Collects and stores water prior to delivery to treatment plant

Removes large debris (fish, sticks, trash, etc.)

Controls algae and other taste and odor causing compounds

Mixes chemicals with raw water to begin coagulation process

Gathers fine particles together to allow for sedimentation and filtration

Settles out suspended particles

Filters suspended particles not settled out

Kills bacteria and other disease causing organisms

Provides disinfectant contact time and stores water for high demand
Coagulation and Flocculation

Vocabulary

Alkalinity
The capacity of water to neutralize acids. This is caused by carbonate, bicarbonate, hydroxide, borate, silicate and phosphate.

Apparent Color
Color of the water that includes not only the color due to substances in the water, but suspended matter as well.

True Color
Color of the water from which turbidity has been removed by filtering.

Coagulation
The clumping together of very fine particles into larger particles (floc) caused by the use of chemicals.

Composite Sample
A collection of samples taken at regular intervals over a 24 hour span. They are combined to form one sample that is representative of the average conditions during the sample period.

Grab Sample
A single sample of water collected at a particular time and place which represent the composition of the water at that particular place and time.

Representative Sample
A sample of water that is nearly identical in content and consistency as possible to that in the larger body of water being sampled.

Disinfection By-Products (DBP’S)
A contaminant formed by the reaction of disinfection chemicals with other substances in the water being disinfected.

Floc
Clumps of bacteria and particulate impurities that have come together to form a cluster.

Flocculation
The gathering together of fine particles after coagulation to form larger particles by a process of gentle mixing.
Jar Test
A laboratory procedure that simulates a water treatment plant’s coagulation/flocculation units with differing chemical doses to determine the optimum coagulant dose.

Specific Gravity
The weight of a particle, substance, or solution in relation to the weight of an equal volume of water. Water has a specific gravity of 1.000 at 4°C.

Conventional Treatment

1. Coagulation –
2. Flocculation –
3. Sedimentation –
4. Filtration -

Coagulation Chemistry Basics

1. Water contains negative ions
2. Positive ions are added to neutralize the negative charge (coagulant)
3. Insoluble floc forms and settles or is filtered out
4. pH effects coagulant’s effectiveness
5. Source water with alkalinity < 40 mg/L is difficult to treat
<table>
<thead>
<tr>
<th>Chemical</th>
<th>Formula</th>
<th>Function (primary coagulant or aid)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum Sulfate</td>
<td>$\text{Al}_2\text{(SO}_4\text{)} \cdot 14 \text{H}_2\text{O}$</td>
<td></td>
</tr>
<tr>
<td>Ferrous Sulfate</td>
<td>$\text{FeSO}_4 \cdot 7 \text{H}_2\text{O}$</td>
<td></td>
</tr>
<tr>
<td>Ferric Sulfate</td>
<td>$\text{Fe}_2\text{(SO}_4\text{)}_3 \cdot 9 \text{H}_2\text{O}$</td>
<td></td>
</tr>
<tr>
<td>Ferric Chloride</td>
<td>$\text{FeCl}_3 \cdot 6 \text{H}_2\text{O}$</td>
<td></td>
</tr>
<tr>
<td>Cationic Polymer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anionic Polymer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonionic Polymer</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Types of Flash Mixing** (<60 second mix time)

1. Hydraulic
2. Mechanical
3. Diffuser
4. Pumped Blender
Streaming Current Meter

1. Measures water charge
   
   Zeta Potential – The difference between the charge of a particle and the water surrounding it. (measured in millivolts)

2. As charge approaches “0” coagulation is optimized

3. Most plants run slightly negative

Enhanced Coagulation
A process designed to remove Natural Organic Matter (NOM)

1. Reduces DBP precursors

2. Lowers pH with acid or CO\textsubscript{2} rather than coagulant

3. Different than “Sweep Coagulation”

Chemical Reactions

Fulvic and Humic substances are found in water and are negatively charged (anions). To remove these substances from the water, the first step is to destabilize or “neutralize” them. This is accomplished by the addition of a positively charged (cationic) inorganic salt (alum, ferric sulfate). Once neutralized, these substances form larger floc particles in the flocculation process and are removed by the settling process.

Different coagulants perform best in different pH ranges. Alum performs best at a pH between 5.5-7.0 with the optimum pH being 5.8. Ferric Sulfate performs best in the pH range of 4.0-6.2 with the optimum pH being 4.5.
The optimum pH enhances coagulation in four main ways:

1. Humic and Fulvic substances dissociate to a lesser degree at lower pH

2. The coagulant demand decreases correspondingly to the degree of molecular dissociation

3. Flocculation is improved at lower pH

4. Sulfuric acid addition prior to coagulant feed preconditions the organic compounds

Jar Testing

1. Used to optimize coagulant dose

2. Used to determine optimum pH

3. Used to determine how much acid is required

4. Used to determine if alkalinity addition is necessary
## Water Treatment Review

<table>
<thead>
<tr>
<th>Change in Source Water</th>
<th>Operator Action</th>
<th>Potential Process Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbidity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alkalinity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Color</td>
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</tr>
</tbody>
</table>

## Change in Coagulation Water Quality Results

| pH                                     |                 |                          |
| Alkalinity                             |                 |                          |
| Turbidity                              |                 |                          |

## Changes in Floc Formation

| Poor Floc Quality                      |                 |                          |