Chloramine Residual Optimization & Management:

MONOCLOR™

CHLORAMINE MANAGEMENT SYSTEMS
Chloramines, used in about a third of municipal water systems, provide longer protection in distribution systems and are less prone to encourage DBP formation.

\[
\text{NH}_3 + \text{OCl}^- \leftrightarrow \text{NH}_2\text{Cl} + \text{HO}^-
\]

Monochloramine is formed by the reaction of chlorine and ammonia with a chlorine atom substituting for one of the three ammonia hydrogen atoms.
There are three “chloramine” variants – only one of which is desirable in a water system.

Only monochloramine is considered a suitable disinfectant.
Chloramine usage has been problematic due to difficulty in accurately controlling ammonia and chlorine dosage in a dynamic distribution system.

- Introduction of ammonia can lead to nitrification as it is a nutrient to AOB’s.
- Over-chlorination can create chloramine variants which lead to taste and odor problems in drinking water (dichloramine and trichloramine).
- Low residual levels can also lead to costly mitigation efforts such as:
  - Chlorine burns
  - Line flushing
  - Water wasting or tank dumping
  - Corrosion control measures

![Ammonia Oxidizing Bacteria (AOB)](image)
In a “real world” water system, chloramine levels are challenged by a number of factors:

- Temperature stratification in reservoirs and tanks
- Chemical stratification in reservoirs and tanks
- Imported or mixed water compatibility
- Water aging in pipelines and reservoirs
- Changes in constituent ratios over time and as pipeline conditions change over transmission distance
Chloramine Breakpoint Curve: Know where you are on the curve

Ideal State of Chloramine Disinfection

Chloramine Breakpoint Curve: Know where you are on the curve
Four criteria must be met for proper chloramine control in reservoirs:

1. Accurate dosing of ammonia and chlorine to ensure proper ratio given the position on the breakpoint curve
2. Proper mixing to ensure a homogenous water body that will not stratify
3. High energy mixing that ensures instantaneous reaction of introduced chemicals
4. Real-time monitoring and control logic to maintain or achieve equilibrium by responding to dynamic reservoir conditions
The Monoclor™ Chloramine Management System operates in two modes:

**The Monoclor™: Mode 1**

- **STAGE 1**: Monoclor™ detects drop in chloramine residual.
- **STAGE 2**: Engage free chlorine feed.
- **STAGE 3**: Chloramine residual is reestablished.

[Diagram showing concentration vs. Cl₂ to NH₃-N ratio]
The Monoclortm Chloramine Management System:

Reservoir Condition: **Free Ammonia Present**

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**Graphs showing concentration and time relations:**

- **Concentration (mg/L):**
  - Cl\textsubscript{2} to NH\textsubscript{3}-N Ratio (wt)
  - Chlorine Applied
  - Chloramine residual
  - Total Chlorine Applied

- **Time (hours):**
  - Chlorine Added
  - Chloramine
  - Free Ammonia
In the Mode 2 - the Monoclor™ detects there is no free ammonia present:

**STAGE 1**
- Monoclor™ detects drop in chloramine residual.
- No Free Ammonia Present

**STAGE 2**
- Engage free chlorine feed.

**STAGE 3**
- Monoclor™ detects further drop in chloramine residual.

**STAGE 4**
- Engage ammonia feed along with free chlorine feed.

**STAGE 5**
- Chloramine residual is reestablished.
The Monoclor™ Chloramine Management System

Reservoir Condition: No Free Ammonia Present
Case Study #1

San Jose Water (CA) – Monoclor™ trailer at San Jose Water 1 MG reservoir

Tank Size: 1 MG
Turnover: 4 days
Problem: Chronically low residual (<0.2 mg/l)
Solution: Monoclor™ System

PSI On-Site Disinfection
A UGSi SOLUTIONS COMPANY
Tank Shark™ hardware is simple and easy to maintain

- Mixing – no electrical service
- Integral Sampling Point
- Chemical Injection
  - Onsite Sodium Hypochlorite (0.8%)
  - Commercial Bleach (12%)
  - Chlorine Gas
  - Aqueous Ammonia or Liquid Ammonium Sulfate (LAS)
Tank Shark™ mixer and injection device was installed while the tank was in service.

TANK & HATCH PENETRATIONS
Introduction of chemicals into the high energy mixing zone ensures instantaneous reaction.

Through Hatch Photo – Evidence of High Energy Plume

Underwater Photo - Chemical Introduction

Air introduced to illustrate chemical injection.
Moving water on the tank surface indicates active and energetic mixing

San Jose Tank Surface 2014
Monoclor™ Chloramine Management System Results

Introduction of “challenge water” volumes

Imported water introduced in high quantities throughout the trial caused momentary and intermittent concentration changes followed by quick recovery
San Jose Water: Benefits of the Monoclor™ Chloramine Management System

- Installation was accomplished in a day
- No internal energy supply required
- No penetration of the tank roof required
- Positive results occurred within 24 hours
- Maintained set points automatically
- Handled difficult imported water spikes quickly
Eastern Municipal Water District (Southern CA) 5.8 MG Landmark Tank had historically variable chloramine levels which made residual management in the distribution system challenging.

![Landmark Tank 1 Residual History](image-url)
The Monoclor™ system achieved and maintained the 3.0 ppm set-point after 4 days from start-up.
Chloramine generation and uniform tank mixing verified by two separate sample points on 5th day as ammonia is introduced.
Total chlorine residual from recent study maintaining 3.0 ppm set-point at corresponding Tank Elevations
Chemical Feed algorithm was turned off and here is what happened:

- Monoclor™ system maintains 3.0 set-point
- Monoclor™ chem feed turned off with Tank Shark™ mixer left on
- EMWD existing cal-hypo feeder turned on
- No meaningful residual
Case Study: East Bay Municipal Utility District (EBMUD) – 10 MG reservoir in six month pilot

June 30, 2014 - December 18, 2014

Six month pilot of 10 million gallon above ground storage reservoir
Chloramine management does not have to be complicated

- **Equilibrium**
  - Mixing & Motive Energy to Attain Homogeneous Tank Conditions

- **Kinetics**
  - Energetic Mixing Zone at Point of Chemical Introduction

- **Sampling**
  - Real Time Sampling - Representative Samples from Reservoir to Assess Conditions

- **Algorithm**
  - Algorithm that Adds Appropriate Quantities of Reactants at the Right Time to Maintain Reservoir Residual

- **Low Maintenance**
  - Minimize Mechanical Parts and Need for Maintenance within Tank

**Residual Control**
MONOCLOR™
CHLORAMINE MANAGEMENT SYSTEMS

Questions?

THANK YOU