

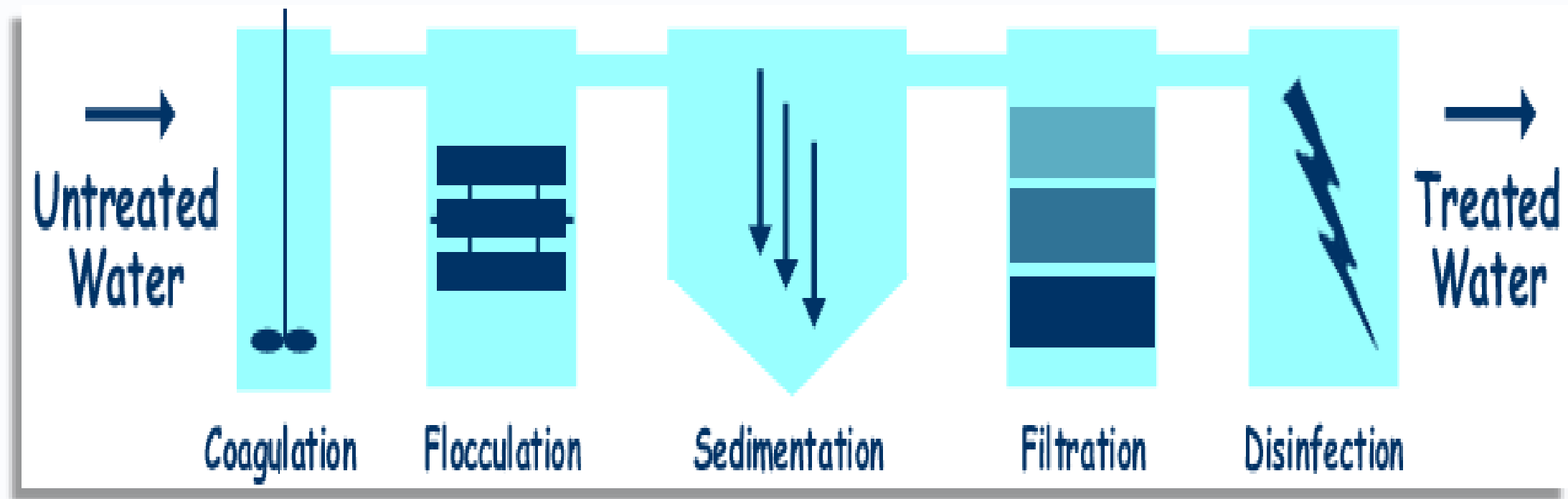
Wastewater Treatment Lecture 10

Coagulation-Flocculation

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Untreated to Treated Water



Size classification of solids in water

Type	Description	Size (mm)
Dissolved	Material consists of molecules or ions that are held by molecular structure of water.	$< 10^{-6}$
Colloidal	Very small particles that technically are suspended but often exhibit many of the characteristics of dissolved substances	$10^{-6} - 10^{-3}$
Suspended	Suspended material consists of particles that are supported by buoyant and viscous forces within water	$> 10^{-3}$

Sedimentation Aided With Coagulation

Turbidity Explained

Turbidity refers to the cloudiness of water caused by suspended particles.

Clear water has low turbidity, while highly turbid water is difficult to disinfect.

Coagulation/Flocculation

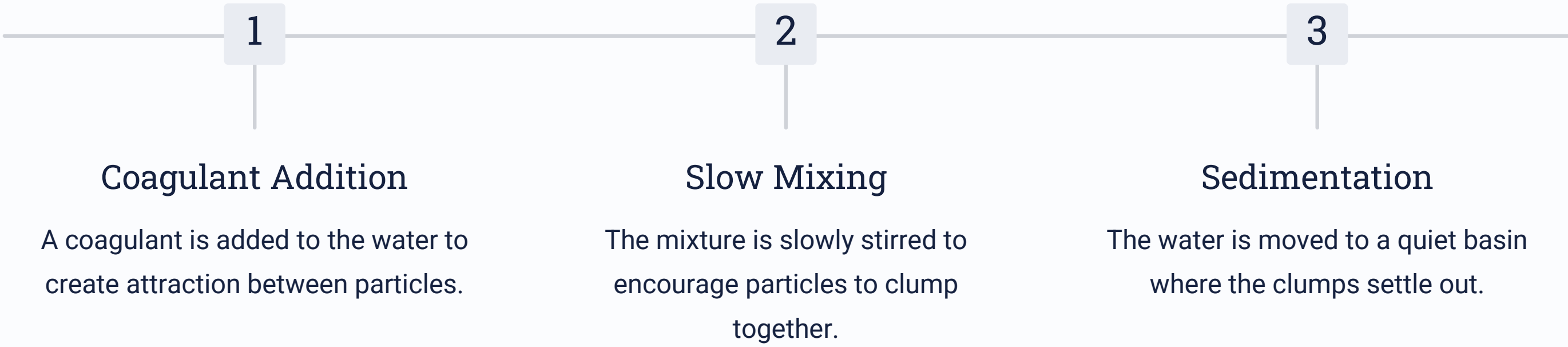
The primary goal of this process is to remove turbidity from the water.

It involves creating larger, easier-to-remove particles.





Coagulation-Flocculation



Coagulation

Challenge

Small particles are hard to remove by sedimentation or filtration.

Solution

Coagulation creates larger particles that are easier to remove.

Mechanism

Chemicals like alum neutralize the negative charges on particles, allowing them to stick together.



Coagulation

1

Alum Addition

A chemical like alum is added to the water.

2

Rapid Mixing

Rapid mixing dissolves the chemical and distributes it evenly.

3

Neutralization

The chemical neutralizes the negative charges on particles.

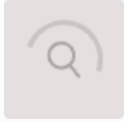
4

Clumping

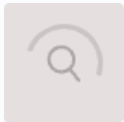
Particles can now stick together, forming larger clumps.



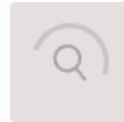
Coagulants



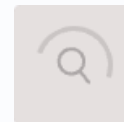
Aluminum Sulfate



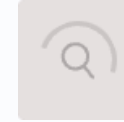
Iron Sulfate



Iron Sulfate



Iron Chloride



Lime



- Aluminum salts are typically cheaper, while iron salts are more effective over a wider pH range.

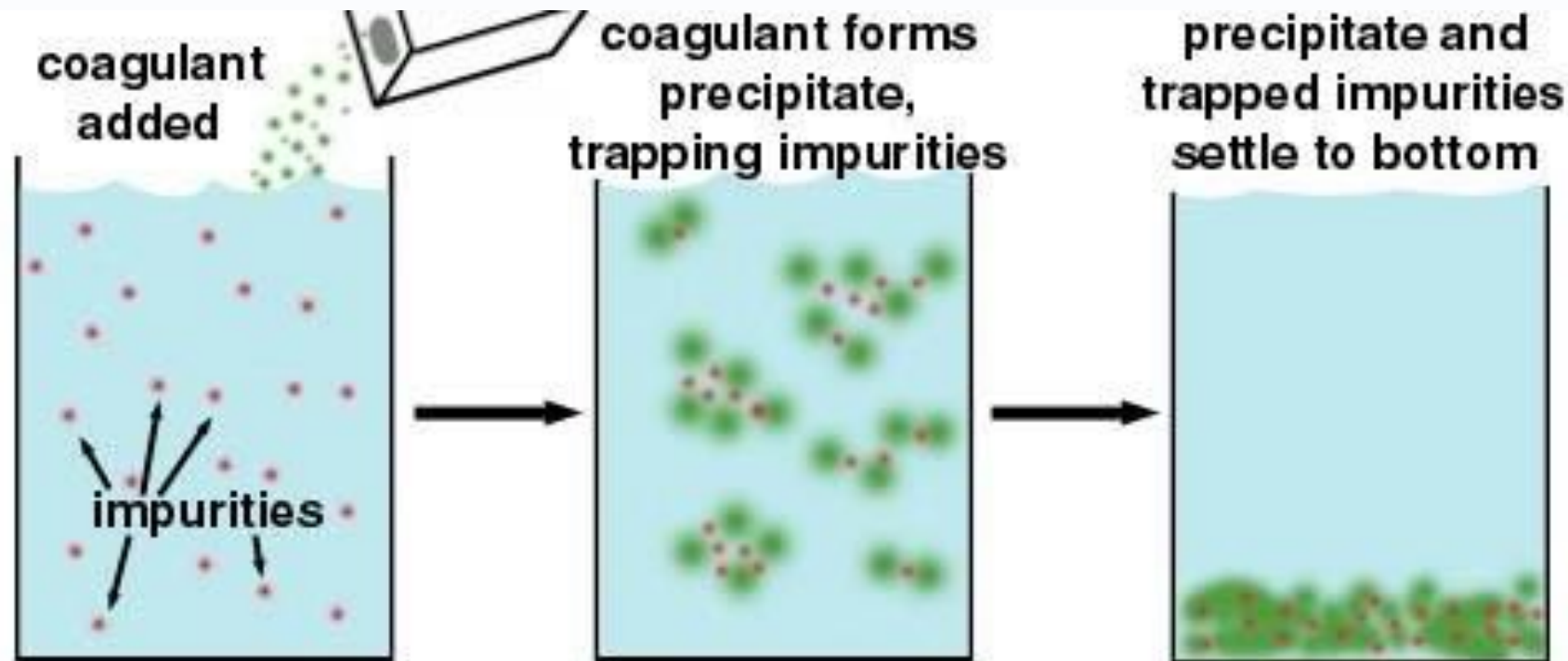
Factors for choosing a coagulant?

1. Easily available in all dry and liquid forms
2. Economical
3. Effective over wide range of pH
4. Produces less sludges
5. Less harmful for environment
6. Fast

Mixing Stages: Rapid and Slow

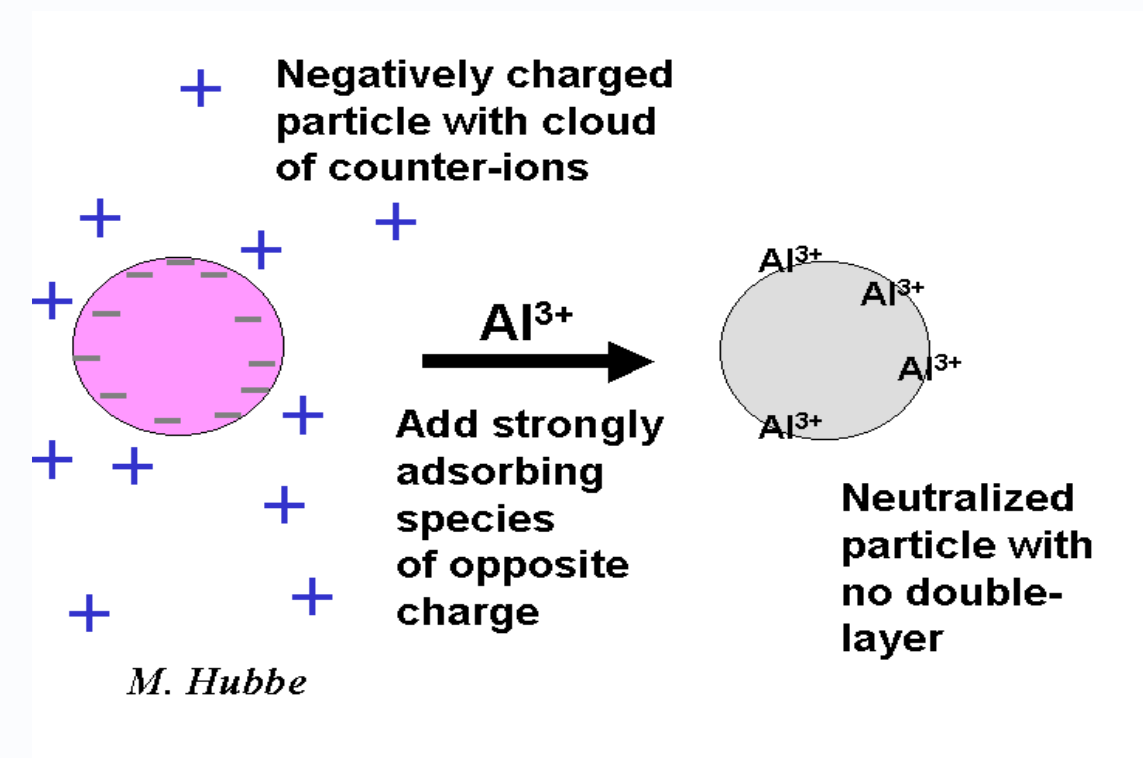
Rapid Mixing

Rapid mixing, or flash mixing, is the initial stage where coagulant is quickly and uniformly dispersed. This process typically occurs in a small basin with a detention period of 30 to 60 seconds, destabilizing colloids and forming nuclei for floc formation.



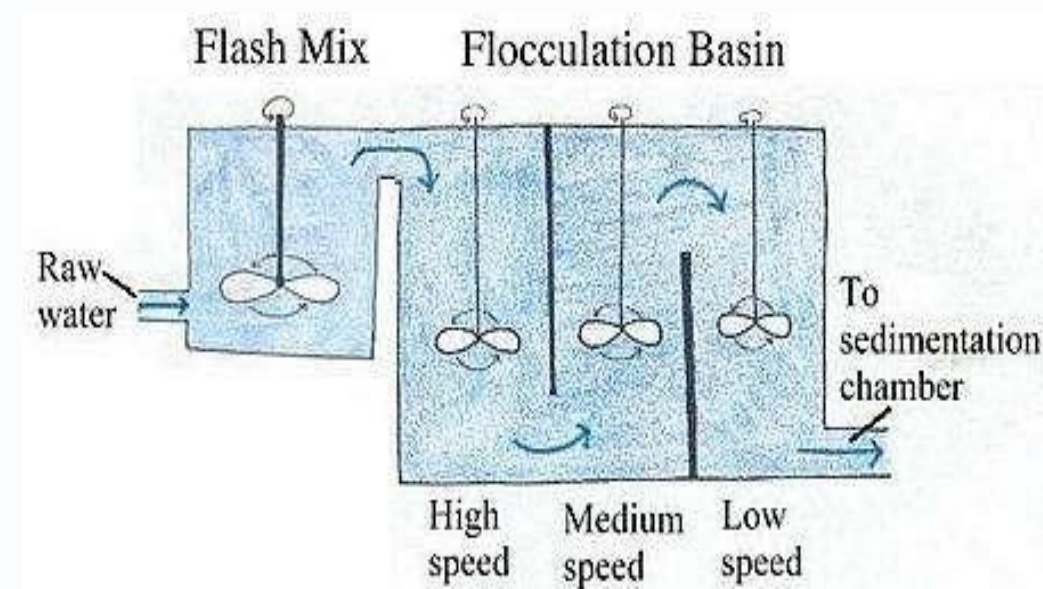
Slow Mixing

Slow mixing follows rapid mixing. This stage promotes collisions between destabilized particles, allowing them to form larger flocs for easier removal.



Flocculation

- The water flows into a tank with paddles that provide slow, gentle mixing.
- The particles now have a neutral charge, allowing them to stick together.
- This slow mixing brings the small particles together to form larger particles called flocs.
- Mixing is done quite slowly and gently in the flocculation step
- If the mixing is too fast, the flocs will break apart into small particles that are difficult to remove by sedimentation or filtration.



Coagulation: Aim and Purpose

Destabilization

Coagulation aims to destabilize suspended particles in water, reducing their stability and causing them to aggregate.

Floc Formation

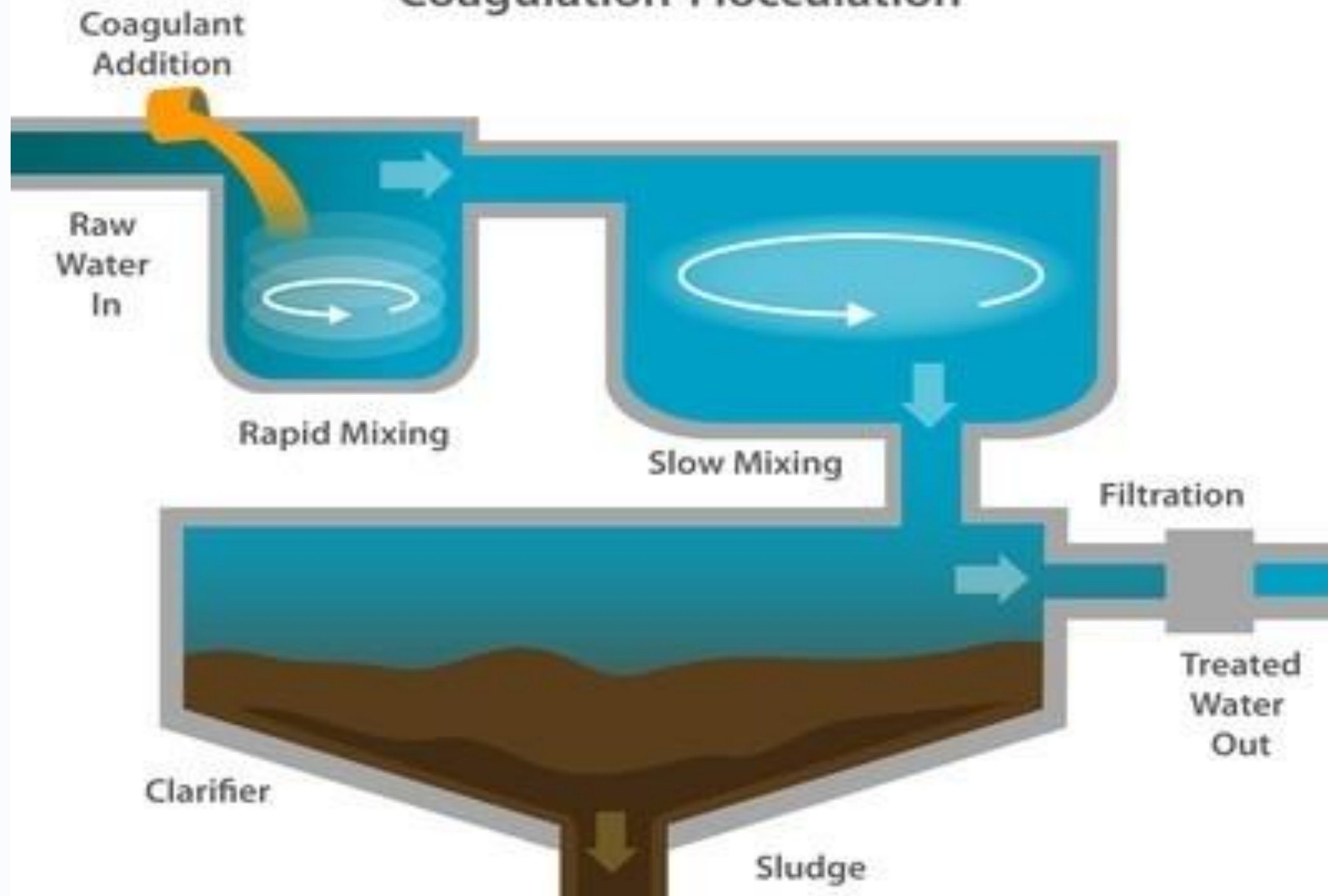
Destabilized particles come together to form flocs, larger clumps that are easier to remove through sedimentation and filtration.

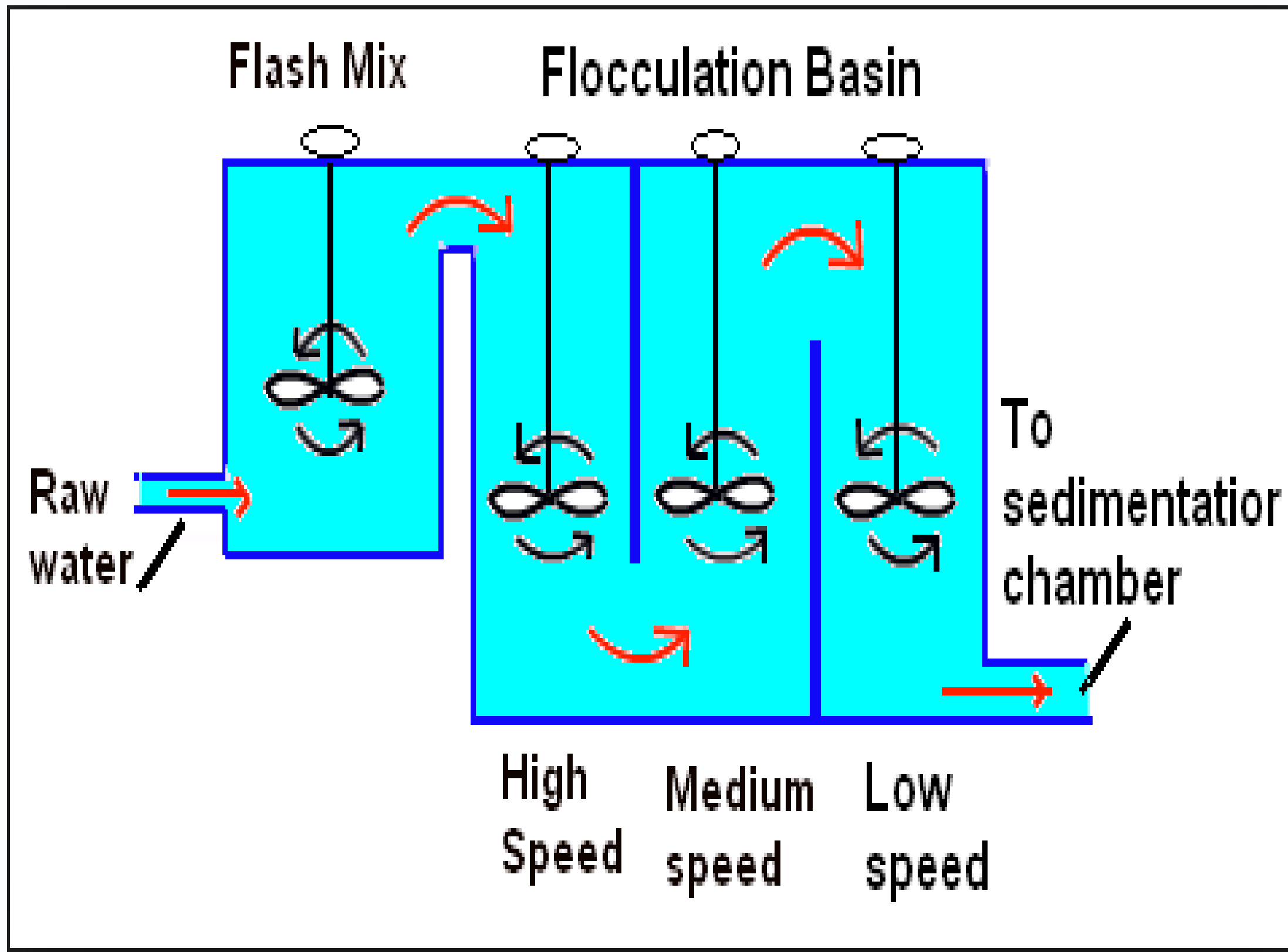
Improved Water Quality

Coagulation improves water quality by removing turbidity, color, and other undesirable substances, resulting in clearer and safer water.



Coagulation-Flocculation





Suspended material

Flocculation

Deposition

