DW Module 14:
Conventional Filtration
Answer Key

UNIT 1 EXERCISE:

Multiple Choice

1. Combined filter effluent turbidity must be below
   A. 0.3 NTU in at least 95% of the turbidity measurements taken and 1.0 NTU at all times
   B. 1.0 NTU in at least 95% of the turbidity measurements taken and 1.5 NTU at all times
   C. 0.3 NTU in at least 95% of the turbidity measurements taken and 0.5 NTU at all times
   D. 0.5 NTU in at least 95% of the turbidity measurements taken and 1.0 NTU at all times

2. Typical sources of turbidity in raw water sources include:
   A. Humic acids and other organic compounds resulting from decay of plants, leaves
   B. High iron concentrations which give waters a rust-red coloration
   C. Heavy rains flushing into a water reservoir
   D. All of the above

3. National Secondary Drinking Water Regulations:
   A. Are focused on treatment goals that are below the regulatory Primary Maximum Contaminant Levels for those contaminants that present health risks based on acute or chronic exposure
   B. Are guidelines regulating contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water
   C. Both A and B
   D. None of the above

4. Venturi and magnetic flow measurement systems are used to:
   A. Regulate the rate at which water flows into the water treatment plant
   B. Measure the rate at which water flows into the water treatment plant
   C. Monitor the chemical which flow into the water treatment plant
   D. All of the above

Vocabulary Review:

											[1]T						
											U						
											R						
											B						
											I						
											D			[2]C			
											I			O			
				[3]C	O	A	G	U	L	A	T	I	O	N			
											Y			V			
														E			
														N			[4]C
														T			L
										[5]D				I			A
	[6]F	L	O	C	C	U	L	A	T	I	O	N		O			R
										S				N			I
[7]S	E	D	I	M	E	N	T	A	T	I	O	N		A			F
										N				L			I
										F				[8]F	L	O	C
										E				I			A
										C				L			T
							[9]S			T				T			I
					[10]C	O	L	L	O	I	D	S		R			O
							U			O				A			N
							D			N				T			
							G							I			
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														N			

UNIT 2 EXERCISE:

1. List the primary coagulants (3 metallic salts and 1 synthetic inorganic polymer) used in the coagulation process.

Ans: *Aluminum Sulfate*
Ferric Sulfate
Ferric Chloride
Polyaluminum Chloride

2. In the space provided, explain the importance of coagulant aids—synthetic organic polymers.

Ans: Coagulant Aids strengthen and add density to the flocs.

3. List three types of chemicals that can be used to add or replace alkalinity or pH.

Ans: Lime, soda ash, caustic soda.

For the following statements, make those that are true with a T, those that are false with an F.

4. *T* The effectiveness of sedimentation, filtration and overall plant performance depends on successful coagulation/flocculation.

5. *F* Poor coagulation/flocculation does not affect performance.

6. *T* Appropriate personal protective equipment needed when handling alum includes goggles, gloves and a respirator.

7. *F* When dissolved in water, alum generally produces negatively charged ions.

8. *F* Using iron slats instead of alum for coagulation is less effective over a broader pH range.

9. *T* Adding chemicals at the wrong location may cause floc to be too large.

10. *T* Coagulants added in the influent line before a flash mix basin will produce better results.

11. *T* Mixing is the rapid uniform distribution of a chemical in the water being treated.

12. *T* If caustic soda comes in contact with skin, burns will result.

13. *T* If an operator observes floc splitting and breaking up in the flocculation chamber, the rate of the flocculators should be slowed down.

14. *T* The main purpose of coagulation/sedimentation is to remove turbidity.

15. *T* A systems Emergency Response Plan contains information on how to clean up a chemical spill.

16. *T* Compartmentalized flocculation chambers allow increasingly large floc to form without being broken apart by the mixing blades.

17. *T* In multiple stage flocculation, floc particles should increase in size.

18. *F* A pH under 9.0 could result in increased dissolved aluminum.

19. F__ Polyphosphate is used to add density to floc particles.

20. F__ Collision of floc particles decreases the overall size of the floc.

21. T__ To overcome slow floc formation in cold water, coagulant aids can be added.

22. F__Coagulant should be added just after a static mixer.

23. A system treats 845,000 gallons of water using 25 pounds of calcium hydroxide (slaked lime) every day. What is the dose?
    a. 1.42 mg/L
    b. 3.55 mg/L
    c. 7.11 mg/L
    d. 9.23 mg/L

24. A system uses 225 lbs of dry polymer as coagulant aid each day to treat a plant flow set at 3,260,000 gpd. What is the dose?
    a. 576.33 mg/L
    b. 103.27 mg/L
    c. 8.28 mg/L
    d. 4.21 mg/L

25. If the plant flow is set at 350,000 gallons and the system uses 12 pounds of anhydrous ferric chloride, what is the dose?
    a. 4.11 mg/L
    b. 411 mg/L
    c. 2.86 mg/L
    d. 286 mg/L

26. The flow to a flocculation basin is 399,000 gpd. The basin holds 11,550 gallons. What is the detention time in the tank, in minutes?
    a. 42 minutes
    b. 35 minutes
    c. 37 minutes
    d. 39 minutes

Unit 3 Exercise

Word Box

a. Water temperature b. Particle size c. Inlet zone d. Detention time e. Gravitational settling f. Particle shape g. Outlet zone h. Relationship of downward movement of particle to forward flow velocity i. Rectangular basin j. Circular or Square basin	k. Electrical charge of particle l. Environmental conditions m. Sludge n. Clarifiers o. Surface loading rate p. Sludge zone q. Settling zone r. Mean flow velocity s. Weir overflow rate t. Tube or Plate settlers

Use the Word Box above to complete the following:

1. Identify the four zones of a sedimentation basin.

   c – Inlet zone
   g – Outlet zone
   p – Sludge zone
   q – Settling zone

2. List four operating parameters important to sedimentation.

   d – Detention time
   o – Surface loading rate
   r – Mean flow velocity
   s – Weir loading rate

3. List the settling characteristics upon which the sedimentation process is dependent.

   a – Water temperature
   d – Gravitational settling
   k – Electrical charge of particle
   b – Particle size
   f – Particle shape
   l – Environmental conditions
   h – Relationship of downward movement of particle to forward flow velocity

Fill in the blanks:

4. The largest portion of the horizontal flow sedimentation basin is the settling zone.

5. If the motor is normally running and the sludge collector is not moving, the most likely cause of a clarifier sludge collector problem would be that a shear pin is broken.

6. A sludge collector device should move very slowly.

7. Increased flow to the treatment plant will affect the settling tank in that the detention time will decrease and the overflow rate will increase.

8. A series of thin parallel plates installed at 45-degree angle for shallow depth sedimentation are known as lamellar plates.

9. Two methods of improving settling efficiency in a sedimentation basin are using tilted plates or tube settlers.

10. If the weir overflow rate for a clarifier is too high, floc carry over will be observed.

11. Improper coagulant dosage and/or improper pH, could cause floc carry over.

12. When increasing the flow rate, the weir overflow rate for the clarifier will be increased.

13. A sedimentation basin is 65 feet long, 20 feet wide and has water to a depth of 12 feet. If the flow to the basin is 1297 gpm, what is the detention time in hours?

Step 1. Determine the volume of the basin:

Volume = Length x Width x Depth
65 feet x 20 feet x 12 feet
15,600 ft^3 for the first basin
x 7.48 gallons conversion factor
116,688 gallons

Step 2. Determine the detention time:

$$\text{Detention Time (time)} = \frac{\text{Volume of Tank (gallons)}}{\text{Influent Flow}}$$
$$= \frac{116{,}688 \text{ gallons}}{1297 \text{ gpm}}$$
$$= 90 \text{ minutes}$$

Step 3. Convert min to hours:

$$\text{hours} = 90 \text{ min} \times \frac{\text{hour}}{60 \text{ min}} = 1 \text{ hour } 30 \text{ minutes} = (1.5 \text{ hours})$$

UNIT 4 EXERCISE:

1 – 4. There are four performance considerations of Filtration listed below. Match each consideration with the correct explanation of that consideration.

Ans:

Performance Consideration	Explanation
Filter Media	Filter production and efficiency
Filter Underdrains	The materials used to filter out impurities
Filter Operating Parameters	The process of reversing the flow of water back through the filter media to remove trapped material.
Backwashing	Where filtered water is collected during normal operation.

5. List two ways filters can become air bound.

Allowing the filter to run too long

Release of dissolved gases from water in the filter

Water is drawn down below the filter surface

6. How can a system achieve longer filter run times?

By applying a layer of anthracite to the filter

Choose the correct answer:

7. The removal of particulates by trapping in the open space between the grains of the media:
   a. Straining
   b. Adsorption
   c. Biological Action
   d. Absorption

8. The measurement used to define the uniformity of filter media:
    a. Specific Gravity
    b. Hardness
    c. Uniformity Coefficient
    d. All of the above

9. One of the most common techniques of eliminating the turbidity spike directly after a filter backwash is to filter to waste during the:
    a. End of a timed backwash
    b. Filter ripening period
    c. Middle of a timed backwash
    d. None of the above

10. Ways to reduce filter ripening time:
    a. Delayed start-up
    b. Filter aid addition like an anionic polymer or coagulant
    c. Filter to waste
    d. All of the above

11. A problem in a filter that can prevent water from uniformly passing through a filter:
    a. Well formed floc
    b. Mudballs
    c. Air binding
    d. Both b and c

12. A method used to indicate when a filter needs backwashed:
    a. Time
    b. Head loss
    c. Increase in effluent turbidity (breakthrough)
    d. All of the above

13. Backwash rates set too high:
    a. This is not a problem
    b. Can cause loss of filter media
    c. Will not adequately expand the filter bed
    d. All of the above

14. A backwash normally uses _____ of treated water produced (finished water).
    a. 1-2%
    b. 2-5%
    c. 6-8%
    d. 8-10%

15. A filter 35 feet wide by 20 feet long needs a backwash rate of 20 gallons per minute per square foot. Determine the required backwash pumping rate in gpm.
    a. 12,000 gpm
    b. 13,000 gpm
    c. 14,000 gpm
    d. 15,000 gpm

16. What is the filter capacity (in gpm) of a system with a sand bed 40 feet in diameter when the filters are rated to have a capacity of 2.5 gpm/sq ft?
    a. 78.5 gpm
    b. 250 gpm
    c. 1,500 gpm
    d. 3,140 gpm

17. A system has filters that measure 25 feet long and 15 feet wide. What is the rated total capacity at a rate of 2 gpm/sq ft?
    a. 250 gpm
    b. 500 gpm
    c. 750 gpm
    d. 1,000 gpm

18. Determine the filter loading rate of a filter 20 feet in diameter treating a flow of 1500 gpm.
    a. 4.8 gpm/sq ft
    b. 9.8 gpm/sq ft
    c. 15.1 gpm/sq ft
    d. 95.2 gpm/sq ft

19. A filter 25 feet long and 35 feet wide treats a total of 1400 gpm. What is the filter loading rate?
    a. 1.6 gpm/sq ft
    b. 3.2 gpm/sq ft
    c. 3.4 gpm/sq ft
    d. 9.8 gpm/sq ft

20. A filter has a diameter of 35 feet. If the desired backwash rate is 25 gpm/sq ft, what backwash pumping rate (gpm) will be required?
    a. 687 gpm
    b. 1,508 gpm
    c. 12,761 gpm
    d. 24,041 gpm

UNIT 5 EXERCISE:

A. Write the 5 components of *Normal* operations of conventional filtration on the lines below.

1.Process Performance Monitoring

2.Process Controls and Equipment

3.Process Support Equipment

4.Housekeeping

5.Laboratory Testing

B. Circle all of the following which are indicators of abnormal operating conditions.

6. Filter backwash solids
7. Filter control valves
8. Floc
9. Increased filtered water turbidity
10. Increased raw water turbidity
11. Jar Test
12. Media cracks and shrinkage
13. Mud balls
14. Rapid filter headloss increase
15. Short filter runs
16. Turbidimeter

C. True/False Mark the following statements with at "T" for true or an "F" for false.

T 17. Process performance monitoring is an ongoing activity for plant operators.
F 18. New analytical equipment never needs calibration.
T 19. Some plants use air scour during filter backwash.
T 20. If a diaphragm pump looks to be operating, but the chemical feed is less than expect, suspect a ruptured diaphragm.
T 21. Equipment maintenance is a routine operating procedure.
T 22. Good floc formation is an indicator of properly operating coagulation/flocculation equipment.
T 24. Sludge drying beds reduce the volume of sludge that must be handled or disposed.
F 25. Media "boils" during filter backwash are an indication of proper cleaning.
F 26. Raw water alkalinity does not affect the water treatment process.