1. At an activated sludge wastewater treatment plant receiving 3.25 MGD, the final effluent suspended solids concentration averages 21.2 mg/L. What would the calculated MCRT value be when the aeration basin carries 2,050 mg/L MLSS and wastes 0.0550 MGD. The waste activated sludge has a concentration of 7,980 mg/L. The aeration tank has a volume of 1.00 MG and the secondary clarifier has an operational volume of 0.250 MG.

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

$$MLSS\ in\ aeration\ tank\ (lbs) = 1 * 2050 * 8.34 = 17,097 lbs$$

$$MLSS\ in\ clarifier\ (lbs) = 0.25 * 2050 * 8.34 = 4,274.3 lbs$$

$$SS\ effluent\ (lbs/day) = 3.25 MGD * 21.2 mg/l * 8.34 = 574.6 lbs/day$$

$$SS\ WAS\ (lbs/day) = 0.055 MGD * 7,980 mg/l * 8.34 = 3,660.4 lbs/day$$

Plugging in the values calculated above: $MCRT(days) = \frac{17,097.6 + 4,274.3}{574.6 + 3,660.4} = 4.8 = \boxed{5\ days}$

2. Given that an activated sludge plant with an influent flow of 1.2 MGD is operated at an MCRT of 6 days and the parameters below, calculate the WAS flow rate in gallons per day.

Two aeration tanks – 0.5 MG each	Two final clarifiers – 0.25 MG each
Final effluent = $20 mg/l$	WAS – 7500 ppm
MLSS –$3600 mg/l$	MLSS volatile solids content = 80%

$$\text{MCRT} = \frac{lbs MLSS(system)}{\frac{lbs}{day} Effluent SS + \frac{lbs}{day} WAS_{SS}}$$

$$\text{lbs MLSS (system)} = (2 * 0.5 + 2 * 0.25) MG * 3600 \frac{mg}{L} * 8.34 = 45036 lbs$$

$$\frac{lbs}{day} Effluent SS = 1.2 MG * 20 \frac{mg}{L} * 8.34 = 200.2 lbs$$

$$\text{MCRT: } 6 days = \frac{45036}{200.2 \frac{lbs}{day} + \frac{lbs}{day} WAS_{SS}}$$

$$\frac{lbs}{day} WAS_{SS} = \frac{45036}{6} - 200.2 = 7306 \frac{lbs}{day}$$

$$7306 \frac{lbs}{day} = WASFlow(MGD) * 7500 * 8.34$$

$$\implies WASFlow(MGD) = \frac{7306}{7500 * 8.34} = 0.116 MGD = \boxed{116,000 \frac{gal}{day}}$$

3. The 1.5 MGD influent to a treatment plant has an average BOD of 280 mg/L. 32% of this BOD is removed in the primary sedimentation tank. The primary effluent flows into an aeration tank containing 7000 lbs of MLSS with 79 % volatile matter. Calculate this plant's F to M ratio.

Influent BOD concentration to the AS basin: $280\frac{mg}{l} * (1 - 0.32) = 190.4\frac{mg}{l}$

$$\frac{F}{M} = \frac{1.5MGD * 190.4\frac{mg}{l} * 8.34}{7000 * 0.79} = \boxed{0.43\frac{F}{M}}$$

4. 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?

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

$$\implies 0.35 = \frac{2100}{x} \implies x = \boxed{6000lbs\ MLVSS}$$

5. 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?

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

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

6. The total influent flow (including recirculation) to a trickling filter is 1.89 MGD. If the trickling filter is 80 ft in diameter, what is the hydraulic loading in gpd/sq ft on the trickling filter?

$$Hydraulic\ loading\ \frac{gpd}{ft^2} = \frac{(1.89 * 10^6)gpd}{(0.785 * 80^2)ft^2} = \boxed{376\frac{gpd}{ft^2}}$$

7. The suspended solids concentration entering a trickling filter is 236 mg/l. If the suspended solids concentration of the trickling filter effluent is 33 mg/l, what is the suspended solids removal efficiency of the trickling filter?

$$\%Removal = \frac{236mg/l - 33mg/l}{236mg/l} * 100 = \boxed{86\%}$$

8. A trickling filter, 70 ft in diameter with a media depth of 6 ft, receives a flow of 0.78 MGD. If the BOD concentration of the primary effluent is 167 mg/L, what is the organic loading on the trickling filter in lbs BOD/day/1000 cu ft?

$$Organic\ loading: \frac{lbs\ BOD}{day - 1000ft^3} = \frac{lbs\ BOD\ feed\ to\ TF\ per\ day}{volume\ in\ 1000ft^3}$$

$$= \frac{\frac{(0.78 * 167 * 8.34)lbs\ BOD}{day}}{(0.785 * 70^2 * 6)ft^3 * \frac{1000ft^3}{1000ft^3}} = \boxed{\frac{47lbs\ BOD}{day - 1000ft^3}}$$

9. A trickling filter has a total flow of 32 MGD. If the recirculation ratio is 0.8, what is the primary effluent flow to the TF?

$$Total\ Flow(Q_T) = Influent\ Flow(Q_I) * (Recirculation\ Ratio(R_R) + 1)$$
$$\implies 32MGD = Q_I * (0.8 + 1) \implies Q_I = \frac{32}{1.8} = \boxed{17.8MGD}$$

10. 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.
Solution:
$$R_R = \frac{Q_R}{Q_I} \implies 1.4 = \frac{Q_R}{4.4} \implies Q_R = 1.4 * 4.4 = \boxed{6.2MGD}$$