Enhanced Coagulation/Enhanced Softening

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Outline

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Introduction

- The 1986 Amendments to the Safe Drinking Water Act (SDWA)
- EPA developed list of maximum contaminant level goal (MCLG) for many contaminants found in drinking water
- For each contaminant, EPA had to establish either a treatment technique or maximum contaminant level (MCL)

Introduction

- The purpose of Stage 1 Disinfection Byproduct Rule (DBPR) is to reduce exposure to disinfection byproducts (DBPs) by limiting allowable DPB concentration in drinking water, and removing DBP precursor material to reduce the formation of identified and unidentified DBPs.
- Stage 1 of the DBPR establishes maximum contaminate levels (MCLs) for some of the know DBPs, maximum residual disinfection levels (MRDLs) for commonly used disinfectants, and a treatment technique for removal of DBP precursor material to reduce the formation of DBPs.
- The DBPR includes MCLs for selected DPBs
  - thrihalomethanes, haloacetic acids, bromate, and chlorite.
- Maximum residual disinfectant levels (MRDLs) for selected disinfectants
  - Chlorine, chloramines, and chlorine dioxide

Introduction

- The MCLs and MRDLs will provide protection against the potential advisers health effects associated with disinfectants and DBPs
- However, it was realized that these limits alone may not address the potential health risks from all DBPs, including those with have yet to be identified

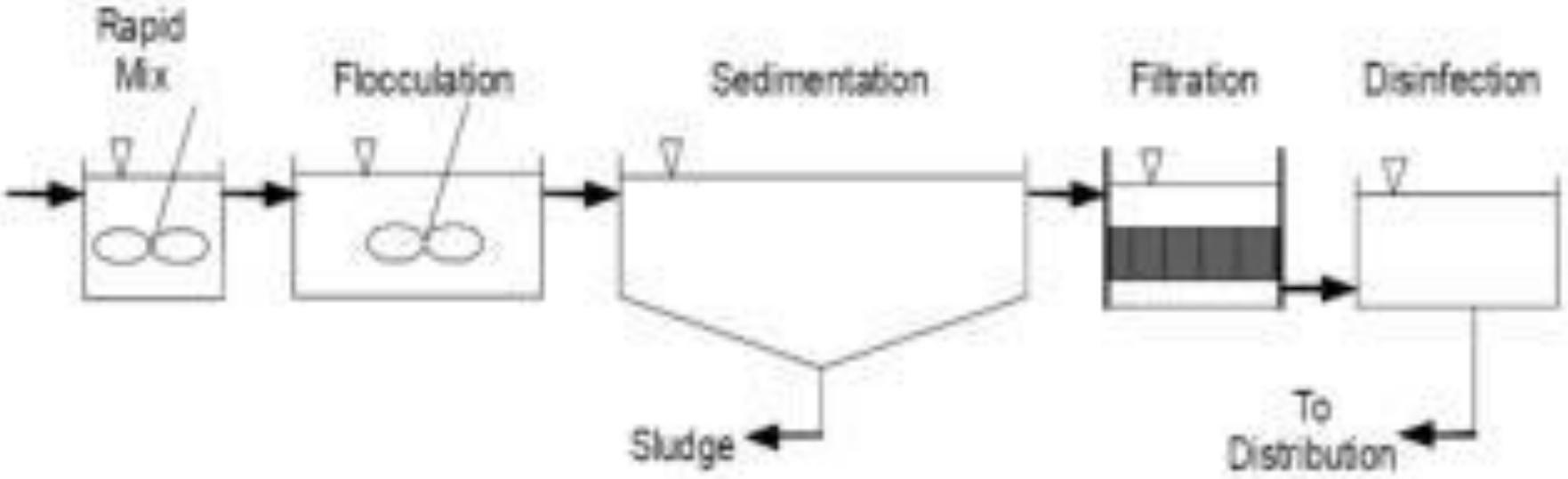
Introduction

- Consequently, a treatment technique requirement is included in the DBPR
- The purpose of the treatment technique for DBP precursor removal is to reduce the formation of DBPs
- Natural Organic Matter (NOM) reacts with disinfectants to form DBPs
  - Therefore, lowering the concentration of NOM (measured as TOC) can reduce DBP formation

Introduction

- TOC removal is required for certain plants under the Stage 1 Disinfectants and Disinfection By-Products Rule (DBP1R)
- The TOC requirements apply to plants that treat surface water or groundwater under the direct influence of surface water (GUDI) using coagulation and sedimentation for treatment

Conventional Surface Water Treatment for Drinking Water



Applicability

- Some type of treatment trains are excluded from the enhanced coagulation/enhanced softening requirements because
  - There source water is expected to be a higher quality (have lower TOC levels)
  - Treatment train are not typically configured to allow significant TOC removal

Applicability

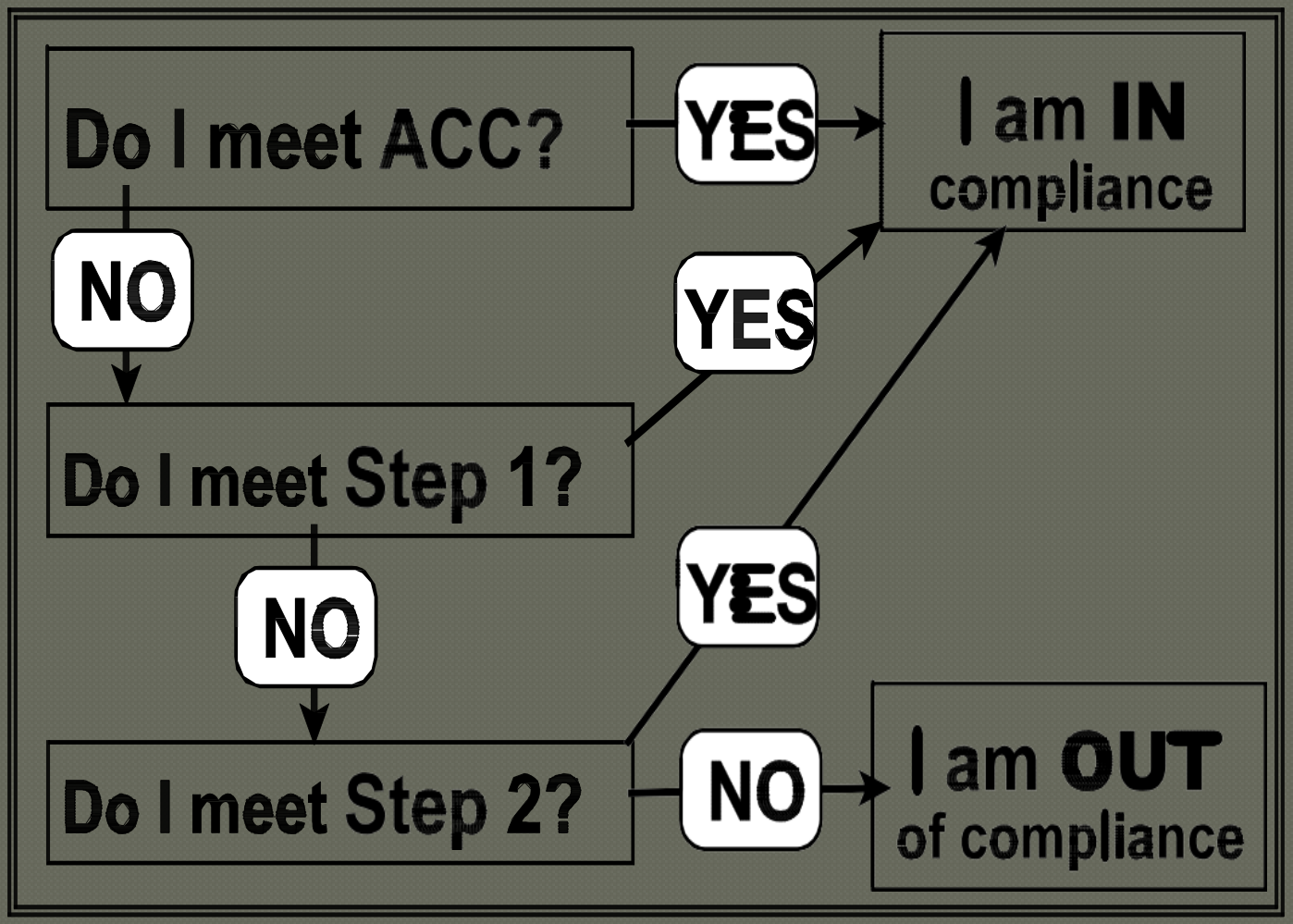
- Why TOC?
  - Easily measured
  - Easily monitored
- However, basing a performance standard on a uniform TOC removal requirement is inappropriate because some waters are epically difficult to treat.

Applicability

- To address these concerns, a two-step performance standard was developed
  - Step 1 requires removal of a specific percentage of influent TOC to demonstrate compliance, based on the TOC and alkalinity of the source water
  - Step 2 allows systems with difficult-to-treat water to demonstrate to the State, through a specific protocol, an alternative TOC removal level for defining compliance
  - The rule also contains certain alternative compliance criteria that allows a system to demonstrate compliance

Applicability

- If the plant does not meet on the of the alterative compliance criteria (ACC or "outs") you must determine whether the plant can meet the Step 1 removal requirement for its water
- If the plant cannot meet Step 1 TOC removal requirements, you must use the Step 2 requirements


Do I meet ACC?
YES
I am IN compliance
NO
YES
Do I meet Step 1?
NO
YES
Do I meet Step 2?
NO
I am OUT of compliance

Step 1

Source Water TOC (mg/L)	Source Water Alkalinity (mg/L)		
	0 to 60	>60 to 120	>120
> 2.0 - 4.0	35.0%	25.0%	15.0%
> 4.0 – 8.0	45.0%	35%	25%
> 8.0	50.0%	40%	30%

Step 2 Alternative TOC Removal Requirements

- A Step 2 jar test will establish the plants required percent removal rate for up to six month
- In a Step 2 jar test, 10 mg/L increments of alum (or an equivalent about of iron coagulant) are added to determine the incremental removal of TOC
- TOC removal is calculated for each 10 mg/L increment of coagulant added
- Coagulant must be added in the required increments until the target pH is achieved

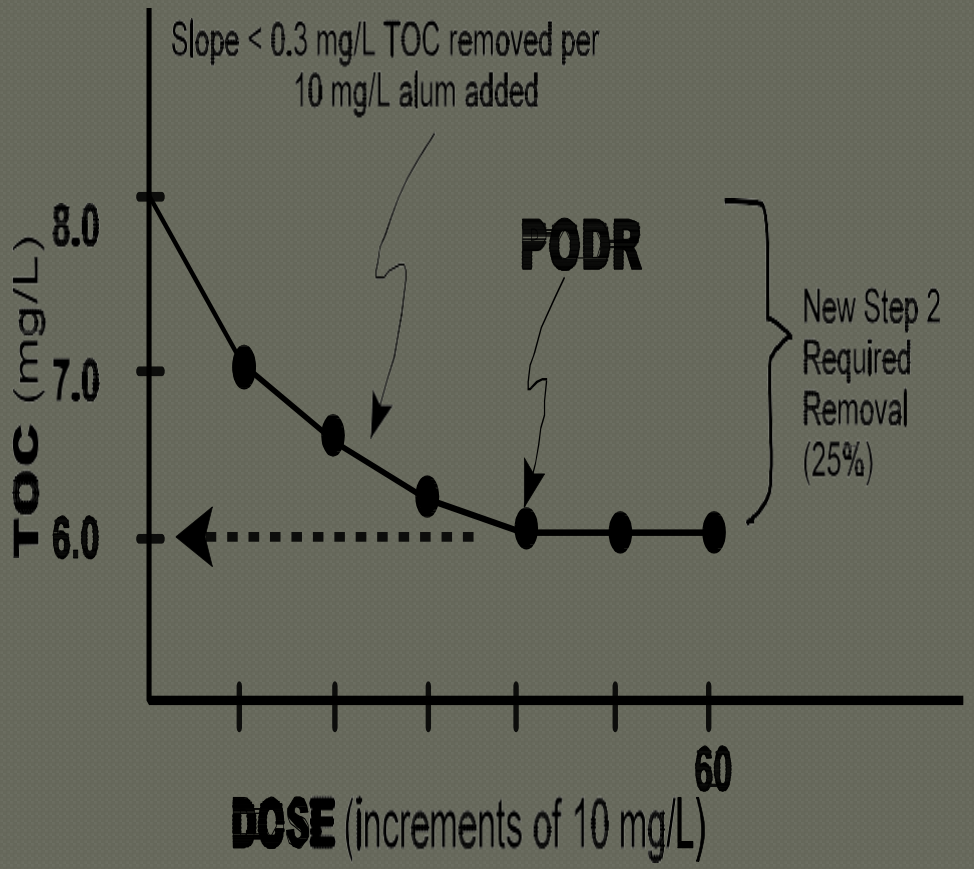
Step 2

- The point where adding another 10mg/L dose of alum does not remove at least 0.3 mg/L of TOC is defined as the point of diminishing return (PODR)
- The percentage of TOC achieved at the PODR in the Step 2 jar test is defined as the plants alternative percent TOC removal requirement

Alum Dose (mg/L)	TOC Level (mg/L)	Change in TOC (mg/L)	TOC Removal (%)
0	4.9	NA	NA
10	4.2	0.7	14.3
20	3.8	0.4	22.2
30	3.5	0.3	28.6
40	3.3	0.2	32.7
50	3.2	0.1	34.7

PODR

Alternative Percent TOC Removal Requirement

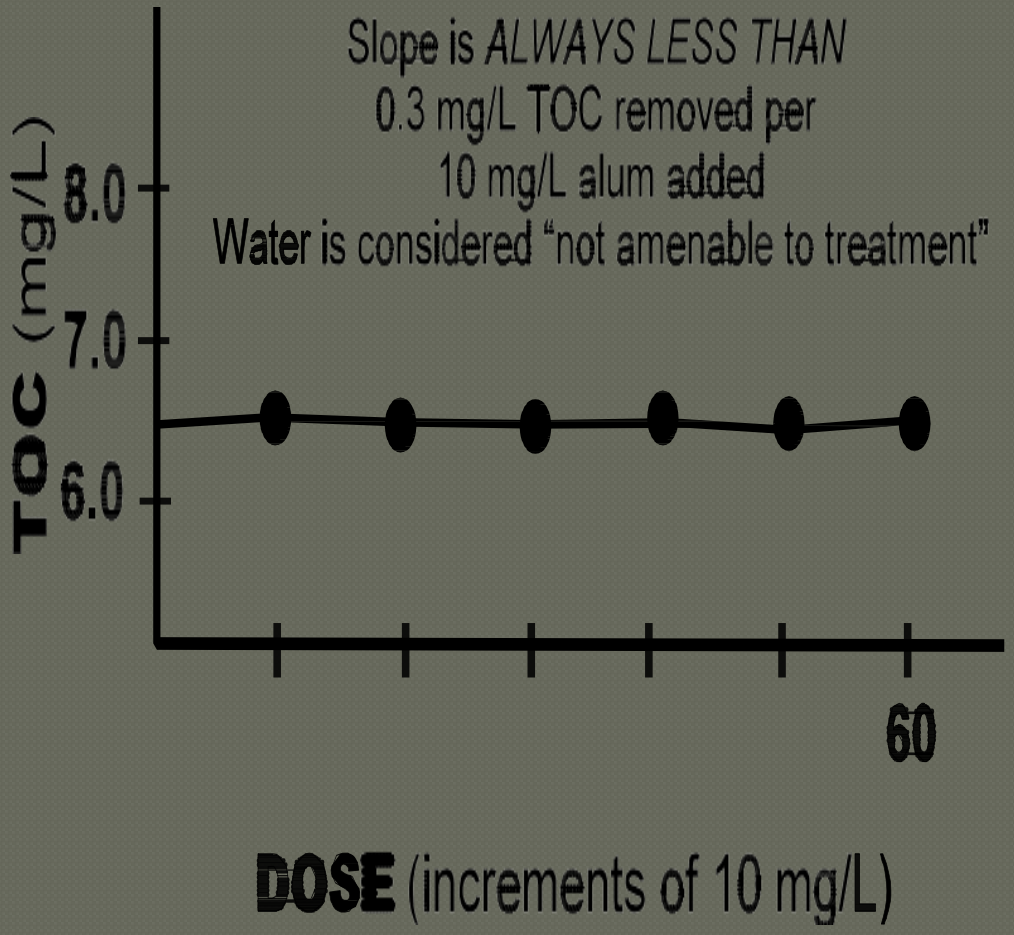

Slope < 0.3 mg/L TOC removed per
10 mg/L alum added
PODR
New Step 2
Required
Removal
(25%)
TOC (mg/L)
8.0
7.0
6.0
60
DOSE (increments of 10 mg/L)

Step 2

- The goal of Step 2 is to determine the amount of TOC that can be removed with reasonable amounts of coagulant and to define an alternative TOC removal percentage
- The procedure is neither designed nor intended to be used to establish a full-scale coagulant dose requirement
- Once a plants alternative TOC removal percentage is approved a plant may achieve this removal at full scale by suing any appropriate combination of treatment chemicals

Step 2

- Water "Not Amenable to Treatment"
  - Sometimes, a Step 2 jar test will show that there is no additional TOC removal, no matter how much coagulant is added
  - Plants may apply to the state for a waiver from the enhanced coagulation requirements if they consistently fail to achieve the PODR
- These plants have a raw water in which enhanced coagulation will not work


Slope is *ALWAYS LESS THAN*
0.3 mg/L TOC removed per
10 mg/L alum added
Water is considered "not amenable to treatment"
TOC (mg/L)
8.0
7.0
6.0
60
DOSE (increments of 10 mg/L)

Alternative Compliance Criteria

ACC	Description	Additional sampling
1	Raw water TOC < 2.0 mg/L	None
2	Treated water TOC < 2.0 mg/L	None
3	TTHM < 40 µg/L; and HAA5 < 30 µg/L, and raw water TOC < 4.0 mg/L; and raw water alkalinity > 60 mg/L	None
4	TTHM < 40 µg/L; and HAA5 <30 µg/L and the system only uses chlorine	None
5	Raw water SUVA < 2.0 L/mg-m	Raw water SUVA
6	Treated water SUVA <2.0 L/mg-m	Treated water SUVA
7	Softening; treated water alkalinity less than 60 mg/L	Treated water alkalinity
8	Softening; magnesium hardness removal greater than or equal to 10 mg/L	Raw and treated water magnesium

ACC

- ACC 1: Raw Water TOC < 2.0 mg/L
- If the raw water contains less than 2.0 mg/L of TOC, calculated quarterly as a running annual average
- This standard also can be used on a monthly basis. For example, in every month in which raw water TOC is less than 2.0 mg/L, the plant can establish compliance for that month by meeting this criterion
- Monitoring and Reporting: There are no extra monitoring and reporting requirements for this "out"

ACC

- ACC 2: Treated Water TOC < 2.0 mg/L
- If a treated water contains less than 2.0 mg/L TOC calculated quarterly as a running annual average, the utility is in compliance with the treatment technique
- This criterion also can be used on a monthly basis. For example, for individual months in which treated water TOC is less than 2.0 mg/L, the plant can establish compliance for that month by meeting that criterion
- Monitoring and Reporting: There are no extra monitoring and reporting requirements for this "out"

ACC

- ACC 3: Raw Water TOC < 4.0 mg/L and
  Raw Alkalinity > 60 mg/L (as CaCO3) and
  TTHM < 40 µg/L and
  HAA5 < 30 µg/L
- It is more difficult to remove TOC from waters with higher alkalinity and lower TOC levels. Therefore, utilities that meet the above criteria can establish compliance with the treatment technique requirements. All of the parameters— TOC, alkalinity, total trihalomethanes (TTHM), haloacetic acids (group of five) (HAA5)—are based on running annual averages, computed quarterly. TTHM and HAA5 compliance samples are used to qualify for this alternative performance criterion
- If the running annual average of each measure listed above satisfies the respective values, the plant is in compliance
- This ACC cannot be used on a monthly basis because the TTHM and HAA5 averages for a whole year are used to calculate compliance.

ACC

- ACC 4: TTHM < 40 µg/L and
  HAA5 < 30 µg/L and
  Chlorine Only
- Plants that use only free chlorine as their primary disinfectant and for maintenance of a residual in the distribution system and that achieve the stated TTHM and HAA5 levels are in compliance with the treatment technique. The TTHM and HAA5 levels are based on running annual averages, computed quarterly. TTHM and HAA5 compliance samples are used to qualify for this alternative performance criterion
- If the running annual average of TTHM is less than 40 µg/L and the running annual average of HAA5 is less than 30 µg/L and the plant uses only chlorine in the plant and distribution system, the plant is in compliance
- This ACC cannot be used on a monthly basis, because the TTHM and HAA5 average for a whole year (running annual average) is used to calculate compliance

ACC

- ACC 5: Raw Water SUVA < 2.0 L/mg-m
  - (liters/milligram-meter)
- If the raw water specific ultraviolet absorption (SUVA) is less than or equal to 2.0 L/mg-m, calculated quarterly as a running annual average, the utility is in compliance with the treatment technique requirements. The EPA guidance document includes a more thorough discussion of SUVA.
- If the running annual average SUVA is less than or equal to 2.0 L/mg-m, the utility is in compliance
- This criterion also can be used on a monthly basis. For example, in every month in which raw water SUVA is less than 2.0 L/mg-m, the plant can establish compliance for that month by meeting this criterion.

ACC

- ACC 6: Treated Water SUVA < 2.0 L/mg-m
- If the treated water SUVA is less than or equal to 2.0 L/mg-m, calculated quarterly as a running annual average, the utility is in compliance with the treatment technique requirements
- This criterion is also available on a monthly basis; for individual months in which treated water SUVA is less than or equal to 2.0 L/mg-m, the plant can establish compliance for that month by meeting ACC 6

ACC

- Specific UV Absorbance (SUVA) calculation is
  - SUVA is simply the UV absorbance at the 254 nm wavelength divided by the DOC of a water sample
  - A high SUVA indicates that a large portion of the organics present in the water

ACC

- ACC 7: Treated Water Alkalinity < 60 mg/L (as CaCO3) (Softening Systems)
- Softening plants meet ACC 7 if their treated water alkalinity is less than 60 mg/L (as CaCO3), measured monthly and calculated quarterly as a running annual average. Softening plants that currently practice lime softening are not required to change to lime-soda ash softening.
- This criterion can be used on a yearly basis. If treated water alkalinity is less than 60 mg/L, calculated quarterly as a running annual average, the plant is in compliance
- This criterion also can be used on a monthly basis. For example, in every month in which a softening plant lowers treated water alkalinity to less than 60 mg/L, the plant can establish compliance for that month by meeting this criterion

ACC

- ACC 8: Magnesium Removal > 10 mg/L (as CaCO3) (Softening Systems)
- Softening plants meet ACC 8 (in Table 8.1) if they remove at least 10 mg/L of magnesium hardness (as CaCO3), measured monthly and calculated quarterly as a running annual average. Softening plants that currently practice lime softening are not required to change to lime-soda ash softening.
- This criterion can be used on a yearly basis. If magnesium removal is at least 10 mg/L, calculated quarterly as a running annual average, the plant is in compliance
- This criterion also can be used on a monthly basis. For example, in every month in which magnesium removal is more than 10 mg/L, the plant can establish compliance for that month by meeting this criterion

Questions