

PRETREATMENT

Field Guide

Nicholas G. Pizzi



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CHAPTER 1

Regulations

This field guide, which is designed to be carried in a shirt pocket, is intended to provide water treatment plant operators with basic tools to use at the job site. The guide is divided into general sections addressing the regulatory, theoretical, operational, inspection, and maintenance considerations of the mixing, coagulation, and sedimentation processes. It also addresses mixing and chemical addition for lime-softening applications and is primarily suited for operators who use mechanical and in-line mixing components that use metal salt coagulants for forming floc particles that settle and filter well. Where applicable, the book includes a discussion on the nature and quantity of solids produced during the processes.

D/DBPR REQUIREMENTS

The Disinfectants/Disinfection Byproducts Rule (D/DBPR) has a large effect on treatment strategies used by public water systems



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(PWSs) in the United States. Water treatment plants (WTPs) that employ coagulation strategies based solely on lowering the turbidity output of the finished product may find that this practice does not always suffice. To control or minimize the production of disinfection by-products (DBPs), WTPs that employ conventional filtration must operate with enhanced coagulation or enhanced softening to achieve the percent removal levels of total organic carbon (TOC) specified in the D/DBPR. Table 1-1 shows the required percentages, which are based on raw water TOC levels and alkalinity.

TABLE 1-1 Required TOC removal levels based on source water alkalinity

TOC, mg/L	Source Water Alkalinity, mg/L as CaCO ₃		
	0–60	>60–120	>120
>2.0–4.0	35.0%	25.0%	15.0%
>4.0–8.0	45.0%	35.0%	25.0%
>8.0	50.0%	40.0%	30.0%

Source: USEPA, *Enhanced Coagulation and Enhanced Precipitative Softening Guidance Manual*, 1999.

ALTERNATIVE COMPLIANCE CRITERIA

Alternatively, a PWS may avoid enhanced coagulation if it can meet one of the following six alternative compliance criteria or one of the two softening criteria discussed in this guide.

1. The source water TOC level is < 2.0 mg/L, calculated quarterly as a running annual average (RAA).
2. The treated water TOC level is < 2.0 mg/L, calculated quarterly as an RAA.
3. The source water TOC level is < 4.0 mg/L, calculated quarterly as an RAA, the source water alkalinity is > 60 mg/L (as CaCO_3), calculated quarterly as an RAA, and either the total trihalomethanes (TTHM) and haloacetic acids (HAA5) RAA are no greater than 0.040 mg/L and 0.030 mg/L, respectively, or the PWS has made a clear and irrevocable financial commitment to the use of technologies that limit TTHM and HAA5 levels to no more than 0.040 mg/L and 0.030 mg/L, respectively. These technologies were required to be installed no later than June 16, 2005.



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4. The RAAs for the TTHM and HAA5 are no greater than 0.040 mg/L and 0.030 mg/L, respectively, and the PWS uses only chlorine for primary disinfection and maintenance of a residual in the distribution system.
5. The PWS's source-water specific ultraviolet absorption (SUVA) at 254 nm, prior to any treatment and measured monthly, is less than or equal to 2.0 L/mg-m, calculated quarterly as an RAA.
6. The finished-water SUVA, measured monthly, is less than or equal to 2.0 L/mg-m, calculated quarterly as an RAA.

ADDITIONAL ALTERNATIVE COMPLIANCE CRITERIA FOR SOFTENING SYSTEMS

1. Softening that results in lowering the treated-water alkalinity to less than 60 mg/L (as CaCO_3), measured monthly and calculated quarterly as an RAA
2. Softening that results in removing at least 10 mg/L of magnesium hardness (as CaCO_3), measured monthly and calculated quarterly as an RAA

CHAPTER 2

Pretreatment Goals

ENHANCED COAGULATION GOALS

Utilities that cannot meet the compliance criteria should know their enhanced coagulation endpoint or the coagulant dosage and pH value which, when achieved, no longer produces significant TOC reduction. Specifically, the enhanced coagulation endpoint has been reached when the source water TOC is not reduced by at least 0.3 mg/L with an incremental dosage increase of 10 mg/L alum (or equivalent ferric salt), and the pH value of the water in the mixing zone reaches a value listed in Table 2-1.

TABLE 2-1 Values for pH in mixing zone needed for enhanced coagulation

Alkalinity, mg/L	Max pH value
0–60	5.5
>60–120	6.3
>120–240	7.0
>240	7.5

Source: USEPA, *Enhanced Coagulation and Enhanced Precipitative Softening Guidance Manual*, 1999.



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The values in Table 2-1 indicate the operator's need for pH monitoring or control equipment in the mixing zone. Goals for pH and detention times need to be established, and all plant operators must know how to check the plant performance against these goals.

Any two WTPs will have different performance goals because each plant's source water quality is different. At a minimum, though, every operator should know the plant goal for pH in the mixing zone.

For example, surface water plants that use alum as a primary coagulant and have colloidal turbidity and TOC in the source water might have a pH goal of 6.0 to 6.2. Each operator at such a plant will monitor the pH of the mixer every two hours, record the result, and adjust alum feed accordingly. Whatever the goals, all shift operators need to understand them and monitor the water for adherence to the goals. Management and staff must set the operating goals and ensure that all staff buy in to them.

SEDIMENTATION GOALS

Sedimentation, or settling, usually depends on gravity to settle or remove particles that are in suspension in the pretreated water. Some further flocculation also occurs in the basins as water flows through them. In the case of upflow solids clarifiers (Figure 2-1), flocculation is a dynamic part of the overall sedimentation process that takes place in the same unit.

These sedimentation basins may be rectangular or circular and may be fitted with devices such as tube settlers (Figure 2-2) that allow them to operate at higher flow rates, but they are all supposed to accomplish a

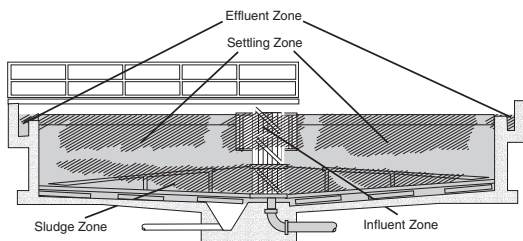


FIGURE 2-1 Cross section of a typical sedimentation basin



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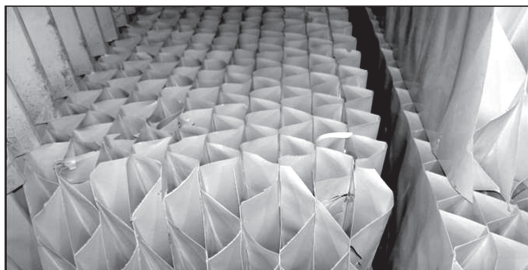


FIGURE 2-2 Tube settlers

primary goal: produce pretreated water of a consistent quality that can be applied to the filters regardless of the incoming source water quality. Put another way, water coming into a sedimentation basin may vary in quality, but water coming out the other end should be reasonably stable in all quality values measured.

Conventional surface water treatment plants will have goals for sedimentation effluent turbidity, and lime-softening plants may have additional goals for pH, alkalinity, and hardness, especially if recarbonation takes place at the end of the basin. If pre-chlorination takes place, plants may have goals for chlorine residual also. Iron- and manganese-removal plants may also need to set removal-efficiency goals for these metals.



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All of a plant's operators need to be aware of the established plant goals and should measure the parameters on a sufficiently frequent basis and be able to make necessary changes.

Suggested turbidity goals for conventional surface water treatment plants are as follows:

- If the average source water turbidity is less than 10 ntu, the sedimentation basins should produce water with a turbidity value of less than 1 ntu 95 percent of the time.
- If the average source water turbidity is greater than 10 ntu, the sedimentation basins should produce water with a turbidity value of less than 2 ntu 95 percent of the time.

Softening plants will have site-specific goals for pH, alkalinity, and hardness for basin effluent, and the operators need to be familiar with them.

Plants that prechlorinate usually strive to keep a small amount of free available chlorine at the end of the sedimentation process so the filters do not become biologically active or carry iron or manganese through them. However, there are exceptions.



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the operator must be aware of the particular requirements at his or her plant.

Sedimentation basins are usually designed to provide a minimum detention time and to allow for loading rates that have been shown to produce properly clarified water.

Detention times for sedimentation basins are determined by dividing the volume by the flow.

Example: If a WTP has two sedimentation basins, each with a capacity of 250,000 gal, what is the overall detention time through sedimentation if the plant is operating at 4 mgd?

Answer: $(2)(250,000 \text{ gals}) \div 4,000,000 \text{ gals/day} = 0.125 \text{ days, or } 3 \text{ hr}$

Loading rates are usually expressed at surface overflow rate (SOR) and weir overflow rate (WOR). The surface area of the basin is used in the first calculation; the total weir length is used in the other.

Examples are as follows: If the surface dimensions of a basin are 58 ft × 100 ft, and the flow through that basin is 5 mgd, what is the SOR?

Answer: 5 mgd is 3,472 gpm. Therefore, the SOR is $3,472 \text{ gpm} \div (58 \text{ ft} \times 100 \text{ ft}) = 0.6 \text{ gpm/ft}^2$



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