Module 20:
Corrosion Control and Sequestering
Answer Key

(edited April 2017)

Exercise for Unit 1 – Background and Properties

1. Under the LCR, insert the population sizes for the following types of systems:

System Size	Population Served
Small	**3,300 and fewer**
Medium	**3,301 to 50,000**
Large	**50,001 and greater**

2. Based on the following lead tap sample results, what is the 90th percentile value of the following samples? **0.018 mg/L**
    Is this system exceeding the action level? **YES**

Sample site	Lead Level (mg/L)
1	0.020
2	0.018
3	0.016
4	0.014
5	0.011
6	0.010
7	0.009
8	0.008
9	0.007
10	0.006

3. When a small or medium system exceeds an AL, name the first step in the corrosion control treatment activity milestones?   Submit a CCT **feasibility study** within 18 months.

4. Which of the following parameters are considered water quality parameters?

    Circle all that apply.

    a.   Temperature

    b.   Conductivity

    c.   pH

    d.   alkalinity

    e.   odor

    Answer: a, b, c, and d.

5.   Systems serving 50,000 or less people (i.e. small or medium systems) must collect WQP samples during monitoring periods in which either AL is exceeded.

    a. True___**X**___   b. False_____

6.   The sample volume size for a lead and copper tap sample is:

    a. 500 ml   b. **1 liter**

7.   An operator must measure pH within **15** minutes of sample collection.

8.   What methodology is **NOT** an EPA-approved method?

    a. Titrimetric

    b. Electrometric

    c. Colorimetric

    d. Color Wheel

✓ Exercise for Unit 2 – Corrosion Principles and Theory

1. When placed in water, <mark>acids</mark>/bases produce hydrogen ions; acids/<mark>bases</mark> produce hydroxide ions.

2. A <mark>salt</mark> is the product of combining an acid and a base.

3. A finished water pH value of 5.0 indicates:

    a. Water is basic
    b. Water is acidic
    c. Water may corrode pipes and fittings
    d. Both a and c
    e. <mark>Both b and c</mark>

4. What objectives can be met with corrosion control treatment?

    a. Minimize amount of lead and/or copper dissolving into tap water.
    b. Maximize the service life of plumbing materials.
    c. Improve the hydraulic characteristics of water distribution systems.
    d. <mark>All of the above.</mark>

5. Controlling lead/copper is achieved by forming a protective layer on the pipe wall that eliminates the corrosion cell.

    a) <mark>True</mark>   b) False

6. What does a Langelier Saturation Index of 1.1 indicate?

    a. <mark>Scaling potential</mark>
    b. Dissolving potential

7. If an operator adjusts the pH of the finished water above the saturation point for calcium carbonate, this will create a protective coating on the pipe wall.

    a) <mark>True</mark>   b) False

8. Determine how the addition of the following chemicals to water will affect pH and complete the table.

If I add:		The pH will be _____ (raised/lowered)
potassium hydroxide	KOH	raised
nitric acid	HNO_3	lowered
lime	$Ca(OH)_2$	raised
sulfuric acid	H_2SO_4	lowered
caustic soda	NaOH	raised
soda ash	Na_2CO_3	raised
hydrochloric acid	HCl	lowered

Common Chemical Names

Table 3.1 - Common pH/Alkalinity Adjustment Chemicals

Chemical Name	Chemical Formula	Common Name
Sodium Hydroxide	NaOH	Caustic Soda
Calcium Hydroxide	$Ca(OH)_2$	Lime
Sodium Bicarbonate	$NaHCO_3$	Baking Soda
Sodium Carbonate	Na_2CO_3	Soda Ash

Q. Do these chemicals act like acids or bases? (**bases**)

Q. Are caustic soda and lime stronger or weaker bases than soda ash or sodium bicarbonate? (**stronger**)

Q. Why? (**Hydroxides produce a greater pH change for the same dosage than carbonates and bicarbonates**.)

Exercise for Unit 3 – Corrosion Control Chemicals

1. List the common names for the following pH/alkalinity adjustment chemicals:

Chemical Name   **Common Name**

Calcium hydroxide   <mark>Lime</mark>
Sodium carbonate   <mark>Soda Ash</mark>
Sodium hydroxide   <mark>Caustic soda</mark>

2. When using caustic soda, it is necessary to have at least 20 mg/L of alkalinity to maintain a stable pH.

    a) <mark>True</mark>   b) False

3. It is not necessary to minimize the length of line for a lime feeder.

    a) True   b) <mark>False</mark>

4. Which type of inhibitor is used to control lead?

    a) Polyphosphate
    b) Silicates
    c) <mark>Orthophosphate</mark>

5. When the pH is raised before disinfection, the inactivation effectiveness of free chlorine is increased.

    a) True   b) <mark>False</mark>

6. When using polyphosphates to **sequester** iron and manganese, why should the chemical feed point be located **before** the disinfection process?

<mark>**To avoid oxidizing the iron and manganese with the chlorine which would create iron and manganese precipitates to be pumped out into the distribution system.**</mark>

Practice Problem: Mixing a Percent Solution

How many pounds of caustic soda are required to be mixed with 50 gallons of water to produce a 12% solution?

?lbs = 8.34 $\frac{lbs}{gal}$ X   Volume (gal)   X   % Strength Solution (either as a decimal or a fraction)

?lbs = 8.34 $\frac{lbs}{gal}$ X   50 gal   X $\frac{12}{100}$ (or 0.12 as a decimal)

?lbs = 8.34 X 50 (gal)   X   0.12 (% strength solution as a decimal)

?lbs = 50.04 lbs

Dry Feed Practice Problem

How many pounds of lime are needed for a desired dosage of 17 mg/L when the average daily plant flow is 200 gpm?

Step 1: Convert flow (in gallons) into MGD so that the feed rate (lbs) formula can be used.

?MG = $\dfrac{1\ MG}{1{,}000{,}000\ \text{gal}}$ X $\dfrac{200\ \text{gal}}{\text{min}}$ X $\dfrac{1440\ \text{mins}}{\text{day}}$ gal = **0.288** MGD

Step 2: Solve for pounds per day (feed rate) for 100% pure chemical (no impurities).

? lbs = volume(MG) x dose(mg/L) x 8.34 = **(0.288)(17)(8.34)** = **40.8** pounds of lime is required.

Liquid Feed Rate Practice Problem: A water plant uses 25% caustic soda to raise the pH of the water. The target dose is 20 mg/L. They treat 600 gpm. How many **pounds** of caustic soda will need to be fed?

Step 1: Convert flow (in gallons) into MGD so that the feed rate (lbs) formula can be used.

?MG = $\dfrac{1\ MG}{1,000,000\ \text{gal}}$ X   (600) $\dfrac{\text{gal}}{\text{min}}$ X   1440 $\dfrac{\text{mins}}{\text{day}}$ gal = **0.864** MGD

Step 2: Solve for pounds per day (feed rate) for 100% pure chemical (no impurities).

Using the formula pounds per day = flow x dose x 8.34 = (**0.864**)(20)(8.34) = **144** pounds of "pure" caustic soda.

Step 3: Calculate # of pounds of 25% solution needed to achieve Step 2 feed rate.

a) Convert % purity of solution into a decimal:

$\dfrac{25\ \%}{100\%}$ = **0.25**

b) Then divide the pounds needed (feed rate of 100% pure chemical) by the purity of the solution (as a decimal).

$\dfrac{144\ \text{pounds}}{0.25\ (\%\ \text{purity as a decimal})}$ = **576 pounds** of 25% caustic soda.

TIP: Answer will always be more pounds than Step 2 result because solution is not 100% pure.

Practice Problem: Calculating the Active Ingredient Weight of a % Solution Chemical

EXAMPLE: How many pounds of caustic soda are there in a gallon of caustic soda that is 50% pure that has a specific gravity of 1.53?

Step 1: Solve weight equation (lbs/gal) for 1 gallon of chemical

Weight, lbs/gal = (Specific gravity of substance) x (weight of a gallon of water)

1.53   x 8.34 $\dfrac{\text{pounds}}{\text{gallon}}$ = **12.76** $\dfrac{\text{pounds}}{\text{gallon}}$

Step 2: Determine the "active ingredient" weight of the caustic soda based on the % purity of solution

a)   Convert % purity of solution into a decimal:

$\dfrac{50\%}{100\%}$ = **0.50**

b)   Multiply the weight of a gallon by the % purity of the product (as a decimal).

12.76 $\dfrac{\text{pounds}}{\text{gallon}}$ x   0.5 = **6.38** pounds of caustic soda in a gallon of 50% caustic soda solution

This "active ingredient" weight provides the pounds of active strength ingredients that are found in each gallon of 50% caustic soda solution. Within the 12.76 pounds of 50% caustic solution, there are 6.38 pounds of active ingredients.

Liquid Feed Rate Practice Problem: A water plant uses 50% caustic soda to raise the pH of the water. The target dose is 30 mg/L. They treat 500 gpm. Specific gravity of 50% caustic soda is 1.53
How many **gallons** of caustic soda will need to be fed?

Step 1: Solve weight equation (lbs/gal) for 1 gallon of chemical

Weight, lbs/gal = (Specific gravity of substance) x (weight of a gallon of water)

1.53   x 8.34 pounds = **12.76** pounds
              gallon   gallon

Step 2: Determine the "active ingredient" weight of the caustic soda based on the % purity of solution

a)   Convert % purity of solution into a decimal:

50%   = **0.5**
100%

b)   Multiply the weight of a gallon by the % purity of the product (as a decimal).

   12.76 pounds x   0.5 = **6.38** pounds of "active" caustic soda in a gallon of 50% caustic soda solution
              gallon

Step 3: Convert flow (in gallons) into MGD so that the feed rate (lbs) formula can be used.

?MGD = 1 MGD   X   (500) gal X 1440 mins   = **0.72** MGD
          1,000,000 gal   min   day

Step 4: Solve for pounds per day (feed rate) for 100% pure chemical (no impurities).

Using the formula lbs/day = flow x dose x 8.34 = (**0.72**)(30)(8.34) = **180** pounds of "pure" caustic soda.

Step 5: Use unit cancellation to convert lbs/day to gals/day

"Active Ingredient" Weight of 50% caustic soda solution

Feed Rate of "100% pure" caustic soda

?gal = 1 gallon   x **180** lbs   = **28.2 gals** of 50% caustic soda
 day   **6.38 lbs**   day   **day**

✓ **Exercise for Unit 4 – Chemical Feed Components and Pump Calibration**

1. Liquid chemical feed components consist of:
    a. Chemical Storage
    b. Calibration cylinder
    c. Metering Pump
    d. Pulsation Damper
    e. **All of the above**

2. Secondary spill containment areas should be provided and include leak detection equipment to provide an alarm in the event of a chemical spill or leak.

    a) **True**   b) False

3. The **foot valve** is used to prevent the pump from losing prime.

4. A clogged suction assembly can be cleaned with a weak acid solution (i.e., vinegar or 1:1HCL).

    a) **True**   b) False

5. Volumetric/**Gravimetric** dry feeders are extremely accurate.

6. Chemical feed calculations involve 4 considerations:

1. Dosage
2. Plant Flow
3. Chemical Product Strength
4. **Product Feed Rate**

7. Why should the discharge point of the injector assembly should be located in the middle of the flow of the pipe?
To provide proper mixing.

8. A pump calibration curve plots feed rate delivery versus the **pump setting**.