Advanced Math

Using Multiple Formulas

1. **How many pounds of pure chlorine are needed to apply a 12.5 mg/l dosage to a tank that is 10 ft tall, 30 ft wide, and 25 ft long?**

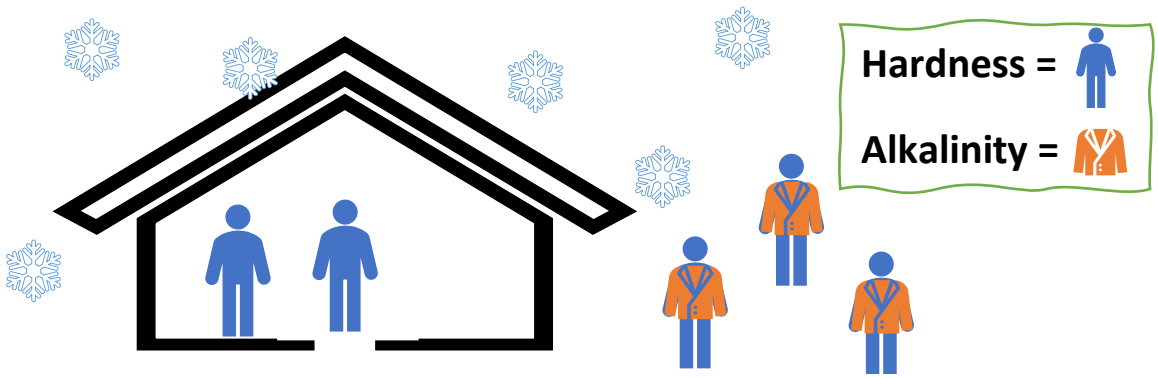
2. **Calculate the dosage given to a 750,000-gallon system after adding 20 pounds of 85% calcium hypochlorite?**

3. **Calculate the demand of a 4 ft diameter by 16 ft tall round tank that was disinfected with 5 pounds of 8% bleach and has a sustained residual of 2.6 mg/l?**

Advanced Math Strategies

Equations to MEMORIZE!

- **EBCT = V ÷ F**
  - V = volume of media
  - F = Flow of water
  - Make sure units match
- **Feed = Permeate + Concentrate**
  - Feed = Water entering R.O.
  - Permeate = Portion of feed water moving through R.O. as Product
  - Concentrate = Portion of feed water Rejected as Waste
- **% Recovery = Permeate ÷ Feed x 100**
  - Percent of water entering an R.O. that becomes Product
- **1˚f change = 1.5% change in production rate**
  - First, find how much the temp. changed x 1.5 = % production change
  - Second, change % to a decimal and multiply by starting prod. rate
  - Third, add or subtract this number from the starting prod. rate
    - Colder = Subtract, Warmer = Add
- **1 psi = 100 ppm TDS Difference**
  - 1 psi of osmotic backpressure towards the feed side for every 100 ppm TDS removed during R.O.



Permanent = Non-Carbonate **Temporary = Carbonate**

Empty Bed Contact Time

1. **Determine the amount of carbon media in cu. ft. needed to remove Hydrogen Sulfide if the flow rate is 2.5 GPM. According to the carbon manufacturer, an EBCT of 4.5 minutes is adequate for Hydrogen Sulfide removal.**

2. **An activated carbon canister is 6 inches in diameter and 18 inches high. The carbon occupies 70% of the canister volume. If the flow rate is 0.11 gallons per minute, what is the EBCT in minutes?**

Water Analysis

1. **From the following water analysis, determine the type and amount of hardness:**

   Total alkalinity = 300 mg/l

   Hardness = 200 mg/l

   Temporary Hardness: _____

   Permanent Hardness: _____

2. **From the following water analysis, determine the type and amount of hardness:**

   Total alkalinity = 150 mg/l

   Hardness = 350 mg/l

   Temporary Hardness: _____

   Permanent Hardness: _____

R.O.

1. **Calculate the feed to an RO that is producing 5 gpm permeate and 15 gpm concentrate.**

2. **Calculate the concentrate to an RO that is producing 10 gpm permeate and with a 40 gpm feed.**

3. **Calculate the recovery of an RO that has a 80 gpd feed and produces 20 gpd.**

4. **When 6 gallons of permeate and 24 gallons of concentrate are produced by an RO unit, what is the recovery?**

5. **Calculate the osmotic back pressure on an RO that has 1600 TDS feed and 100 TDS permeate.**

6. **An RO unit is making 20 gph at 77*f. If the temperature drops to 65*f what will the production rate be?**

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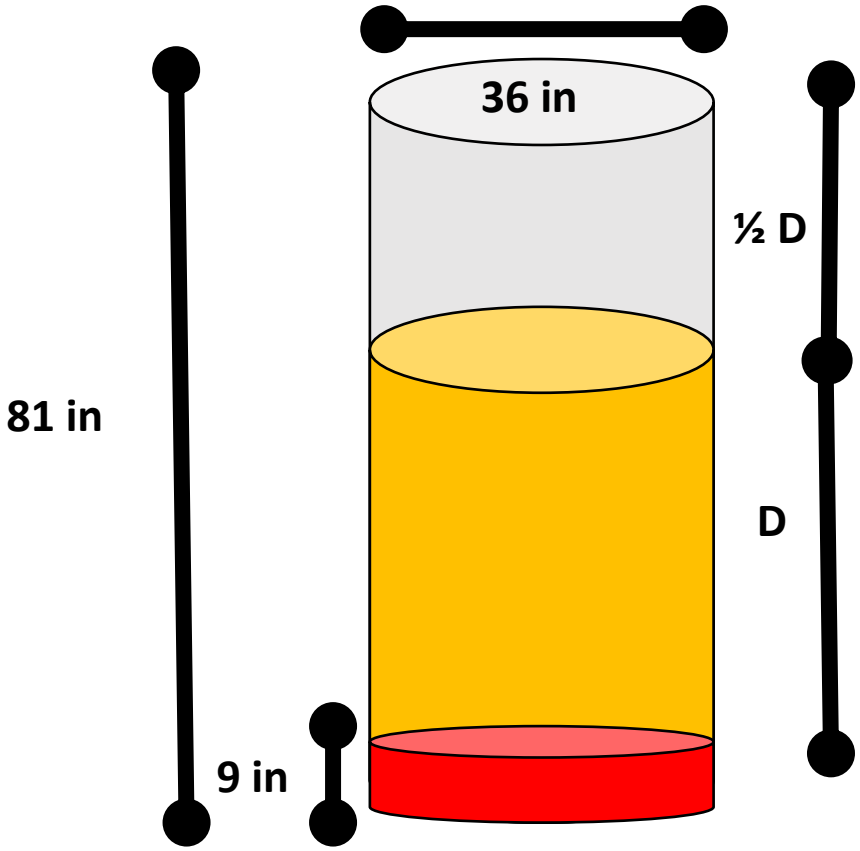
Using the Diagram, answer the following Questions:

1. **How many cubic feet of resin does the unit contain?**

2. **How many gallons of water can the freeboard hold?**



Advanced Math Answer Key

Multiple Formulas:

1. V = Length x Width x Height ➔ V = 25 x 30 x 10 = 7,500 cu. ft. x 7.48 = 56,100 gal. = 0.0561 MG
   (MG)(mg/l)(8.34)= Lbs. ➔ ? = 0.0561 x 12.5 x 8.34 **= <u>5.8 Lbs.</u>**
2. Lbs. Comp. = Lbs. Pure / % Cl_2 ➔ 20 = Lbs. / 0.85 ➔ Lbs. = 20 x 0.85 = 17 Lbs.
   Dosage = Lbs. / (MDG x 8.34) ➔ ? = 17 / (0.75 x 8.34) = 17 / (6.255) = **<u>2.7 mg/l</u>**
3. V = π x R^2 x Height ➔ V = 3.14 x 2 x 2 x 16 = 200.96 cu. ft. x 7.48 = 1,503 gal. = 0.0015 MG
   Lbs. Comp. = Lbs. Pure / % Cl_2 ➔ 5 = Lbs. / 0.08 ➔ Lbs. = 5 x 0.08 = 0.4 Lbs. Pure
   Dosage = Lbs. / (MGD x 8.34) ➔ Dos. = 0.4 / (0.0015 x 8.34) = 0.4 / (0.01251) = 32
   Dosage = Demand + Residual ➔ 32 = ? + 2.6 ➔ ? = 32 – 2.6 = **<u>29.4 mg/l</u>**

Empty Bed Contact Time (EBCT):

1. EBCT = V / F ➔ 4.5 = ? ÷ 2.5 ➔ ? = 4.5 x 2.5 = 11.25 gal ÷ 7.48 = **<u>1.5 cu. ft. Media</u>**
2. V = π x r^2 x Height ➔ V_{total} = 3.14 x 0.25 ft. x 0.25 ft. x 1.5 ft = 0.29 cu. ft. x 7.48 = 2.2 gal.
   V_{media} = 70% x V_{total} ➔ V = 0.70 x 2.2 gal. = 1.5 gal. media
   EBCT = V / F ➔ 1.5 gal. / 0.11 GPM = **<u>14 minutes</u>**

Water Analysis:

1. Temporary (Carbonate) Hardness = **<u>200 mg/l</u>**
   Permanent (Non-Carbonate) Hardness = **<u>0 mg/l</u>**
2. Temporary (Carbonate) Hardness = **<u>150 mg/l</u>**
   Permanent (Non-Carbonate) Hardness = **<u>200 mg/l</u>**

R.O. Math:

1. Feed = Permeate + Concentrate ➔ ? = 5 gpm + 15 gpm = **<u>20 gpm</u>**
2. Feed = Permeate + Concentrate ➔ 40 gpm = 10 gpm + ? ➔ ? = 40 – 10 = **<u>30 gpm</u>**
3. % Recovery = Perm. / Feed x 100 ➔ ? = 20 / 80 x 100 = **<u>25%</u>**
4. Feed = Permeate + Concentrate ➔ Feed = 6 + 24 = 30
   % Recovery = Perm. / Feed x 100 ➔ ? = 6 / 30 x 100 = **<u>20%</u>**
5. TDS diff. = Feed TDS – Perm. TDS ➔ TDS diff. = 1600 ppm – 100 ppm = 1500 ppm
6. Pressure = TDS diff. / 100 ➔ ? = 1500 / 100 = **<u>15 psi.</u>**
7. Change in Temp = Start Temp. – End Temp. ➔ Change in Temp. = 77 – 65 = 12
   % change = 1.5% x Change in Temp. ➔ % Change = 1.5% x 12 = 18%
   Change in Prod. = % Change x Start Prod.➔ Change in Prod. = 0.18 x 20 = 3.6 gph
   Colder = Start Prod. + Change in Prod. ➔ 20 gph – 3.6 gph = **<u>16.4 gph</u>**

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1. V = π x r^2 x Height ➔ V = 3.14 x 1.5 x 1.5 x 4 = **<u>28.26 cu. ft.</u>**
2. V = π x r^2 x Height ➔ V = 3.14 x 1.5 x 1.5 x 2 = 14.13 cu. ft. x 7.48 = **<u>105.7 gal.</u>**