Indiana Water Operator Training Manual

Lesson Seven – WT3 operators

Contents

WT3 systems and operators

A class WT3 (Water Treatment 3) system includes systems that meet the following:

- (A) Acquire water from one (1) of the following:
  - (i) Ground water
  - (ii) Purchase
- (B) Utilize chemical feed
- (C) Have one (1) of the following:
  - (i) Pressure or gravity filtration
  - (ii) Ion exchange processes if the population served is greater than five hundred one (501)
  - (iii) Lime soda
  - (iv) Reverse osmosis

A grade WT3 operator is a certified operator qualified to operate a Class WT1, WT2 and WT3 water treatment plant after having fulfilled the following requirements:

- (A) Possess a high school diploma or its equivalent
- (B) Meet the qualifications of the certification rule
- (C) Must be able to:
  - (i) maintain inventories;
  - (ii) order supplies and equipment; and
  - (iii) interpret chemical and bacteriological sample reports
- (D) Attain the following acceptable work experience at a minimum:
  - (i) Two (2) years in the operation of a class WT3 water treatment plant
  - (ii) Successful completion of educational work at college level in:
    - (AA) engineering
    - (BB) chemistry, or
    - (CC) science related to water treatment may be substituted for work experience required according to item (i) at the ratio of four (4) semesters or six (6) quarters of schooling for a maximum substitution of one (1) year of experience

For persons employed by a DSL, WT3, WT4 or WT5 system, an Operator in Training (OIT) classification is available.

A grade Operator-in-Training (OIT) is available under the following guidelines:

(1) to a person meeting the following:

(A) Currently employed at a public water system with facilities classified as a class WT 3, class WT 4 or class WT 5 water treatment plant or a DSL water distribution system

(B) has fulfilled the qualifications of the certification rule

(2) In accordance with the following:

(A) Until the OIT meets the experience requirement needed for the classification of treatment plant or distribution system where the OIT is accumulating work experience

(B) Operating work must be accomplished under the supervision of a certified operator-in-responsible-charge who must verify to the Commissioner the satisfactory achievement of acceptable experience by the OIT

(C) An OIT may not:

(i) serve as a certified operator in responsible charge

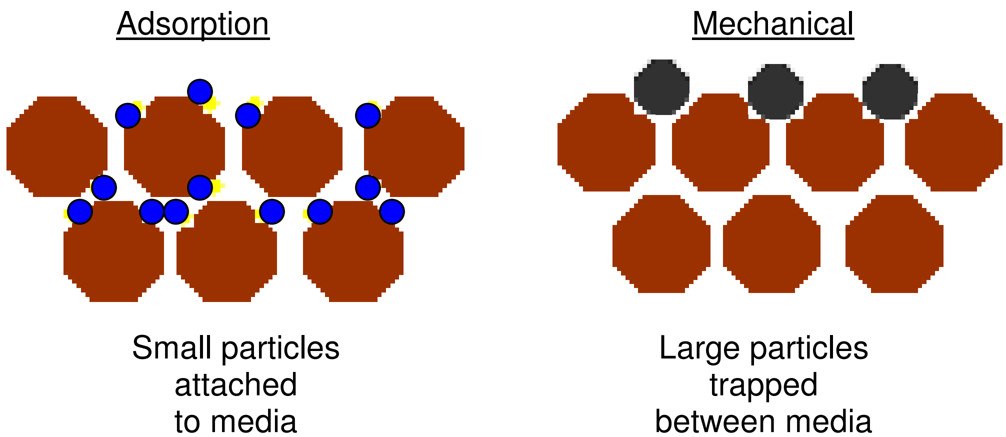
(ii) transfer an OIT certification to a water treatment plant or distribution system with a public water system identification number (PWSID) different than the PWSID for which the certification was issued;

(iii) hold two (2) treatment plant or distribution system OIT certifications concurrently; or

(iv) renew the OIT certification

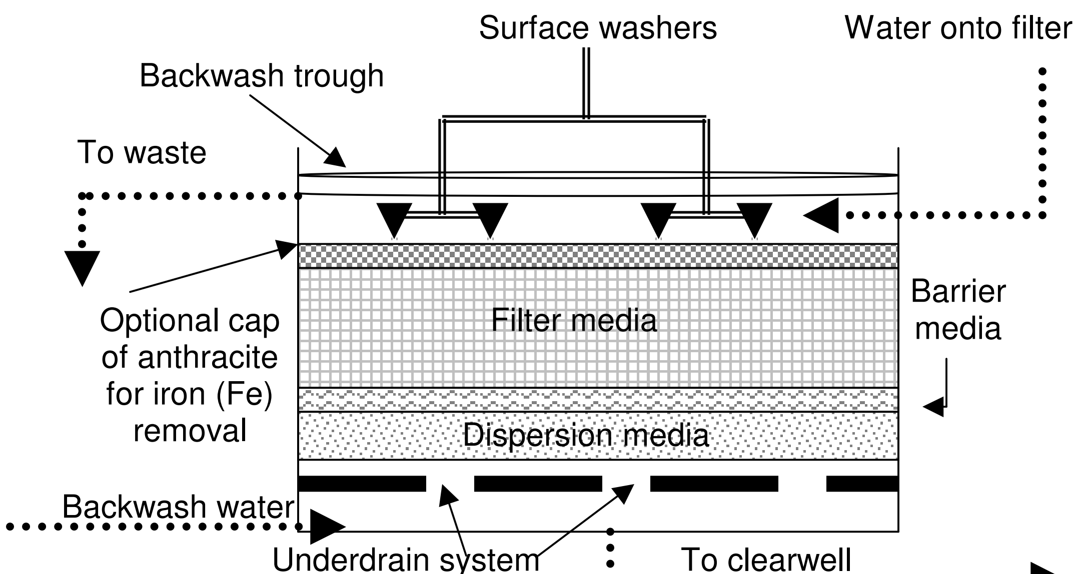
Filtration

Both gravity and pressure water treatment filters work using the same principles. Water flows through a media mixture (usually sand) and particles suspended in the water either attach to the irregular surfaces of the media by adsorption, or the particles are trapped between media by mechanical means. The following drawings illustrate the two types of filtration.



Gravity filters

Gravity water treatment filters are usually found in larger treatment facilities. Here is a typical diagram:



The steps of gravity filtration are:

1. Turn on the water and allow it to flow onto the filter at a rate of about two gallons per minute per square foot of media surface area.

2. If possible, waste the filtered water at the beginning of the filter run because the first few minutes of the run often produce somewhat turbid water (turbidity spike).

3. As the filter accumulates contaminants, the water level will rise due to the build-up of particles from adsorption and mechanical filtration. This is called “head loss.” Operating experience will determine the head loss point at which the filter should be backwashed (cleaned).

4. When the need for backwashing is observed, turn off the incoming water and allow the filter to drain.

5. Close the filter drain and, if equipped with surface washers, run them for a few minutes to break up the particles trapped at the surface of the filter.

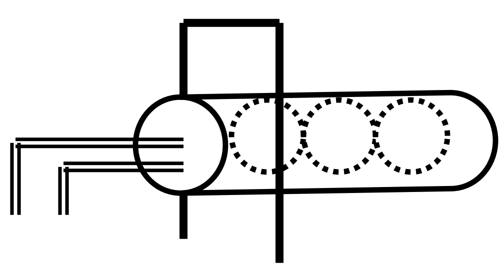
6. Introduce clean (previously treated) water to the bottom of the filter at a rate-of-flow sufficient to expand the filter media by about 20-25%. The backwash water will flow into the backwash trough to waste. Again, operating experience will determine how long to backwash.

7. Allow the filter to rest unused for an hour or more before placing it back into service.

Pressure filters

Pressure filters work very much like gravity filters, but pressure filters, as the name implies, are fully enclosed and operated under pressure.

Vertical pressure filters are usually, but not always, fairly small (say, four to eight feet high). These compact units are well suited for smaller water systems and lend themselves to easy expansion. Horizontal pressure filters often are found in larger water systems. These filters can be quite large (20 or more feet long) and can be located with the piping inside a building and the rest of the structure outside of the building. There may be multiple filter cells within a single tank.



While similar in design and operation to gravity filters, pressure filters can operate at much higher rates-of-flow than gravity filters. Filter flows of six to 12 gallons per minute per square foot of media surface area are not uncommon, but vary by manufacturer.

Backwash rates for pressure filters vary between manufacturers. It is important to follow the backwash instructions provided by the filter manufacturer or design engineer.

For both gravity and pressure filters, it is important to note that lower water temperatures require lower backwash rates, and higher water temperatures require higher backwash rates. Remember, colder water is denser than warmer water.

Lime soda softening

As previously discussed in lesson five of this manual, hard water has calcium (Ca) or magnesium (Mg) ions in it. Usually we measure hardness as calcium carbonate ($CaCO_3$). It is a molecule made of one atom of calcium, one atom of carbon (C) and three atoms of oxygen. Hardness is usually measured in milligrams per liter (mg/l) or grains per gallon (GPG).

Hardness as calcium carbonate

	mg/l	*GPG*
Soft water	0-17	0.0-1.0
Moderately hard water	60-120	3.5-7.0
Very hard water	180 & over	10.5 & over

(1 GPG = 17.1 mg/l)

There are two kinds of water hardness. Carbonate hardness is known as temporary hardness. Heating water causes precipitation (dropping out of solution) of carbonate hardness. It is one of the reasons why water heaters get deposits at the bottom.

Non-carbonate hardness is permanent and heating water does not affect it. Non-carbonate hardness comes from sulfates and chlorides of calcium and magnesium in water.

Lime soda softening is a two-stage process and is used to reduce the hardness of very hard water. Water with 35-40 grains per gallon (GPG) can be reduced to a hardness of 5-10 GPG. Slake lime [$Ca(OH)_2$] can be added to hard water to precipitate the carbonate hardness. Filtration, clarification, settling, etc., can remove the precipitate.

Soda ash (Na_2C0_3) is added after the reduction of carbonate hardness and the non-carbonate hardness precipitates and, again, can be removed by filtration, clarification, settling, etc.

Lime soda softening requires large settling tanks and has pros and cons:

Advantages

- Reduction of some total dissolved solids
- Taste and odor improvements
- Removal of:
    - Iron
    - Arsenic
    - Heavy metals

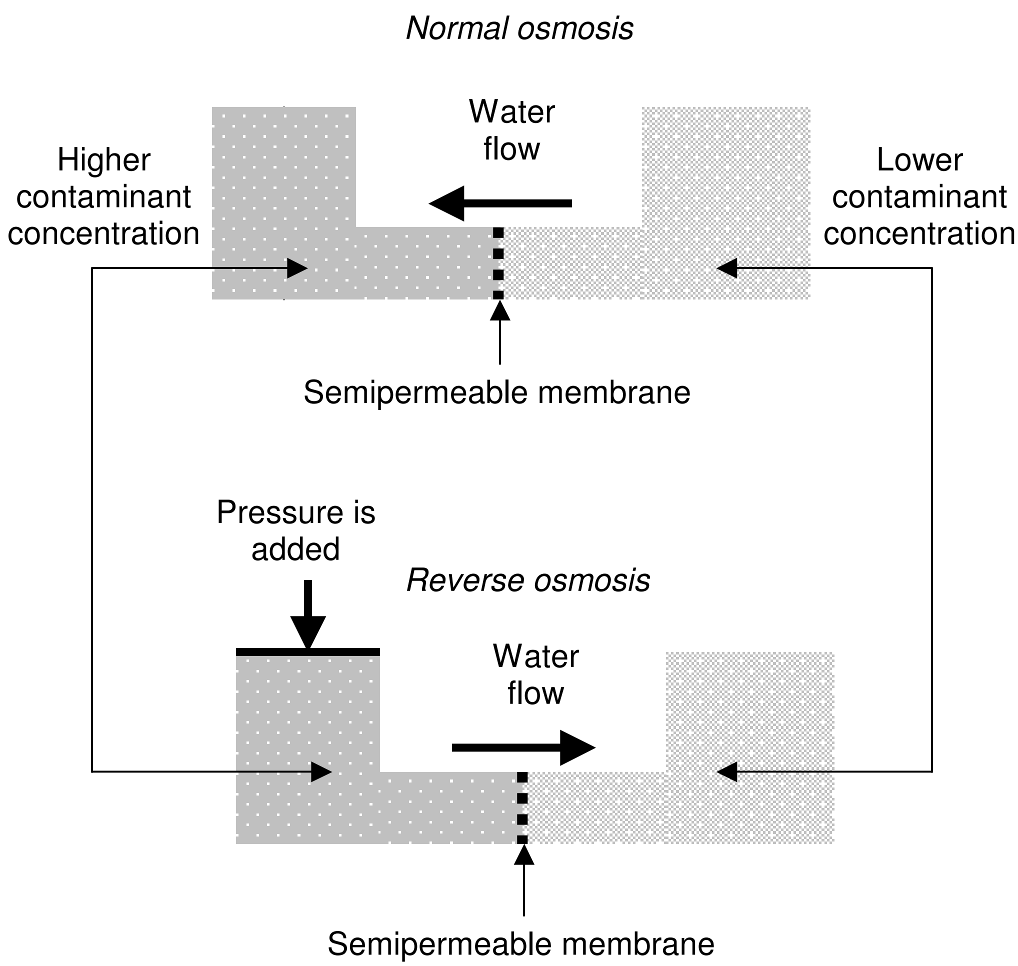
Disadvantages

- Requires pH adjustments
- Systems hard to operate and control
- Sludge disposal a problem

Reverse osmosis

According to Dictionary.com, osmosis is the diffusion of fluid through a semipermeable membrane from a solution with a low solute concentration to a solution with a higher solute concentration until there is an equal concentration of fluid on both sides of the membrane. Reverse osmosis is a method of producing pure water by forcing saline or impure water through a semipermeable membrane across which salts or impurities cannot pass.

Sometimes a couple of pictures are better than 69 big words.



As is the case with most water treatment methods, there are a variety of considerations to be made when choosing reverse osmosis.

Reverse osmosis can reduce:

- Arsenic
- Asbestos
- Fluoride
- Herbicides
- Lead
- Mercury
- Nitrate
- Pesticides
- Radium
- Salt

Semipermeable membranes are fragile:

- Hard water can clog membrane
- Chlorine can destroy membrane
- Membrane must be rinsed regularly to prevent scaling
- Prefiltration is usually required

Advanced ion exchange softening

Advanced ion exchange softening at water treatment plants works much like a basic ion exchange softener, but on a larger scale. Undesirable hardness ions are exchanged for more desirable ions. Various types of chemicals and resins may be used, depending upon the manufacturer's design.

Many advanced ion exchange softening units are fairly small, like vertical pressure filters, and can be combined for increased capacity.

Advanced ion exchange softening is best used for additional softening following lime-soda softening, or treating water that is not too hard to begin with, say less than (<) 10 GPG.

This type of softening has little effect on the pH of water. Some types of softeners may add salt to water, which is undesirable for people with certain health conditions.

Ion exchange should not be used when the concentration of iron (Fe), manganese (Mn) or the combination of the two exceeds 0.3 mg/l. Ion exchange should not be used on raw or wash waters containing *(high)* dissolved oxygen.

Most deep well waters are fairly low in dissolved oxygen (DO). Shallow wells may have higher DO. In low DO water, Fe and Mn are soluble and remain dissolved in the water. Water softeners will remove some soluble Fe and Mn.

In high DO water, Fe and Mn become insoluble, are no longer dissolved, and become visible as red colored and staining. Water softeners will become clogged from insoluble Fe and Mn. Prefilters ahead of the softener are necessary to remove Fe and Mn in high DO situations.

Sometimes water system customers may complain of a thin black sludge or oily sheen on top of their coffee or tea. Fe and/or Mn reacting with the tannins and acids in beverages often cause this condition. These complaints are a good indicator that Fe and/or Mn are slipping through the water treatment system.

Congratulations. You have completed lesson seven of the Indiana Water Operator Training Manual.

To test your comprehension of the material included in lesson seven, a self-graded examination has been prepared for your use. The examination begins on the next page. There are 10 questions that will take a total of about 10-15 minutes to complete. Do not over analyze the questions. Just look for the best answer.

Good luck with the test. You will find the answers in Appendix G-7 of this manual.

There is a Microsoft PowerPoint® slideshow associated with these lessons. The slideshow is located on the compact disc included with this manual.

If you do not have the disc, or would like to view the slideshow on the Internet, you may find it at http://www.Indianawateroperatortraining.org.

Indiana Water Operator Training

Self-graded examination

Lesson 7

<u>Check one best answer per question</u>

Question1.
Water filtration removes impurities by what means?
___A. Adsorption
___B. Mechanical
___C. Ion exchange
___D. Both A and B above

Question 2.
Anthracite (coal) cap layers are used in water filters to assist in the removal of what?
___A. Oxygen (O_2)
___B. pH (0-14)
___C. Hydrogen (H)
___D. Iron (Fe)

Question 3.
Media expansion is the best guide for backwashing pressure filters.
___A. True
___B. False

Question 4.
Lime-soda softening lowers the pH of water it treats.
___A. True
___B. False

Question 5.
Reverse osmosis can reduce levels of:
___A. Arsenic
___B. Lead
___C. Pesticides
___D. All of the above

Question 6.
Semipermeable membranes are used in reverse osmosis because they are tough and can take a lot of abuse.
___A. True
___B. False

Question 7.
Your water system water is very hard (>40 GPG). Which is not a good choice for softening the water?

___A. Reverse osmosis
___B. Ion exchange
___C. Lime-soda
___D. None of the above

Question 8.
In normal operation (treatment mode), a household water softener, like the ones to the right, work by:

___A. Exchanging salt for hardness
___B. Exchanging hardness for salt
___C. Filtering out hardness
___D. All of the above

Question 8.

Question 9.
High dissolved oxygen in the raw water improves the operation of ion exchange water softeners.

___A. True
___B. False

Question 10.
Reading tea leaves can be fun. Can you learn anything about your water quality from your customer’s tea?

___A. Yes
___B. No