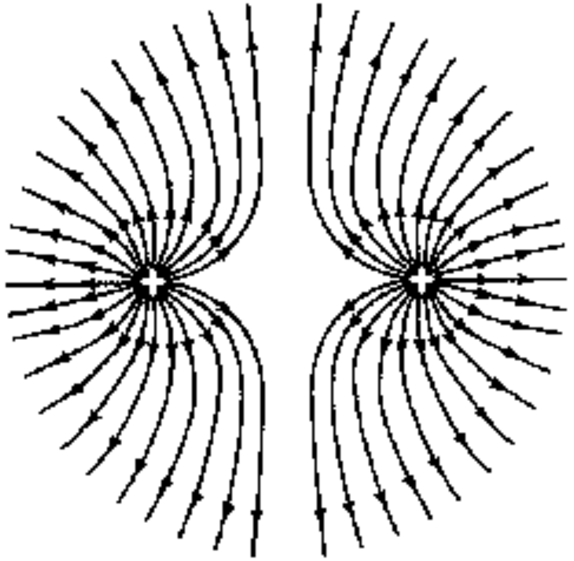
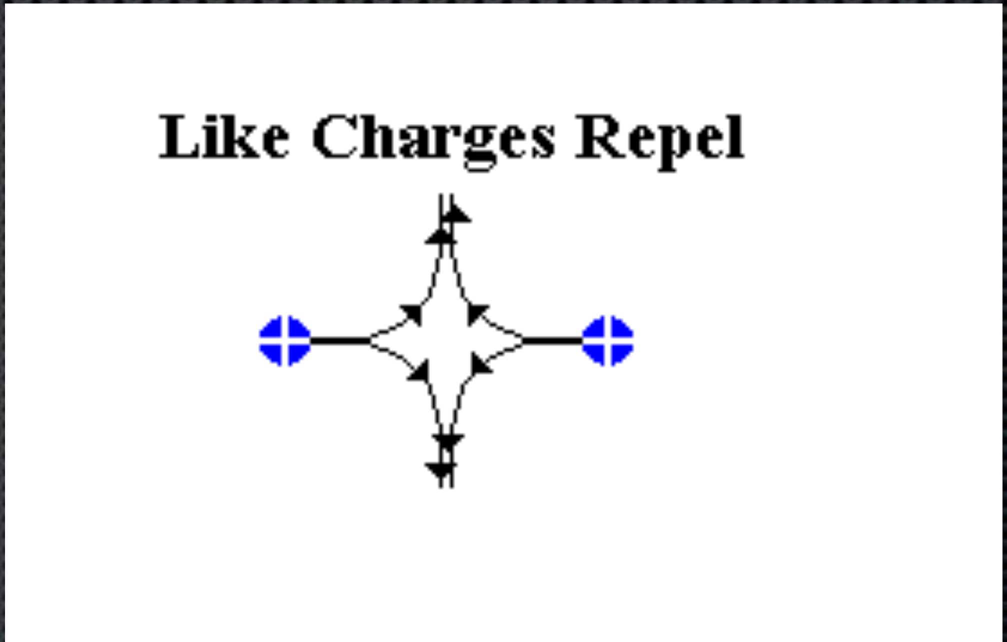
MICROMETRIX

Streaming Current Instrument Training

Like-Charged Particles Repel



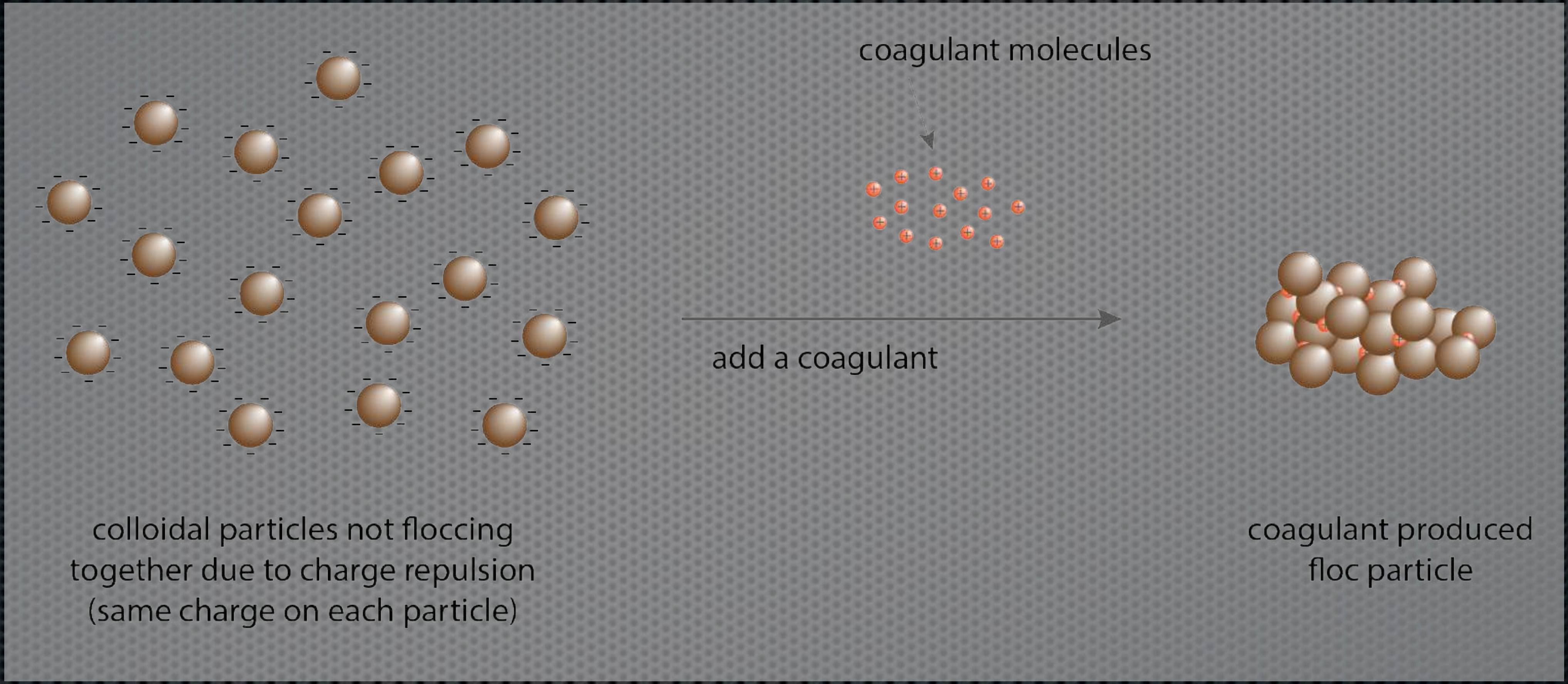
Two equal and similar charges

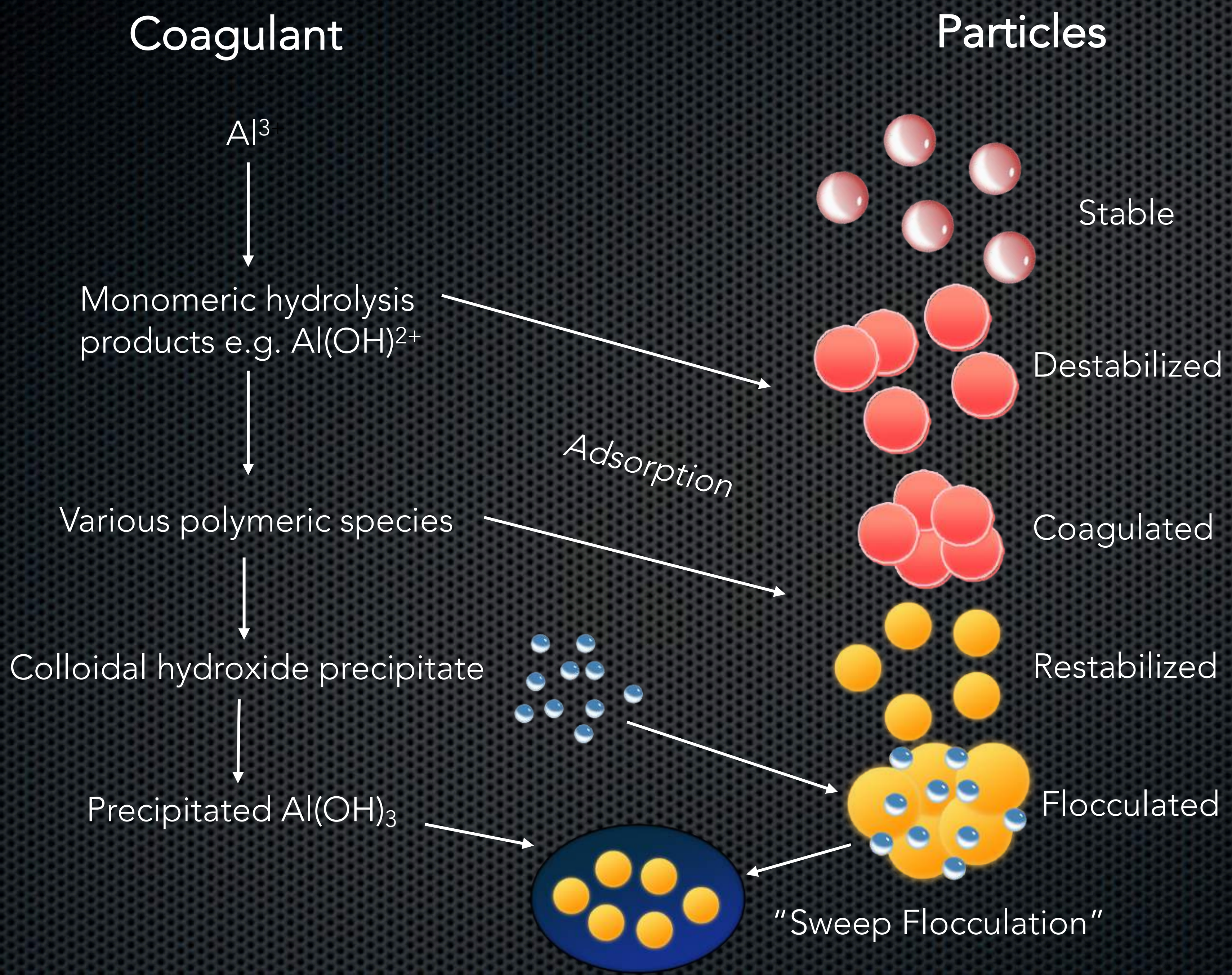


Coagulant

- A coagulant is a charged chemical species that is added to destabilize colloidal particles, so they are free to aggregate.
- Positively charged metal salts are used to neutralize negatively charged natural particles

Neutral Particles Flocculate



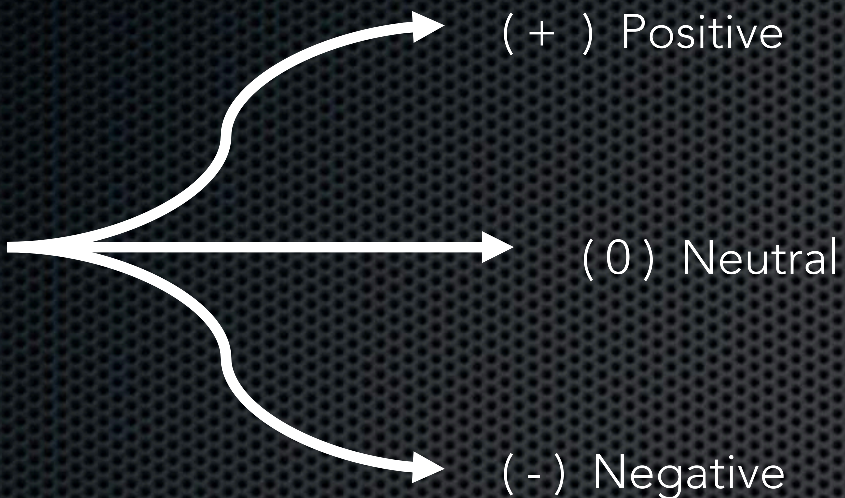


Coagulant
Particles
Al3+
Stable
Monomeric hydrolysis products e.g. Al(OH)2+
Destabilized
Adsorption
Various polymeric species
Coagulated
Colloidal hydroxide precipitate
Restabilized
Flocculated
Precipitated Al(OH)3
"Sweep Flocculation"

Common Coagulants

- Aluminum Sulfate (Alum)
- Ferric Sulfate
- Ferric Chloride
- Polymeric Inorganic Coagulants
- (Polyaluminum Chloride)

SCM Charge Measurement



Ionic and Colloidal

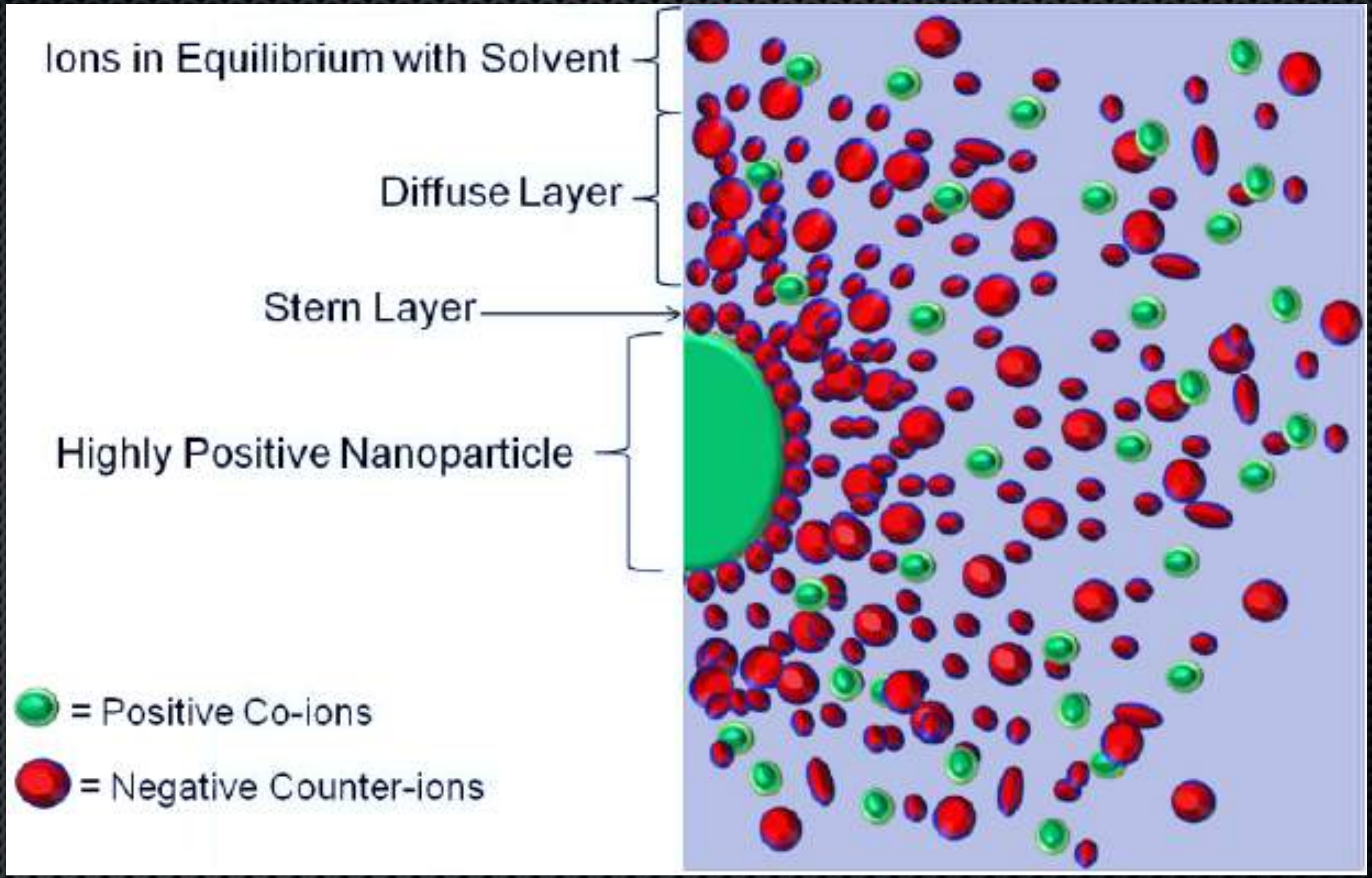
Background

- Particle charge/distances influence stability
    - Like-charged particles repel
    - Opposite-charged particles attract
    - Neutral particles are free to collide and aggregate
    - Van Der Waals forces cause particles to attract

Double Layer Model

The Double Layer

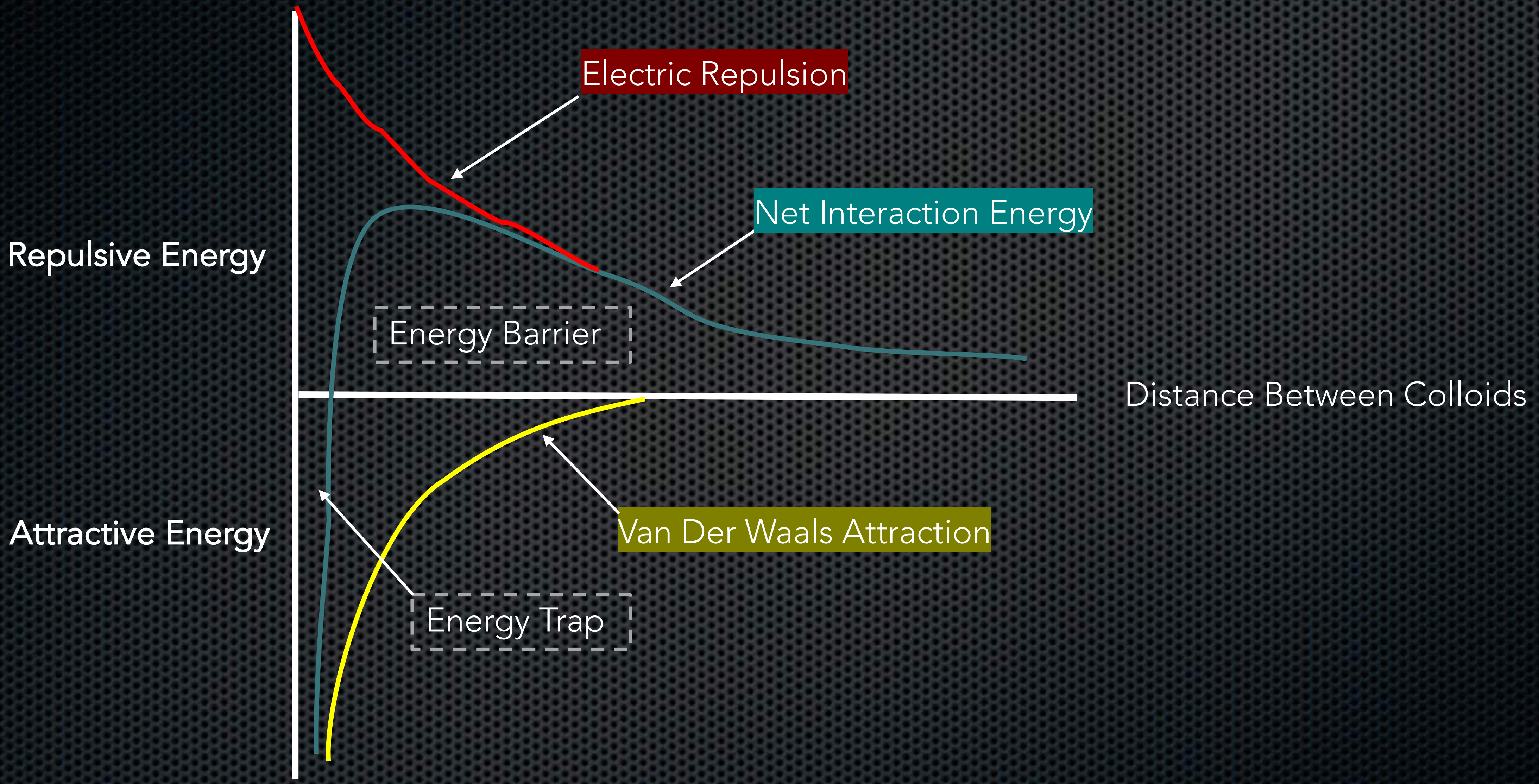
- The left view shows the change in charge density around the colloid
- The right shows the distribution of (+ & -) ions around the charged colloid



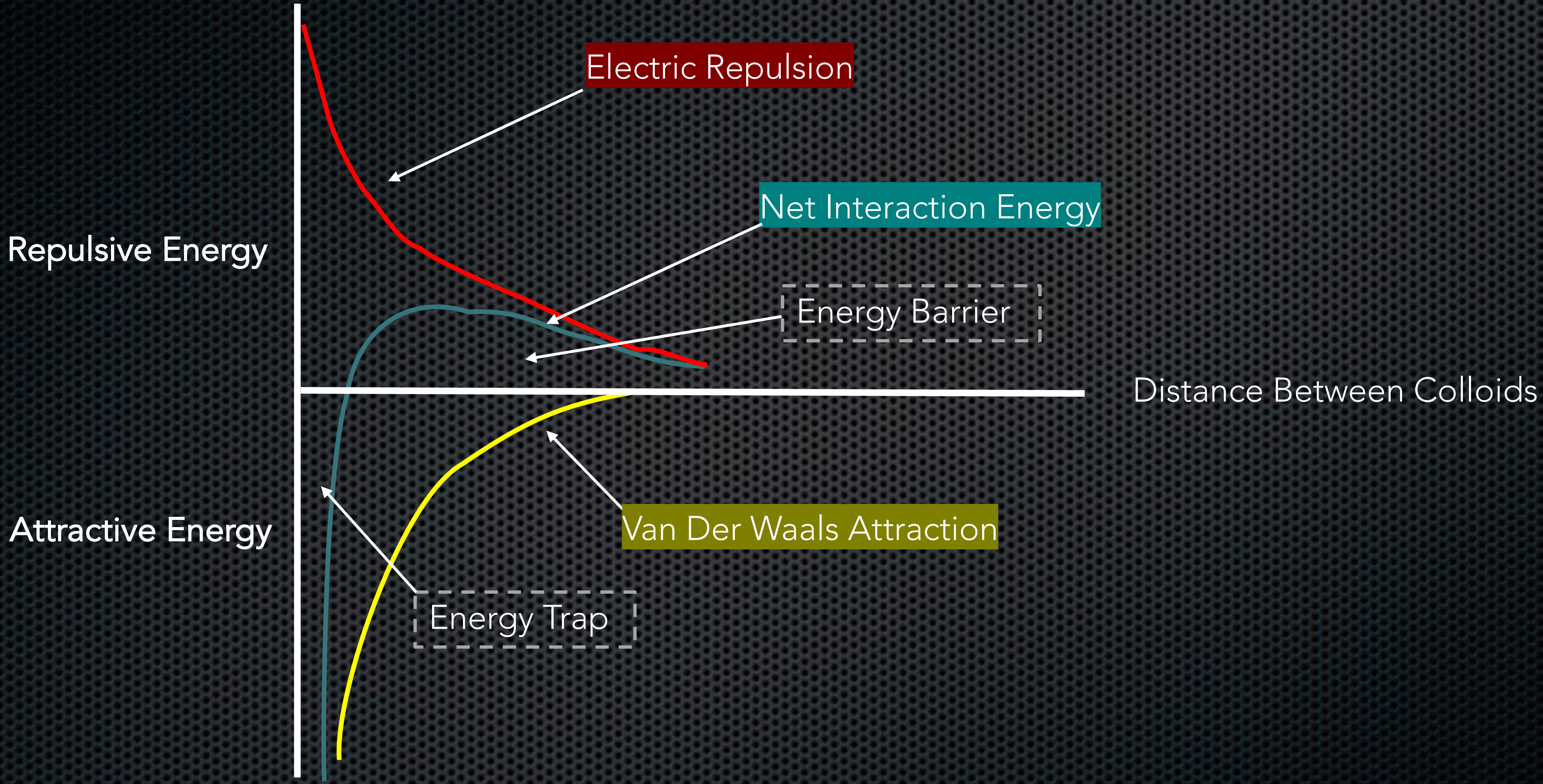
Double Layer

- The double layer consists of counter-ions in the stern layer and the charged atmosphere in the diffuse layer
- The thickness of the layer is determined by the concentration of ions in the solution and the type of counter-ion
  - Type refers to the valence of the positive (+) counter-ion
    - Example: (Al^{+3}) ions are much more effective in charge neutralizing colloidal material than (Na^{+})

Stabilized Colloids



Destabilized System



Names for Streaming Current Devices

- Streaming Current Meter – SCM
- Streaming Current Detector – SCD
- Streaming Current Monitor – SCM
- Particle Charge Detector – PCD
- Particle Charge Analyzer – PCA

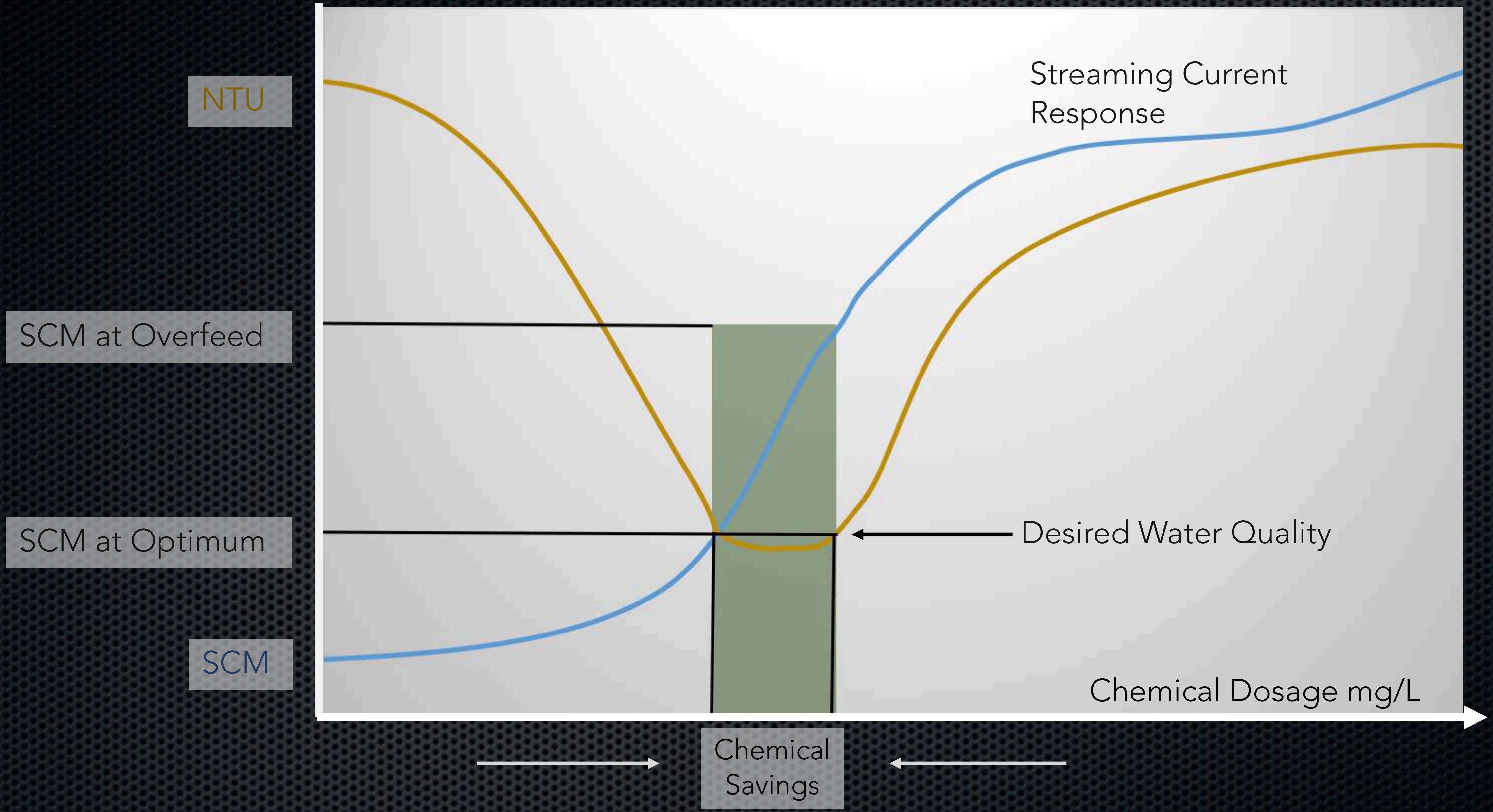
Applications for SCMs

- Municipal Drinking Water
- Papermaking Process
- Sludge Dewatering
- Industrial Water and High Purity

Drinking Water Treatment

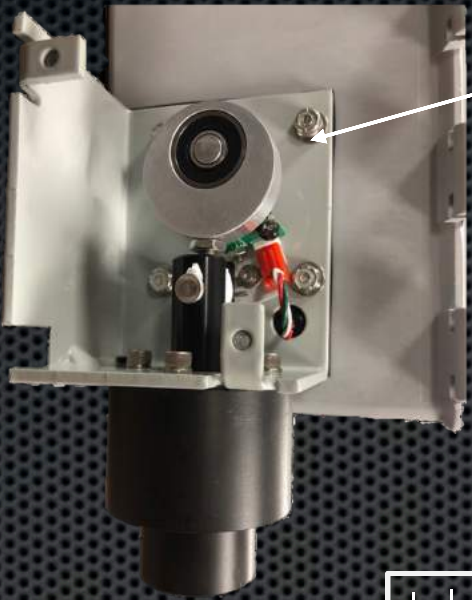
- Plants began using these devices back in the early eighties for coagulant control
- The American Water Works Research Foundation funded a project in 1986 to report on the satisfaction of users of Streaming Current technology

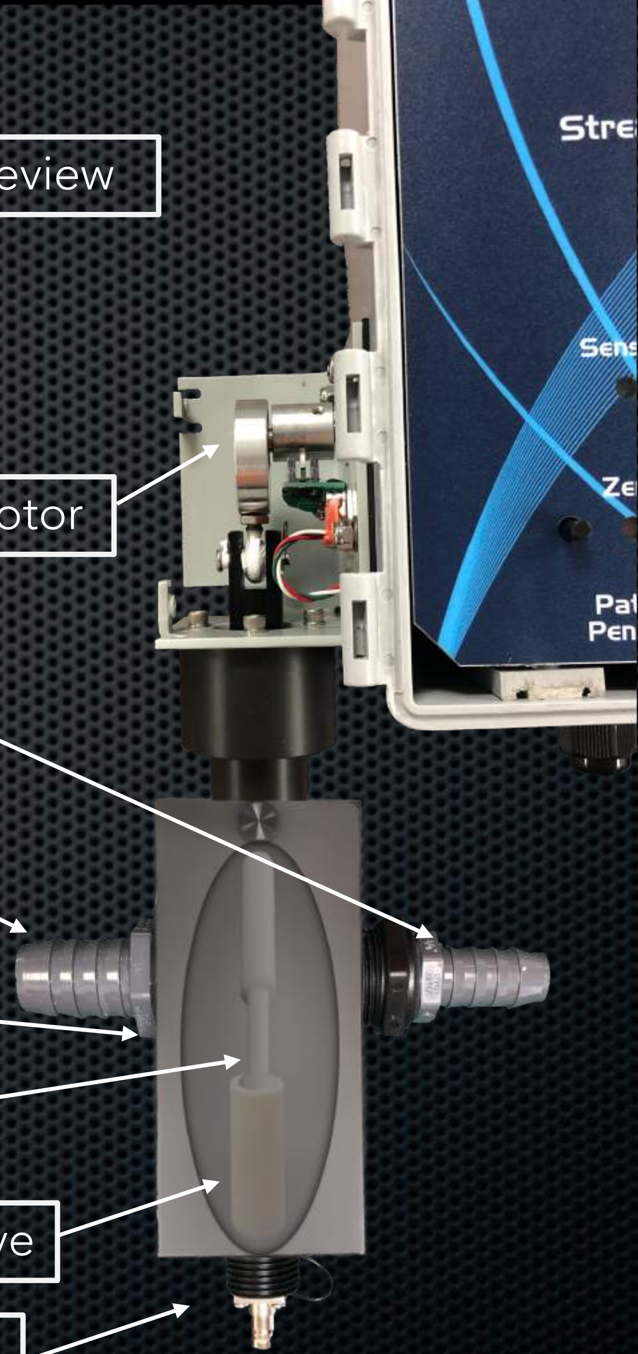
SCM vs NTU


NTU
SCM at Overfeed
SCM at Optimum
SCM
Streaming Current Response
Desired Water Quality
Chemical Dosage mg/L
Chemical Savings

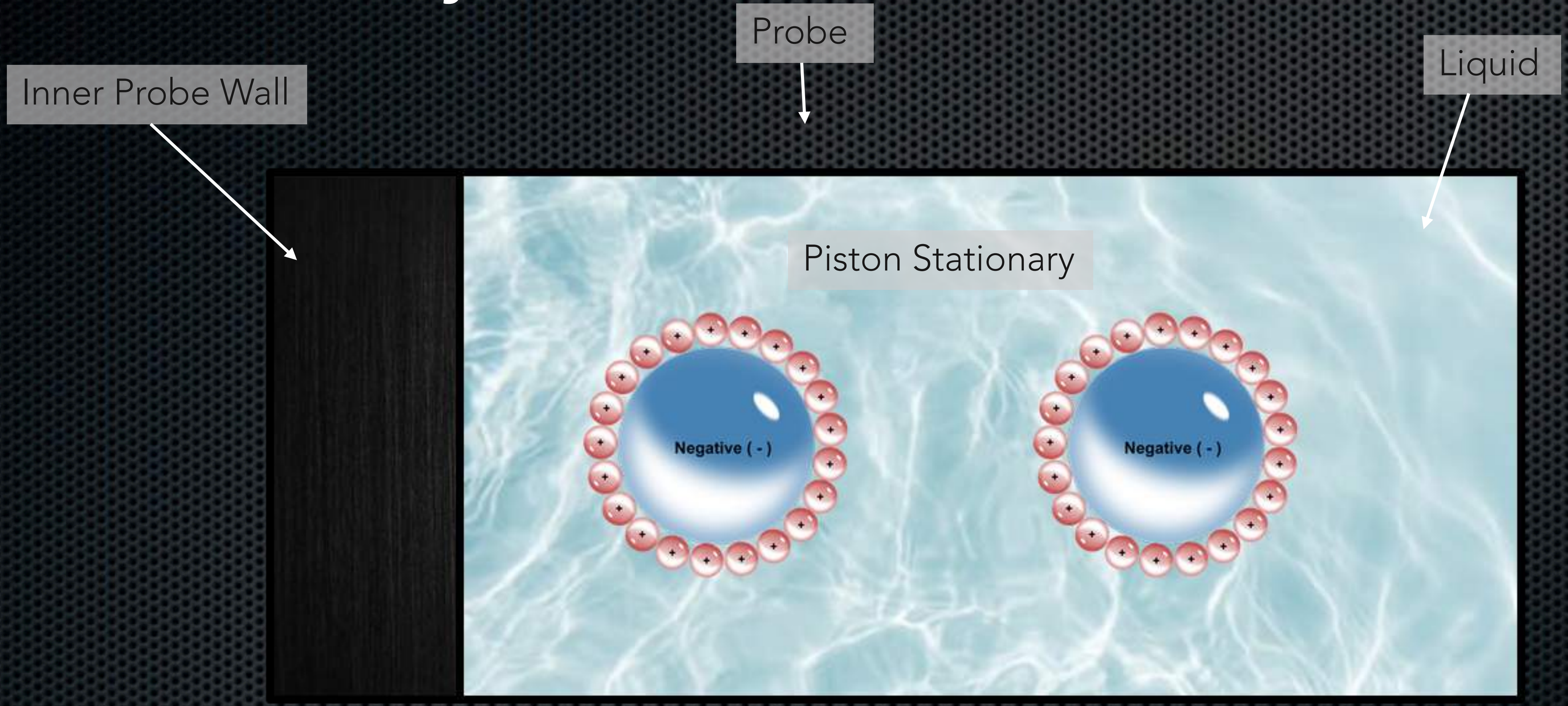
SC Sensor

- Stainless Steel Electrode
- Replaceable Sleeve
- Teflon and Delrin Material
- Spare Sleeve/Piston



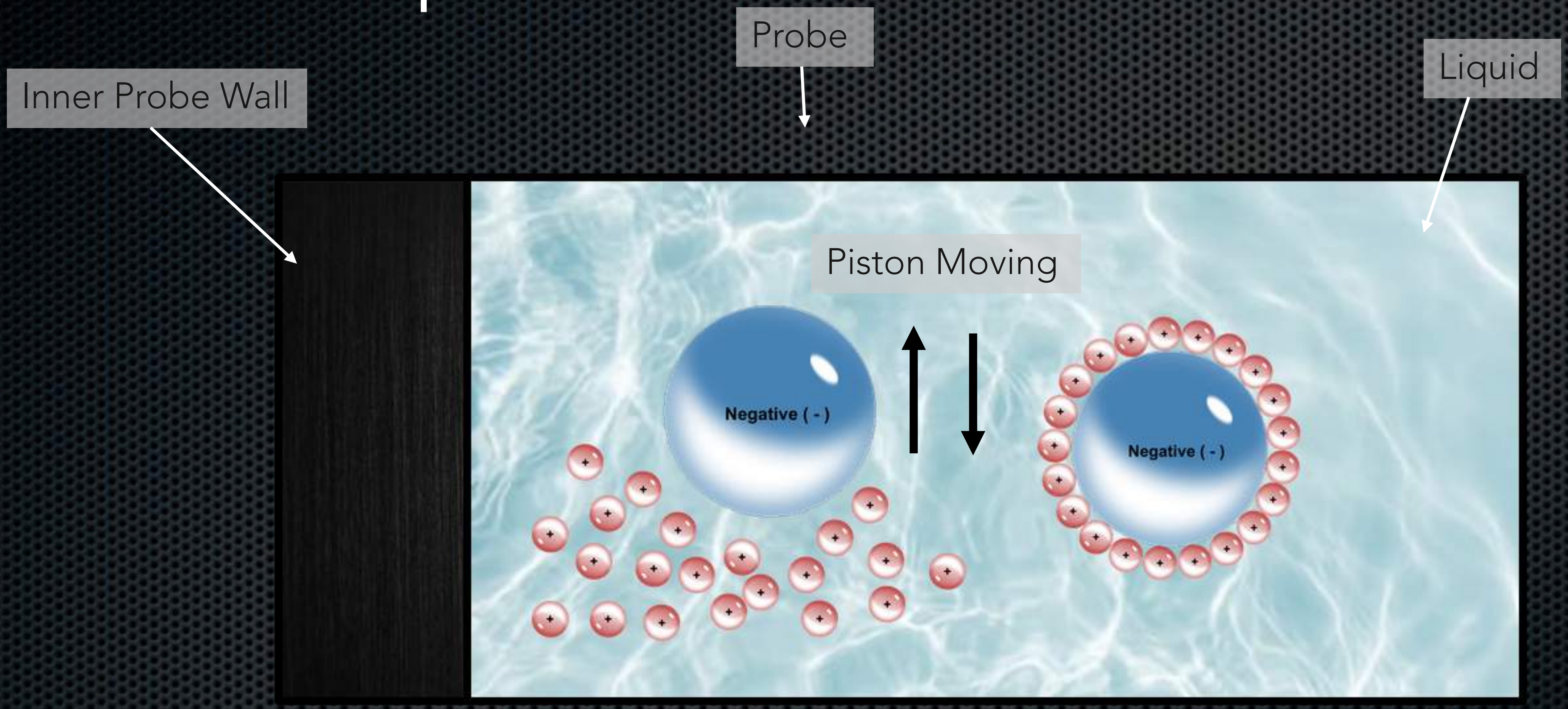


Stationary

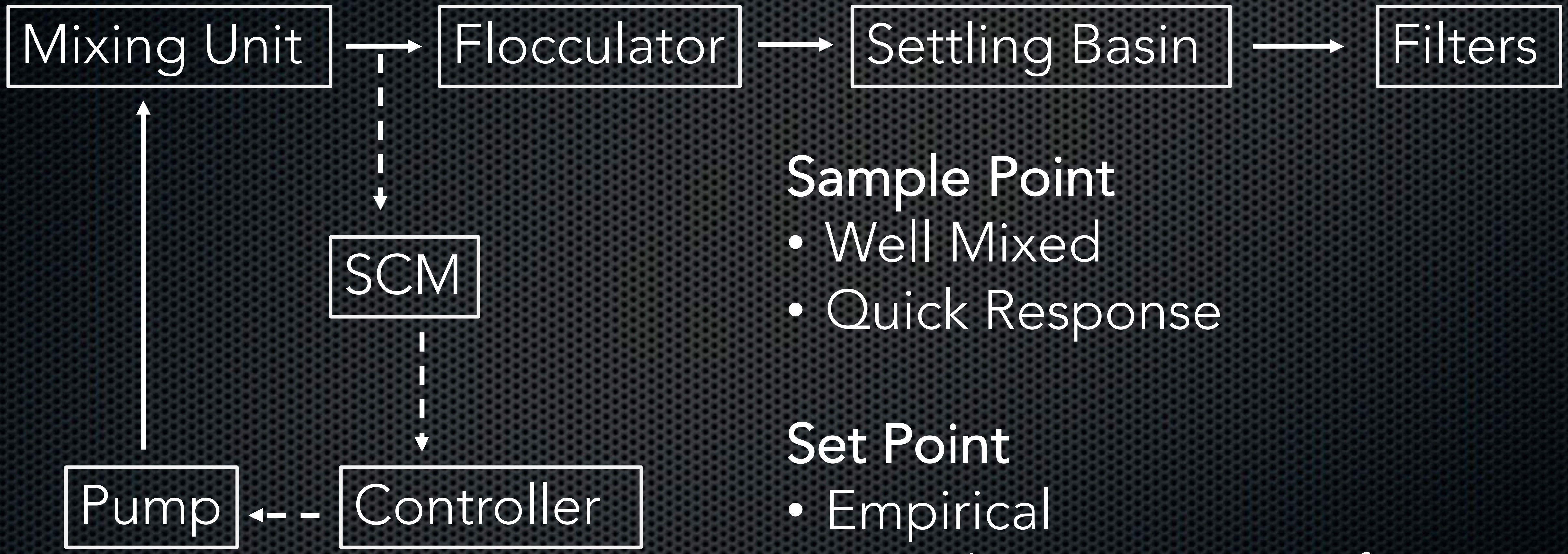


Probe
Liquid
Inner Probe Wall
Piston Stationary
Negative (-)
Negative (-)

Piston Upstroke



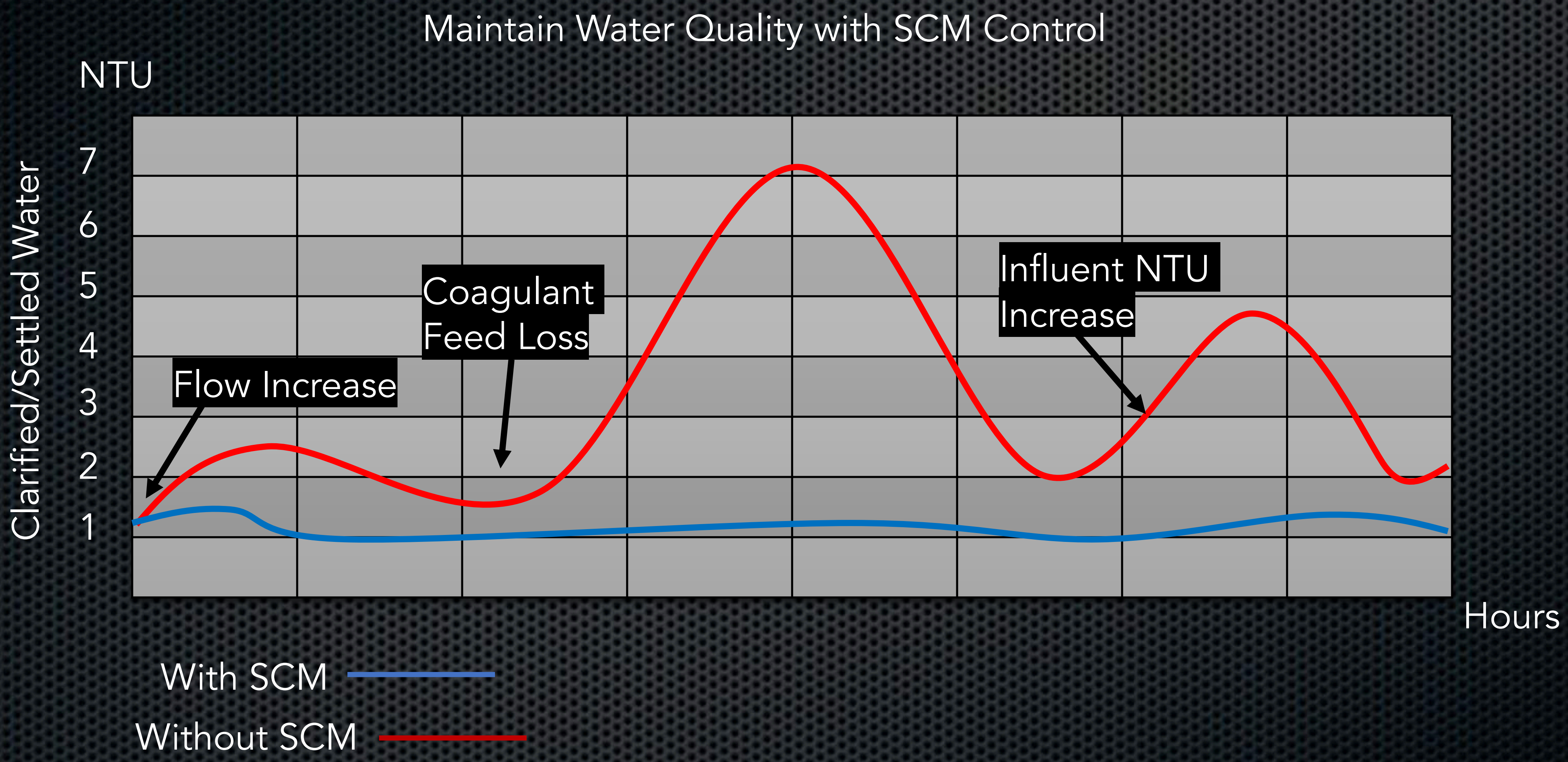
Background



Sample Point
- Well Mixed
- Quick Response

Set Point
- Empirical
- Based on Process Performance

Preventing Upsets



Factors Affecting Operation

- Chemical Factors
- Response Time and Lag Time
- Location of Sample Point

Chemical Factors

- Ionic strength (conductivity) – typically is sufficiently constant in most water treatment applications
- Ohms law $E = I \times R$
- An increase in conductivity decreases the SCM sensitivity

Chemical Factors

- pH – Similar to the effect on Zeta Potential
- An increase in pH moves the SC reading in the negative direction for simple systems
- Trends may be more complex for higher pH values >8
- May see a decrease in sensitivity for very high pH >10

Response Time

- Lag time is of considerable importance for proper use of the SCM
- System Lag time equals process detention/lag time plus sample line detention/lag time
- The SCM value decreases with time
- Feedback signal produced by the SCM
- Controller changes the output to the pump proportionally
- Process controller has programmable tuning constants for lag times

- Built-in alarm functions that alert the operator immediately if an overfeed or underfeed of chemicals is encounters
- The setpoint is established empirically by the operator to determine what amount of dosage corresponds to optimum chemical feed
- The process of establishing the setpoint begins when a system is producing acceptable water
- An incremental decrease in dosage is made and the effect is observed by evaluating the finished quality

Sample Point

- The sample point should follow mixing
- Uniform dispersion
- Reaction of coagulant
- Fluctuations in the SC reading may indicate incomplete mixing
- Sample near the center of a pipe or channel
- Avoid sample locations prone to collecting silt, sand, or grit
- Shorten sample lines when possible to minimize clogging and reduce response time

Factors Affecting Dose

- Flow Rate
- Coagulant Strength
- Solids Concentration
- pH
- Particle Charge
- Single Offset

Flow Rate

- A change in plant flow must correspond to a proportional change in chemical feed
- Automatic flow proportioning can utilize SCM as a trim adjustment
- Drastic changes in flow can affect lag time

Coagulant Strength

- The strength of the coagulant or flocculant may vary and can be detected with the SCM
- Examples have been seen in slurry or polymer makedown

Solids Concentration

- An increase in influent solids, particle concentration, (turbidity), and organic matter will increase the coagulant demand
- The SCM reading will move in the negative direction under these conditions

pH

- Changes in the H+ ion concentration will affect the SCM
- Sampling between the coagulant and other chemicals can reduce interference of chemicals used to adjust pH
- The chemicals can also be dosed proportionally to minimize effects

Particle Charge

- Variations in colloidal and sub-colloidal (i.e. color) particle charges are measured with the SCM

Signal Offset

- The absolute SCM reading which corresponds to optimum coagulation efficiency is not necessarily Zero
- The instruments have the capability to force a “Zero” reading at optimum conditions to allow for an easy reference

Other Factors

- A periodic “re-optimization” is recommended to verify the proper SCM setpoint
- Downstream process parameters such as settled and filtered turbidity and particle counts are useful for optimizing
- The floc meter/PDA can be used as well

Installation

- The most common problem is clogging of sample line to SCM
- Recommend relocation to reduce buildup of silt or other debris
- Cyclone separators and “Y” can be used
- Periodic Auto or manual flushing
- Increase flow rate
- Short sample lines with visible drains

Operational Difficulties

- Location of sensor at sample point vs. in the Lab (remote sensor)
- Signal offset due to sample limitations
- Provides information more rapidly than a Jar Test, but doesn't indicate process performance only deviations from optimum
- Chemical savings are more substantial under changing conditions
- Excessive lag time can lessen response to change in dosage
- SCM requires scheduled preventative maintenance
- Samples high in Iron or manganese require more frequent cleaning
- A loss of response or sensitivity typically indicates cleaning is required

Recommendations for Successful Operations

- Sample times from coagulant addition to SCM are typically 3-5 minutes
- SCM must be installed far enough downstream to allow proper mixing (i.e. After rapid or incline mixer, vanturi's or several pipe bends, etc.)
- Optimize pH control for proper coagulation
- Maintain sample flow through sensor and use flow alarm for automatic dosing
- Keep the SCM Maintained
- Get the instrument "tuned up" periodically (replace piston and probe components if necessary)
- Periodically check optimization of the process and verify the SC setpoint

Determination of Proper Set Point

- First optimize plant process – flocculation, particle and NOM removal
- Minimize filter effluent turbidity/particle count
- Minimize coagulant dose and maintain water quality
- Maximizing plant/process efficiency
- "Zero" streaming current reading

Maintenance and Troubleshooting

- Source water quality can affect the frequency of maintenance and cleaning
- High turbidity, high iron and manganese levels and “foul” the electrode bore faster
- Oxidized iron and manganese can be cleaned with a reducing agent
- Worn probe components must be replaced

Request a Quote or Ask a Question

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