JAR TESTING: CONSIDERATIONS AND PROCEDURE

Purpose of Coagulation and Flocculation

- Remove particulate impurities, especially non-settleable solids and color from the water being treated

- Non-Settleable solids include colloidal material that exhibits slightly negative charges repelling one another and staying in Suspension

- These contain microbes including pathogens

Removal of Turbidity by Coagulation & Production of Floc

- Neutralization of repulsive charges
- Precipitation with sticky flocs
- Bridging of suspended matter
- Providing “agglomeration sites” for larger floc
- Weighting down of floc particles

Factors Affecting the Coagulation Process

- pH (Al from 5 – 7; Fe from 5 – 8)
- Alkalinity of water (> 30 ppm residual)
- Concentration of Salts (affect efficiency)
- Turbidity (constituents and concentration)
- Type of Coagulant used (Al and Fe salts)
- Temperature (colder requires more mixing)
- Adequacy of mixing (dispersion of chemical)

Primary Coagulants

- Primary coagulants are lime, aluminum sulfate (alum), ferrous sulfate, ferric sulfate and ferric chloride

- These inorganic salts will react with the alkalinity in the water to form insoluble flocs which will trap the suspended matter in them

Use of Alum as a Coagulant

- Earliest and Most Widely Used Coagulant
- Effective Range pH 5.0 to 7.0 (6.5 optimal)
- Reacts with Alkalinity
- Results in drop in pH
- For every 2 mg/L Alum 1 mg/L Lime is

Use of Ferrous Sulfate (Copperas) and Lime for Coagulation

- Combination produces Ferric Hydroxide
- pH 8.4 range to 9.0
- Oxygen must added by aeration or chemically such as chlorine
- Very effective for turbid water
- Care must be taken because color not removed at high pH

Use of Ferric Chloride as a Coagulant

- Has wider pH range than Ferrous Sulfate
- Typically used where color removal is also desirable
- Does not require oxygen supplement

Use of Ferric Sulfate as a Coagulant

- Does not require oxygen supplement
- Effective over wider pH ranges
- Lower doses required that Ferrous Sulfate

Secondary Coagulants or Coagulant Aids

- Coagulant aids are often added to help stimulate the production of floc

- They include sodium aluminate, sodium silicate and various synthetic organic water soluble polyelectrolytes or polymers

Desirable Floc Quality

- The best floc are smooth circular particles that tend to settle quicker
- Irregular shaped particles settle slower
- Large clumps (popcorn floc) settle fast but are caused by chemical overdosing

Performance Measurement Using the Jar Test

- A jar test is a laboratory procedure where varying dosages of coagulant are tested in a series of glass or plastic jars under identical conditions

- The jars are injected with coagulant dosages and mixed to match flash mix & flocculation field conditions as closely as possible

- After mixing and settling the jars are observed to determine which dosage produce the largest, strongest floc or which dosage produces the floc that settles the fastest

- Other laboratory tests sometimes include a jar test to determine the optimal pH or determine the turbidity of the

Factors Affecting the Coagulation Process Revisited

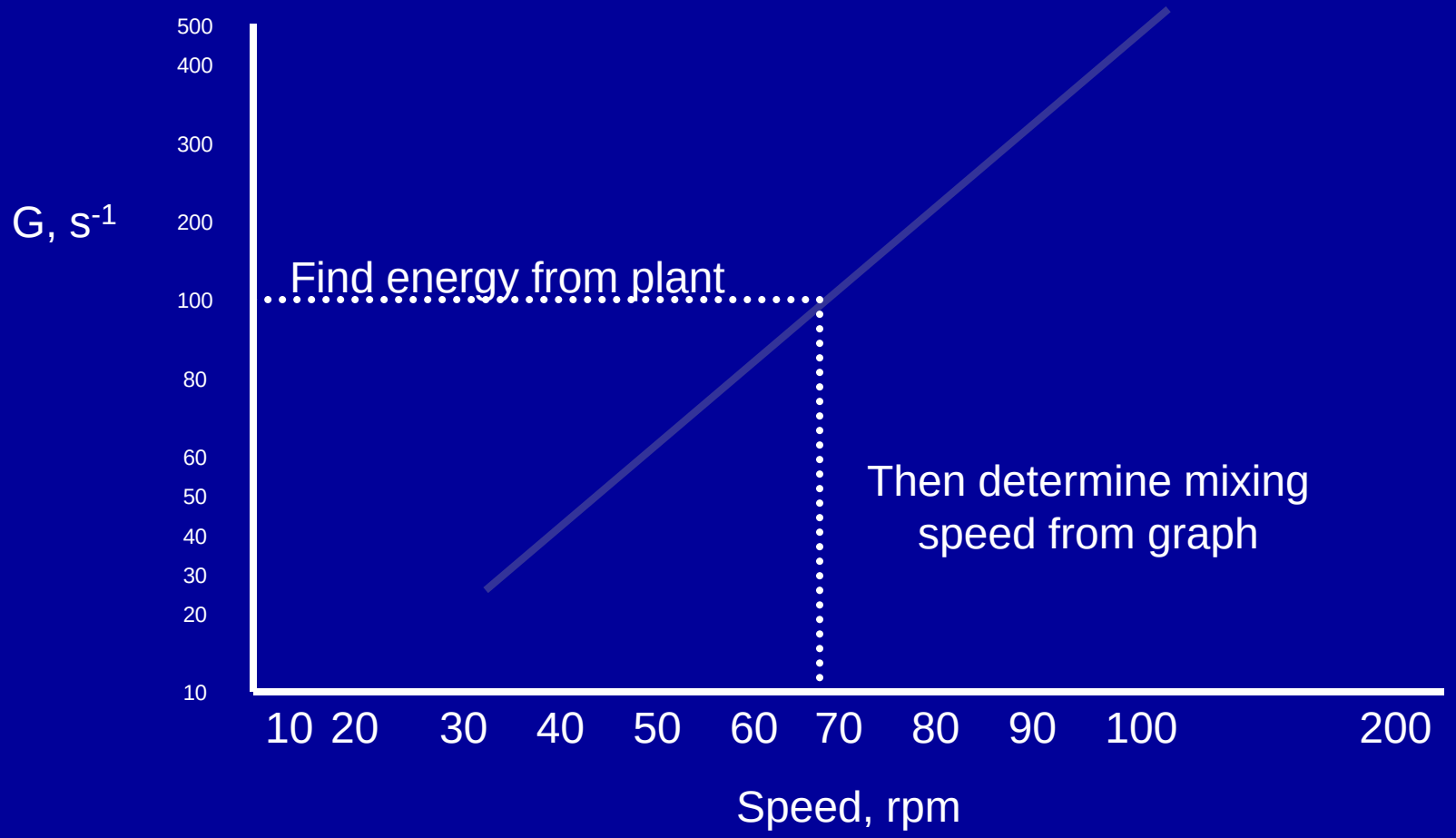
- pH range: 5 – 7
- Alkalinity of water > 30 PPM residual
- Concentration of Salts affects efficiency
- Turbidity (constituents and concentration)
- Type of Coagulant used (Al and Fe salts)
- Temperature (colder requires more mixing)
- Adequacy of mixing (dispersion of chemical)

Jar Test Apparatus and Procedures

- Four or six paddles
- Typically, one container is used as control
- RPM gauge allows for mixing speeds to match plant conditions for flash mix and flocculation
- Can be programmable or manual

Determining Mixing Scheme

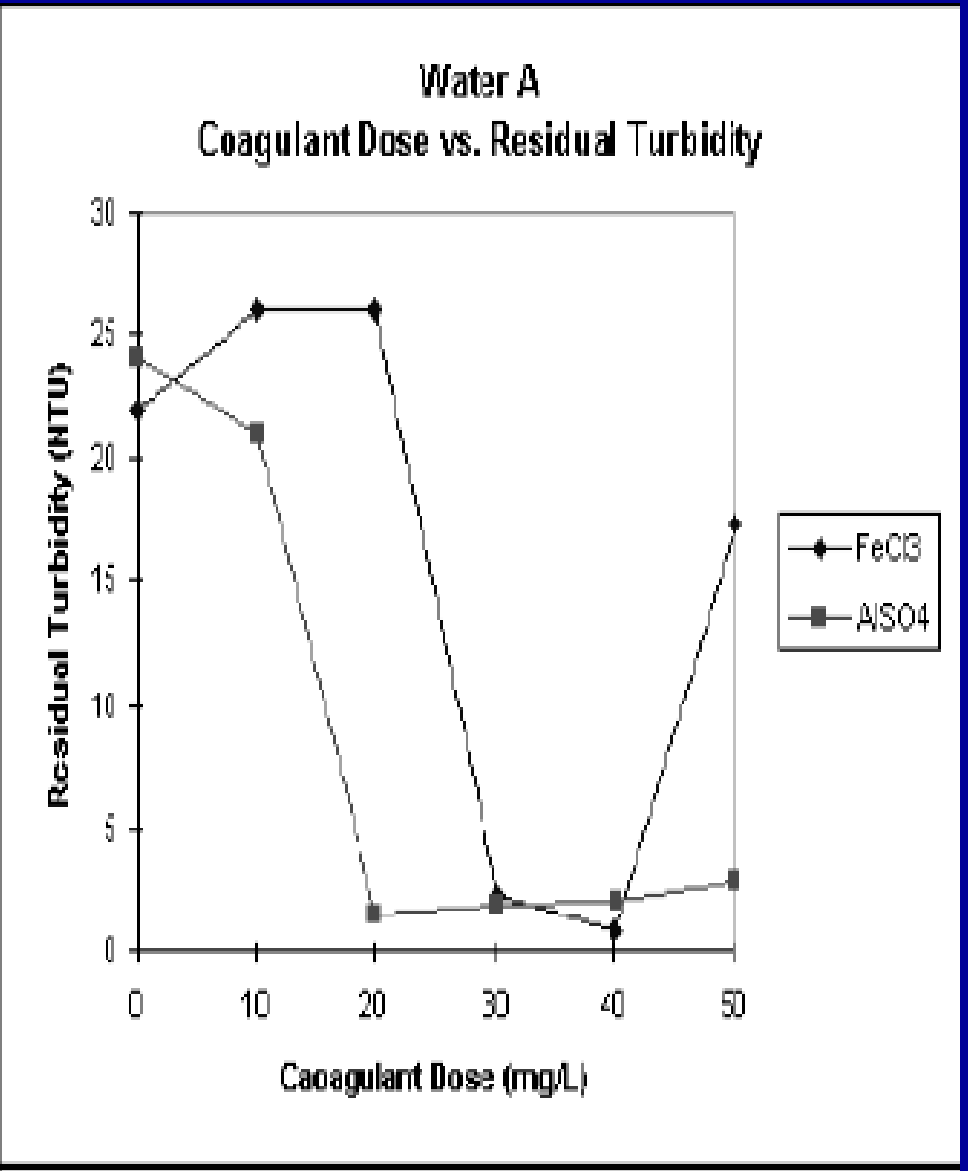
Graph Created by Camp, 2930s



Evaluation of Jar Test Results

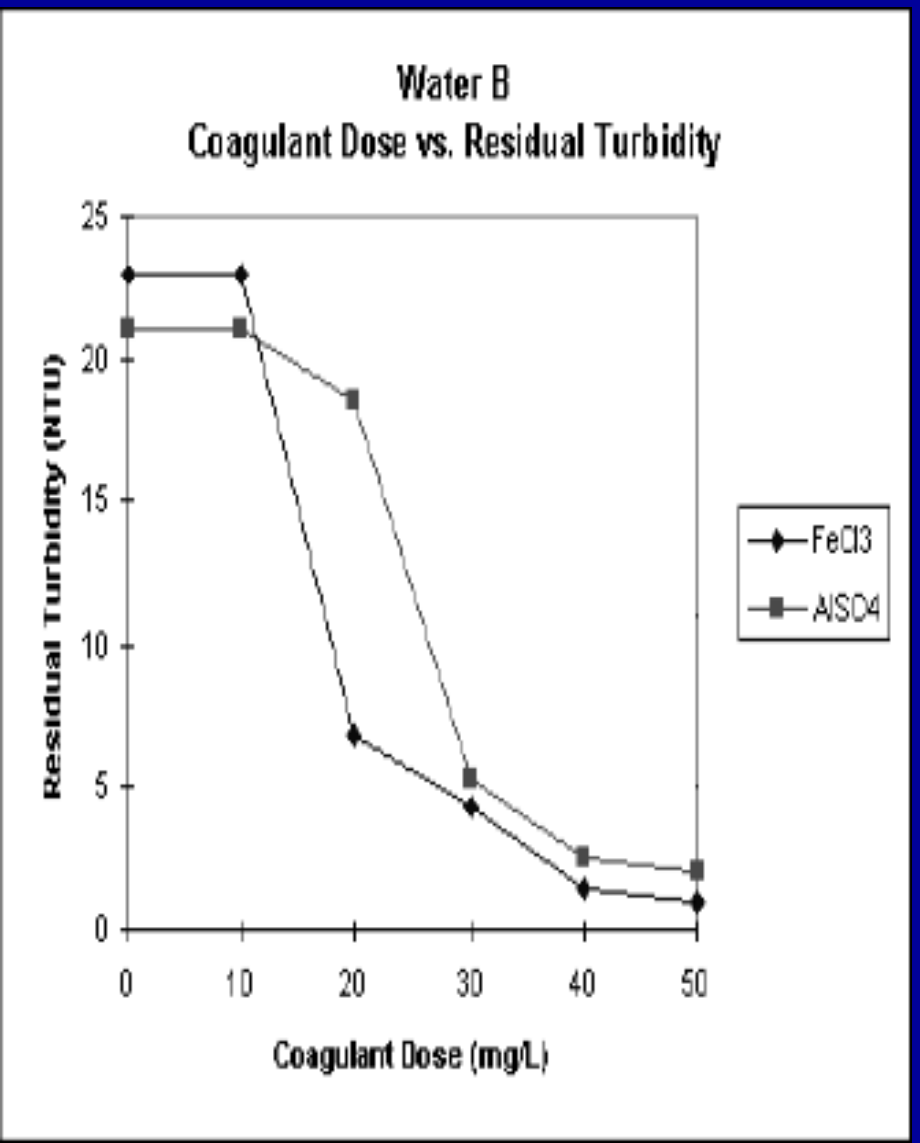
- Rate of Floc Formation
- Type of Floc Particles
- Clarity of the Water between the Floc
- Size of the Floc
- Amount of Floc
- Clarity of Water above Settled Floc
- Volume of Floc

Jar Test Plot for Low Alkalinity Water



- Alum initially reacts with low alkalinity
- With Ferric Chloride requires chemical to reach optimal pH before reacting
- Adding too much

Jar Test Plot for Higher Alkalinity Water



- Higher Coagulant doses are needed for high alkalinity waters
- Ferric Chloride required more chemical but reached lower turbidity
- Since Alum did not produce water <1 NTU a coagulant aid is

Additional Analyses for Jar Testing

- TOC
- Alkalinity
- pH
- Turbidity of Supernatant
- Filtered Turbidity of Supernatant

JAR TESTING PROCEDURE

Purpose

To determine the optimum concentration of coagulant to be added to the source water