Exam Math Review
Treatment Grades III & IV
Answer Key

The Division of Water Quality
makes no claim as the accuracy of
any answers provided herein.

Certification Exam Review
Treatment Grade III & IV

Math Problems - Conversions

1. 100 feet of pressure head is how many psi?

$1\ psi = 2.31\ ft$

$100\ ft \times \frac{1\ psi}{2.31\ ft} = 43.29\ psi$

2. 750 cubic feet of wastewater is how many gallons?

$1\ ft^3 = 7.48\ gal$

$750\ ft^3 \times \frac{7.48\ gal}{1\ ft^3} = 5,610\ gal$

Math Problems - Areas

1. What is the clarifier surface area of the treatment plant. The plant has a 40 foot diameter primary clarifier and a 45 foot diameter secondary clarifier?

$0.785 \times (40\ ft)^2 + 0.785 \times (45\ ft)^2 = 2,846\ ft^2$

2. If a treatment plant receives 1.0 MGD, and the plant has a 48 foot diameter primary clarifiers. What is the surface loading rate of the clarifiers in gal./ft.^{2} ?

$0.785 \times (48\ ft)^2 = 1,809\ ft^2$

$\frac{1,000,000\ gpd}{1809\ ft^2} = 552.9\ \frac{gpd}{ft^2}$

Math Problems - Efficiency

1. If the efficiency of the primary clarifier is 55% and the TSS influent to the clarifier is 280 mg/L. What is the TSS effluent from the clarifier?

$280\ mg/L \times 55\% = 154\ mg/L$ removed

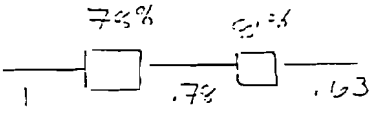
280 ⟶ ⟶ 126 mg/L

↓ 154 mg/L

$0.55 = \frac{280 - out}{280}$

2. The motor has an efficiency of 78% and a pump has an efficiency of 81%. What is the "wire to water" efficiency?

$78\% \times 81\% = 63.18\ \%$



Math Problems - Chlorine Equation

1. What is the chlorine feed rate per day for a flow of 1.5 MGD with a dose rate of 15 mg/L.

$8.34\ \frac{lbs}{gal} \times 1.5\ MGD \times 15\ mg/L = 187.65\ \frac{lbs}{Day}$

2. How many pounds of BOD are received at a treatment plant, if the flow is 900,000 gpd and the BOD influent concentration is 195 mg/L?

$8.34\ \frac{lbs}{gal} \times 0.9\ MGD \times 195\ mg/L = 1463.67\ \frac{lbs}{day}$

Math Problems - Volumes

1. How gallons of wastewater is there in a 45 foot diameter primary clarifier that operates at 10 foot sidewall depth? Assume the clarifier has a 4 foot deep conical bottom.

$$0.785 \times (45\ ft)^2 \times 10\ ft + \frac{1}{3} \times 0.785 \times (45\ ft)^2 \times 4\ ft$$

$$18{,}016\ ft^3 \times \frac{7.48\ gal}{1\ ft^3} = 134{,}758\ gal$$

2. What is the volume of a trickling filter that is 85 foot in diameter and 6 feet deep?

$$0.785 \times (85\ ft)^2 \times 6\ ft = 34{,}030\ ft^3$$

Math Problems - Time

1. Activated sludge has a rectangular aeration tank that is 25 foot by 18 foot and operates at a 10 foot depth. If the plant has a flow of 0.75 MGD, what is the HRT?

$$25\ ft \times 18\ ft \times 10\ ft = 4500\ ft^3 \times 7.48\ \frac{gal}{ft^3} = 33{,}660\ gal$$

$$\frac{33{,}660\ gal}{750{,}000\ gpd} = 0.045\ days \times 1440\ \frac{min}{day} = 64.6\ min$$

2. A sludge pump has a bore of 8 inches and a stroke of 4.5 inches. The pump operates at 30 cycles/minutes. How long will it take to pump 750 gallons of sludge?

$$0.785 \times \left(\frac{8}{12}\ ft\right)^2 \times \frac{4.5}{12}\ ft = 0.131\ ft^3$$

$$0.131\ ft^3 \times 7.48\ \frac{gal}{ft^3} = 0.98\ gal \sim 1\ gal$$

$$\frac{750\ gallons}{30\ gpm} = 25\ min$$

3. A treatment plant has three aeration basins, each 35 feet by 20 feet by 9 feet deep. The MLVSS concentration in all the basins is 2,800 mg/L. Sludge is wasted at a rate of 300 lbs/day. The flow through the plant is 1.2 MGD, and the effluent TSS concentration is 5 mg/L. Given the volatility is 70%, what is the solid retention time?

$$MLSS = \frac{2800\ mg/L}{70\%} = 4{,}000\ mg/L$$

$$3 \times 35\ ft \times 20\ ft \times 9\ ft = 18{,}900\ ft^3 \times 7.48\ \frac{gal}{ft^3} = 141{,}372\ gal$$

solids → $8.34\ \frac{lbs}{gal} \times 0.141\ MG \times 2{,}800\ mg/L = 3300\ lbs$

losses → $300\ \frac{lbs}{day} + 8.34\ \frac{lbs}{gal} \times 1.2\ MGD \times 5\ mg/L = 350\ \frac{lbs}{day}$

$$SRT = \frac{3300\ lbs}{350\ lbs/day} = 9.4\ days$$

Math Problems - F/M Ratios

1. An oxidation ditch has a volume of 0.75 million gallons. The MLSS concentration in the ditch is 3,800 mg/L. The influent BOD is 230 mg/L and the plant has a flow of 0.5 MGD. The volatility of the influent is 65%. What is the F/M ratio?

food – $8.34\ \frac{lbs}{gal} \times 0.5\ MGD \times 230\ mg/L = 959\ \frac{lbs}{day}$

bugs – $8.34\ \frac{lbs}{gal} \times 0.75\ MG \times (3{,}800\ mg/L \times 0.65) = 15{,}450\ lbs$

$$\frac{F}{M} = \frac{959}{15{,}450} = 0.06$$

2. Given the desired F/M ratio is 0.2. The aeration tank is 50 foot by 15 foot and the tank is 12 foot deep. The MLVSS concentration in the tank is 5,800 mg/L. The plant treats 0.25 MGD with an influent BOD concentration of 225 mg/L. Should sludge be wasted? if so how many pounds?

$$food = 8.34\ \frac{lbs}{gal} \times 0.25\ MGD \times 225\ mg/L = 469\ \frac{lbs}{day}$$

$$\frac{F}{M} = 0.2 \qquad F = 0.2\,M \qquad M = \frac{F}{0.2}$$

$$bugs\ wanted = \frac{469\ \frac{lbs}{day}}{0.2} = 2{,}346\ lbs$$

$$50\ ft \times 15\ ft \times 12\ ft = 9000\ ft^3 \times 7.48\ \frac{gal}{ft^3} = 67{,}320\ gal$$

$$bugs = 8.34\ \frac{lbs}{gal} \times 0.067\ MG \times 5{,}800\ mg/L = 3256\ lbs$$

$$waste = 3256\ lbs - 2346\ lbs = 910\ lbs$$

3. An anaerobic digester's supernate has a concentration of 30,000 mg/L and the digester produces 400 pounds of dry sludge per day. How many gallons of liquid sludge are produced a day?

$$400 \frac{lbs}{day} = 8.34 \frac{lbs}{gal} \times ? \times 30{,}000 \text{ mg/L}$$

$$? = \frac{400 \frac{lbs}{day}}{250{,}200 \frac{lbs}{gal} \frac{mg}{L}} = 0.0016 \text{ MGD}$$

1600 gpd

Math Problems - Solid Retention Time

1. An aeration tank has the dimensions of 45 feet by 20 feet by 12 feet. The MLSS concentration in the tank is 3,500 mg/L. Sludge is wasted at a rate of 200 lbs./day and the effluent concentration is 5 mg/L. If the flow through the plant is 0.8 MGD, what is the SRT of the plant?

$$45 \text{ ft} \times 20 \text{ ft} \times 12 \text{ ft} = 10{,}800 \text{ ft}^3 \times 7.48 \frac{gal}{ft^3} = 80{,}784 \text{ gal}$$

$$MLSS \rightarrow 8.34 \frac{lbs}{gal} \times 0.0808 \text{ MG} \times 3{,}500 \text{ mg/L} = 2{,}358 \text{ lbs}$$

$$TSS_{eff} \rightarrow 8.34 \frac{lbs}{gal} \times 0.8 \text{ MGD} \times 5 \text{ mg/L} = 33.36 \frac{lbs}{day}$$

$$\frac{2358 \text{ lbs}}{200 \frac{lbs}{day} + 33.36 \frac{lbs}{day}} = 10.1 \text{ days}$$

2. A plant has two 55 foot diameter aeration tanks, each are 12 feet deep. The MLSS concentration in one tank is 3,500 mg/L, and the other concentration is 4,000 mg/L. Sludge is wasted at a rate of 450 lbs./day and the effluent concentration is 2 mg/L. If the flow through the plant is 1.35 MGD, what is the SRT of the plant?

per tank $\rightarrow 0.785 \times (55 \text{ ft})^2 \times 12 \text{ ft} = 28{,}496 \text{ ft}^3 \times 7.48 \frac{gal}{ft} = 213{,}146 \text{ gal.}$

Solids $= 8.34 \frac{lbs}{gal} \times 0.213 \text{ MG} \times 3{,}500 \text{ mg/L} + 8.34 \frac{lbs}{gal} \times 0.213 \text{ MG} \times 4{,}000 \text{ mg/L}$

$= 13{,}323 \text{ lbs}$

$$\text{losses} = 450 \frac{lbs}{day} + 8.34 \frac{lbs}{gal} \times 1.35 \text{ MGD} \times 2 \text{ mg/L} = 473 \frac{lbs}{day}$$

$$SRT = \frac{13{,}323 \text{ lbs}}{473 \frac{lbs}{day}} = 28.2 \text{ days}$$