Drinking Water Treatment

Lab Lecture the week of Nov 2
Lab held in Marston 26 the week of Nov 9

Objectives

- Understand conventional drinking water treatment process

- Determine the importance of coagulation and flocculation

- Estimate the best dose of coagulant through jar-tests and estimating the disinfection by product formation

Conventional drinking water treatment

Physical

- Associated with the appearance of water color, turbidity, taste and odor

Chemical

- Remove chemical that could cause health concerns (fluorides, chlorines, nitrates, disinfection byproducts)

Microbiological

- Pathogen removal
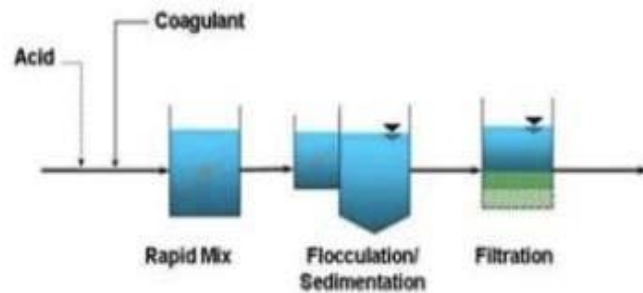
Conventional drinking water treatment

Figure 1. Schematic of conventional water treatment process (USEPA, 2015)
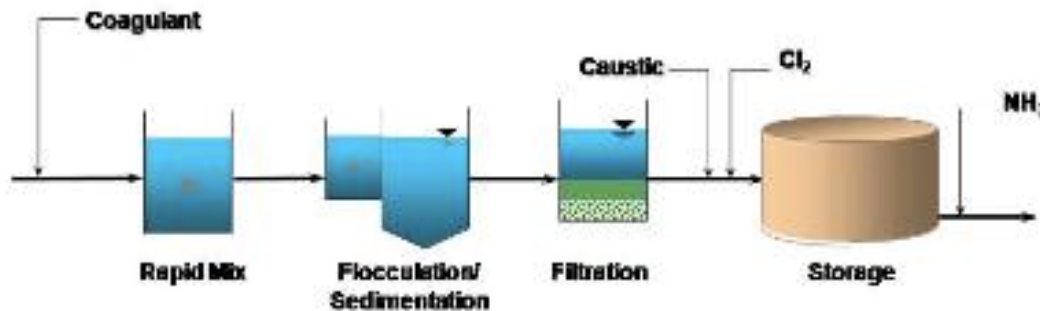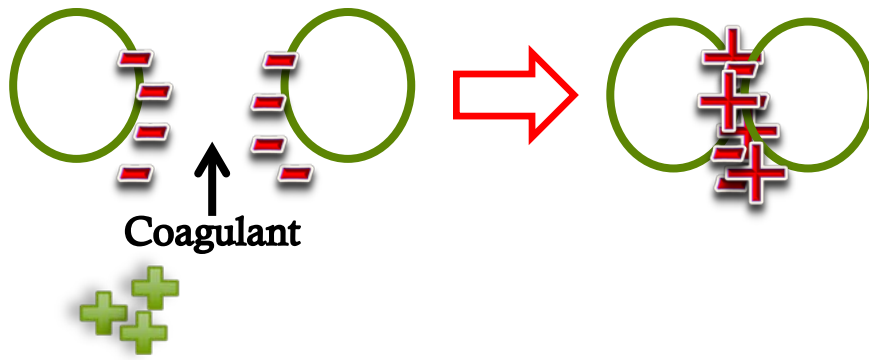

Figure 2. Schematic of conventional water treatment process with chlorine addition in the treatment process
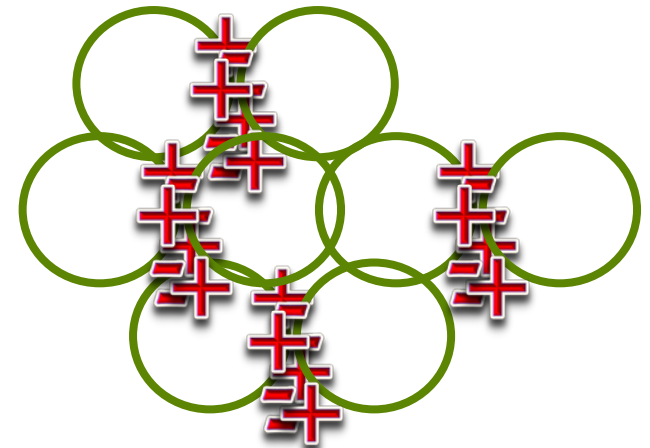
Coagulation and flocculation

Coagulation:
- destabilizes negatively charged particulate matter and natural organic matter
- Removal of particulate matter suspended in the water
- These contain microbes including pathogens

Flocculation:
Forcing fine particulates to clump together into a floc, which then could be removed by creaming, sedimentation or filtration

Coagulation and Flocculation (Cont'd)

Neutralization and destabilization of stable, negatively charged particles → Formation (coagulation) of flocs → Bridging of suspended flocs → Formation of large, heavy flocs → Weighting down of flocs

Coagulation and Flocculation (Cont'd)

- Factors affecting coagulation:
  - pH (Al: from 5-7; Fe from 5-8)
  - Alkalinity of the water
  - Concentration of the coagulants (affect efficiency)
  - Turbidity of the solution
  - Type of coagulant used
  - Temperature of mixture (colder T requires more mixing)
  - Adequacy of mixing (dispersion of chemicals)

Coagulation and Flocculation (Cont'd)

If coagulation and flocculation are not done well……

Settling tank

Q

Inlet zone

Sludge zone

outlet zone
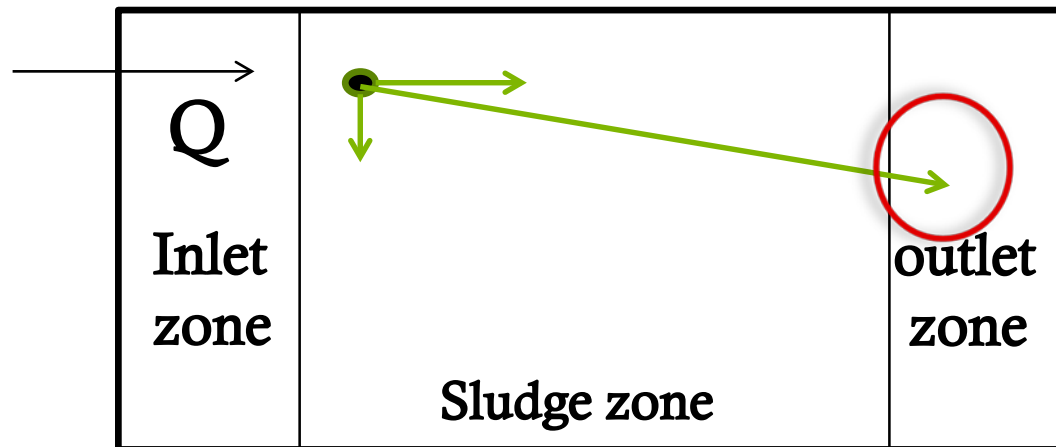
THEREFORE WE USE JAR TESTS TO FIND OPTIMAL COAGULANT DOSE, pH AND SPEED OF MIXING

Jar Test Procedure

- 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

JAR-TESTS

| Add 6 different doses of alum to water sanples | → | Rapid mixing 0.5-1 min (Coagulation) | → | Slow mixing 30-60 min (Flocculation) | → | Settling for 30-60 min (Settling) | → | Removal of supernatant to measure turbidity |

- Prepare graph of alum dose vs turbidity

- Find ideal alum dose by finding the dose with the lowest turbidity

Chlorination
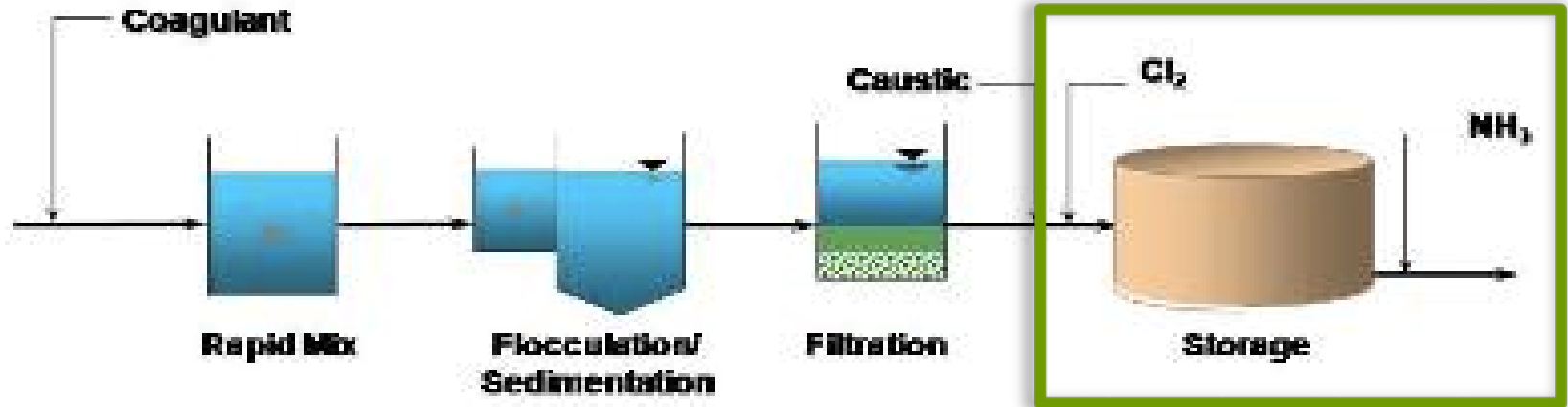
Chlorination

- Natural Organic Matter (NOM) transformed by chlorination

- NOM + Br-/I- + Chlorine $\longrightarrow$
  Disinfection by-products (DBPs)

- DBPs include the 4 trihalomethanes, 5 haloacetic acids, bromate and chlorite
  - Regulated by EPA

- In order to prevent DBP formation, reduce chlorine residual