLSS: 3,600 mg/L
   MLVSS: 2,800 mg/L
   RAS SS: 8,500 mg/L
   RAS VSS: 6,630 mg/L
   RAS flow: 100%
   WAS flow: 35,000 gpd
   AS Effluent TSS: 25 mg/L
   AS Effluent BOD: 19 mg/L
   Settleability results: 60 min= 300 ml/L
   Settleability results: 30 min= 320 ml/L

   (a) Calculate the MCRT

   (b) Calculate the F/M Ratio

   (c) Calculate the SVI

   Solution:

   (a) $MCRT(days) = \dfrac{MLSS\ in\ aeration\ tank\ (lbs) + MLSS\ in\ clarifier\ (lbs)}{SS\ effluent\ (lbs/day) + SS\ WAS\ (lbs/day)}$

   $MLSS\ in\ aeration\ tank\ (lbs) = 1.8 * 3,600 * 8.34 = 54,043 lbs$

   $MLSS\ in\ clarifier\ (lbs) = 0.8 * 3,600 * 8.34 = 24,019 lbs$

   $SS\ effluent\ (lbs/day) = 2.5 MGD * 25 mg/l * 8.34 = 521 lbs/day$

   $SS\ WAS\ (lbs/day) = \dfrac{35,000}{1,000,000} MGD * 8,500 mg/l * 8.34 = 2,481 lbs/day$

   $MCRT(days) = \dfrac{54,043 + 24,019}{521 + 2,481} = \boxed{26\ days}$

   (b) $F : M = \dfrac{(lbs/day)\ primary\ effluent\ BOD\ entering\ the\ aeration\ tank}{(lbs)\ MLVSS\ in\ the\ aeration\ tank}$

   $F : M = \dfrac{220 * (1 - 0.3) * 2.5 * 8.34}{1.8 * 2,800 * 8.34} = \boxed{0.08}$

   (c) SVI (ml/g)= $\dfrac{Settled\ sludge\ volume\ in\ ml/l\ after\ 30\ min}{MLSS\ mg/l} * 1000 \dfrac{mg}{g}$

$$\text{SVI}=\frac{320ml/l}{3,600mg/l} * 1000\frac{mg}{g} = \boxed{89ml/g}$$

8. What is the Sludge Volume Index given the following:
   MLSS = 2800 mg/L; MLVSS 2400 mg/l; Settled Volume after 30 minutes = 250 ml/L

   Solution:
   $$\text{SVI (ml/g)}= \frac{Settled\ sludge\ volume\ in\ ml/l\ after\ 30\ min}{MLSS\ mg/l} * 1000\frac{mg}{g}$$

   $$\text{SVI}=\frac{250ml/l}{2800mg/l} * 1000\frac{mg}{g} = \boxed{89ml/g}$$

9. trickling filter plant operating at a recirculation ratio of 1 receives a raw wastewater flow of 2 MGD. This means that the flow being applied to the filter would be:
   *a. 4 MGD.
   b. 1 MGD
   c. 3 MGD
   d. 2 MGD
   e. 6 MGD
   Solution:

   $$Recirculation\ Ratio(R_R) = \frac{Recirculated\ Flow(Q_R)}{Influent\ Flow(Q_I)}$$

   $$\implies 1 = \frac{Recirculated\ Flow(Q_R)}{2MGD} \implies Recirculated\ Flow(Q_R) = 2MGD$$
   $$\implies Flow\ to\ TF = Recirculated\ Flow(Q_R) + Influent\ Flow(Q_I) = 2 + 2 = \boxed{4MGD}$$

10. What is the hydraulic loading of a trickling filter with a 100-foot diameter, if it receives a flow of 4.0 MGD?
    a. 480 GPD/ft2
    *b. 510 GPD/ft2
    c. 540 GPD/ft2
    d. 570 GPD/ft2
    e. 600 GPD/ft2

11. trickling filter wastewater treatment plant receives a flow 1.95 MGD. Calculate the organic loading to this plant if it has a 135 ft diameter trickling filter with a 5 foot media depth and has a primary effluent BOD concentration of 110 mg/L.
    a. 0.5 lbs BOD/1,000 cu.ft/day.
    b. 2.7 lbs BOD/1,000 cu.ft/day.
    *c. 25 lbs BOD/1,000 cu.ft/day.
    d. 39 lbs BOD/1,000 cu.ft/day.
    e. 44 lbs BOD/1,000 cu.ft/day.

12. Calculate the pounds of BOD per day entering the trickling filter

DATA: Raw wastewater flow is 15 MGD
Raw wastewater BOD is 150 mg/L
There is a 30% reduction in BOD across the primary clarifiers

a. 560 lbs/day
b. 870 1 bs/ day
c. 880 1 bs /day
*d. 1600 lbs/day

13. The desired trickling filter recirculation ratio is 1.4. If the primary effluent flow is 4.4 MGD what is the trickling filter effluent flow that needs to be recirculated.

a. 3.1 MGD
*b. 6.2 MGD
c. 1.9 MGD
d. 4.7 MGD

14. A trickling filter receives a total flow of 2.2 MGD, including recirculation. If the recirculation ratio is 1:1, what is the influent flow to the plant?

a. 4 .4 MGD ·
b. 2.2 MGD
*c. 1.1 MGD
d. 1.0 MGD
e. none of the above