DW Module 22:
Inorganic Removal
Answer Key

Municipal and Industrial Discharge

What are some examples of municipal and industrial discharges that contribute inorganics to the water supply?

Ans: Phosphorous from municipal wastewater treatment plants contribute inorganics.
NOTE TO INSTRUCTOR: Various other answers are possible.

Non-point and Run-off

What are some examples of non-point and run-off that contribute inorganics to the water supply?

Ans: Inorganics are contributed from nitrates due to run-off from fields to which fertilizer has been applied; sodium from salting icy roads; and iron from acid mine drainage.
NOTE TO INSTRUCTOR: Various other answers are possible.

Water in Contact with Piping

What are some inorganics that find their way into the water supply via water in contact with piping?

Ans: Inorganics are found due to increased lead levels because of dissolution of lead-tin solder used in plumbing fixtures; “red water” is due to the corrosion of cast iron pipes; and asbestos in water is from leaching of asbestos-cement pipes.
NOTE TO INSTRUCTOR: Various other answers are possible.

Water Treatment By-products

What are some examples of water treatment by-products that contribute inorganics in the water supply?

Ans: Contributions include aluminum residuals from overfeeding aluminum sulfate (alum), a water treatment plant coagulant; and bromate formation as a by-product of feeding ozone for disinfection to a raw water containing bromine.
NOTE TO INSTRUCTOR: Various other answers are possible.

What consequences could scale from hard water produce?

Ans: It can produce scale formation inside water conveyance pipes, which could lead to problems such as gradual restrictions in the pipe cavity, increased pumping expenses, and so on.
NOTE TO INSTRUCTOR: Various other answers are possible.

REVIEW:

Exercise

Match the letter of the definition to the word it describes.

1. __D__ Solute
2. __E__ Supersaturated
3. __G__ Precipitation
4. __A__ Oxidation
5. __B__ Anion
6. __F__ Cation
7. __C__ Buffer

A. A chemical reaction between an oxidant chemical, such as chlorine, and a soluble constituent, such as manganese, that results in the constituent being converted into its solid form.

B. An elemental atom or compound with a negative charge.

C. A water whose chemical makeup neutralizes any acids or bases added, without a significant change in pH.

D. The dissolved component of a solution.

E. Unstable condition in water, whereby a substance is contained at a concentration greater than the saturation concentration for that substance.

F. An elemental atom or compound with a positive charge.

G. The separation from a solution of a substance made insoluble as the result of a chemical reaction.

Write your answer below each question.

8. Name three sources of inorganic constituents.

Ans: Any three of the following are acceptable: naturally occurring; municipal and industrial discharges; non-point and runoff; water in contact with pipe materials; water treatment by-products.

9. What do MCL drinking water standards protect?

Ans: Primary Maximum Contaminant Levels protect acute and chronic health concerns.

10. What do SMCL drinking water standards protect?

Ans: Secondary Maximum Contaminant Levels protect against aesthetically unpleasant characteristics.

11. List three conditions that may contribute to process selection for inorganics removal.

Ans: Any three of the following are acceptable: target contaminant to be removed; source water quality and variability; reliability of the treatment process; existing conditions; flexibility; utility capabilities; and environmental compatibility.

12. How can in-plant sources contribute to high levels of iron and manganese?

Ans: Accumulated solids in sedimentation basins can become anoxic (anaerobic) and "go septic," which results in the conversion of particulate iron and/or manganese into their soluble forms, with subsequent release to the process flow; downstream filtration may not be able to remove these contaminants.

13. Identify three common treatments for iron and manganese.

Ans: Any three of the following may be acceptable (site specific): oxidation/filtration; coagulation/filtration; ion exchange; and sequestration.

14. Identify two common treatments for aluminum.

Ans: pH adjustment/coagulation/filtration and coagulant dose adjustment/filtration are treatments.

15. Identify two common treatments for hardness.

Ans: Any two of the following may be acceptable (site specific): ion exchange; lime softening; membrane filtration; and sequestration.

16. Identify one common treatment for nitrates.

Ans: Any one of the following is acceptable: ion exchange or membrane filtration.

17. List two less common inorganics and one treatment for each.

Ans: Any treatment from the following list is acceptable for the specific inorganic: arsenic (precipitation; adsorption; ion exchange; membrane filtration); hydrogen sulfide (GAC; oxidizing filter; manganese greensand; aeration/filtration; chemical oxidation with chlorine/filtration; chemical oxidation with potassium permanganate/filtration; chemical oxidation with ozone/filtration).

18. Should ion exchange be used for surface or groundwater sources?

Ans: Ion exchange is used for groundwater sources.

19. Which treatments are actually pretreatment techniques for filtration?

Ans: Oxidation and coagulation are pretreatments for filtration.

20. Explain how ion exchange works.

Ans: In ion exchange, a chemical process is used to reversibly transfer ions between synthetic media (referred to as a resin with the ion exchange process) and the water being treated. The specific type of resin used has a selective affinity for the ions of one element over another; ions of the element saturated onto the resin are replaced with the target (undesirable) ions of another element due to preferential selection for this ion by the resin. Depending on the desired element to be treated, an anion- or cation-based resin is used.