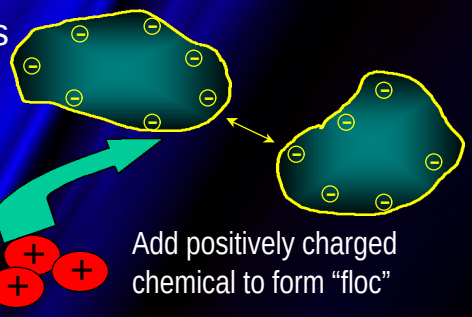
## Coagulation: The Key to Particle Removal

- In surface waters, particles are negatively charged (above pH 5)
  - Bacteria
  - Organic molecules
  - Inorganic salts
  - Clay particles



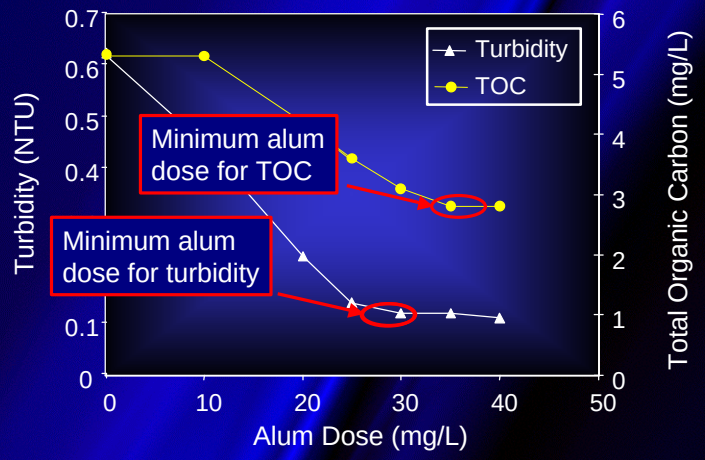
Add positively charged chemical to form "floc"

## Optimizing Coagulation Conditions for Particle Removal

- Objective of a "jar test" is to optimize coagulation/flocculation process to maximize particle removal:
  - Coagulant dose
  - Coagulant type (alum, ferric chloride, polyaluminum chloride)
  - Mixing speeds
  - Retention times

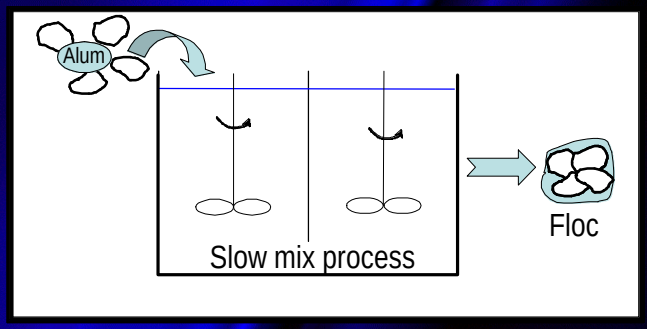
Standard bench-test set-up

## Optimizing Coagulation Conditions for Particle Removal




## Flocculation

- Objective is to mix suspended particles with coagulant
- Form a “floc” for improved clarification



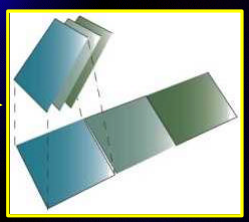
## Clarification Options

- Sedimentation
  - Coagulated-flocs settle at bottom of tank due to gravity
- Upflow-Clarification
  - Coagulated particles flow though a flocculated sludge blanket and are “trapped” in blanket
- Dissolved Air Flotation
  - Dissolved air acts to “float” coagulated particles to the top of tank, where skimming occurs

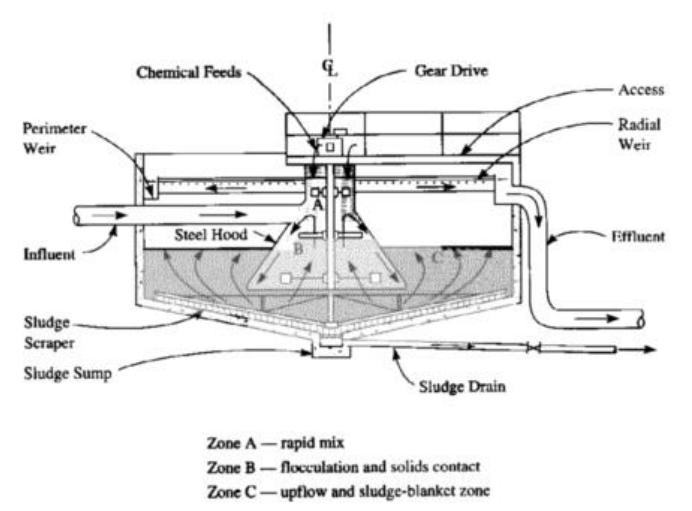
## Sedimentation

- Process by which flocculated particles settle out of solution by gravity
- Process modifications:
  - Lamella plates
  - Settling tubes

*Both approaches act to increase surface area and thereby decrease contact time*



## Upflow Solids Clarifier




## Dissolved Air Flotation

- Similar objective as sedimentation
  - Separate particulate matter from liquid
- General principle…
  - "Balloons float and rocks sink"
  - Lighter colloidal material are easier to float than sink…
- DAF primarily used for raw waters that:
  - Contain heavy algal blooms
  - Have low turbidity, low alkalinity & highly colored
  - Atlantic Canada

## Dissolved Air Flotation

- Compared to Sedimentation, the advantages of DAF are:
  - Reduced coagulant requirements
  - Smaller tanks in comparison to sedimentation
  - Higher sludge concentration
  - Start-up is relatively quick

## Dissolved Air Flotation

- System works by having air saturating a water stream
  - Requires air saturation system
- Essentially the more dissolved air in the system; the greater the bubble concentration
  - Bubbles act to “float” turbidity to surface of tank
  - See next slide…