Continuing Education Course #222
Lime Soda Water Softening Calculations

1. Which of the following sets of ions cause hardness in water?
- a. carbonate and bicarbonate
- b. chloride and sulfate
- c. sodium and potassium
- d. calcium and magnesium

2. The total hardness (or simply hardness) of a water sample is due to the sum of which of the following?
- a. calcium hardness and carbonate hardness
- b. calcium hardness and magnesium hardness
- c. carbonate hardness and magnesium hardness
- d. magnesium hardness and noncarbonate hardness

3. At a pH of 7.5 alkalinity in water will be primarily due to which of the following?
- a. carbonate ions
- b. bicarbonate ions
- c. hydroxide ions
- d. carbon dioxide

4. What would be the concentration of bicarbonate ion expressed in mg/L $CaCO_3$ in a water sample of pH 9 that has a total alkalinity of 80 mg/L?
- a. 8
- b. 50
- c. 72
- d. 135

5. Carbonate hardness is due to which of the following?
- a. Calcium or Magnesium ions together with carbonate or bicarbonate ions
- b. Calcium or Magnesium ions together with carbonate ions, but not with bicarbonate ions
- c. Calcium or Magnesium ions together with sulfate or chloride ions
- d. Calcium ions, but not Magnesium ions

6. Calculate the calcium non carbonate hardness (in mg/L as $CaCO_3$) for a water sample with Total Hardness = 140 mg/L as $CaCO_3$, Calcium Hardness = 110 mg/L as $CaCO_3$, and Alkalinity = 90 mg/L as $CaCO_3$.
- a. 90
- b. 20
- c. 30
- d. 50

7. Which of the following are typical noncarbonate anions present in water?

○ a. carbonate and bicarbonate
○ b. sulfate and chloride
○ c. nitrate and carbonate
○ d. bicarbonate and acetate

8. A water sample has calcium hardness of 90 mg/L as $CaCO_3$. What is its calcium hardness in meq/L?

○ a. 45 meq/L
○ b. 2.0 meq/L
○ c. 1.8 meq/L
○ d. 50 meq/L

9. Which of the following is the equivalent weight to be used for converting meq/L of quicklime to mg/L of quicklime?

○ a. 37
○ b. 53
○ c. 28
○ d. 22

10. Which lime soda softening process alternative discussed in this course is capable of providing the most complete hardness removal from the water being treated?

○ a. Selective calcium removal
○ b. Split treatment
○ c. All are capable of reaching the same level of hardness in the finished water.
○ d. Two-stage, excess lime softening

11. Which of the following is the purpose for adding soda ash in the Two-stage, excess lime softening process?

○ a. to precipitate non-carbonate hardness
○ b. to neutralize the excess lime added in the first stage
○ c. to precipitate magnesium hardness

12. The single-stage, selective calcium removal process works well for water sources with magnesium hardness of _____.

○ a. 40 mg/L as $CaCO_3$ or less
○ b. 60 mg/L as $CaCO_3$ or greater
○ c. 60 mg/L as $CaCO_3$ or less
○ d. 40 mg/L as $CaCO_3$ or greater

13. Split treatment typically requires less chemicals than the two-stage excess lime process because _____.

○ a. noncarbonate hardness is not removed
○ b. magnesium hardness is not removed
○ c. only a portion of the influent is treated with excess lime and the bypassed portion is used to neutralize the excess lime
○ d. no soda ash is used in this softening process

14. Which lime soda water softening process should be used to treat water that has the following analysis: total hardness = 140 mg/L as $CaCO_3$; calcium hardness = 110 mg/L as $CaCO_3$; alkalinity = 100 mg/L as $CaCO_3$?

○ a. Split Treatment
○ b. Two-Stage Excess Lime Treatment
○ c. Selective Calcium Removal
○ d. Single Stage Excess Lime Treatment

15. Which of the following correctly describes the typical location for recarbonation in the split treatment softening process?

- a. after the first stage sedimentation
- b. after filtration
- c. after the second stage sedimentation
- d. Recarbonation is not typically used in the split treatment softening process.

16. The level of excess lime typically used in the two-stage, excess lime softening process is about _____.

- a. 120 mg/L as $CaCO_3$
- b. 35 mg/L as $CaCO_3$
- c. 12 mg/L as $CaCO_3$
- d. 95 mg/L as $CaCO_3$

NOTE: The following question was revised on 22 June 2018

17. The calcium hardness removed from water in any of the lime soda softening processes is precipitated as _____.

- a. calcium carbonate ($CaCO_3$)
- b. calcium sulfate ($CaSO_4$)
- c. calcium hydroxide [$CaOH)_2$]
- d. Calcium bicarbonate [$CaHCO_3)_2$]

18. What fraction of the incoming flow should be bypassed in a split treatment lime soda softening process which has the Mg hardness in the raw water = 1.1 meq/L, if the lower limit of the Mg hardness residual is taken to be 0.2 meq/L, and the design final Mg hardness in the treated water is 0.8 meq/L?

- a. .544
- b. 0.667
- c. 0.752
- d. 0.612

19. Calculation of the daily requirement of any of the lime soda softening chemicals in lb/day requires values for the dosage of the chemical, the design plant flow, and _____.

- a. the equivalent weight of the chemical
- b. the alkalinity of the raw water
- c. the molecular weight of the chemical
- d. the equivalent weight of $CaCO_3$

20. The magnesium hardness removed from water in any of the lime soda softening processes is precipitated as _____.

- a. magnesium carbonate ($MgCO_3$)
- b. magnesium sulfate ($MgSO_4$)
- c. magnesium hydroxide [$Mg(OH)_2$]
- d. magnesium bicarbonate [$Mg(HCO_3)_2$]