Tank Mixing Pilot and Full-Scale Case Studies

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Many people contributed to these studies...
- South Coast Water District, CA
- Camarillo Water District, CA
- Old Town Water, ME
- Pinellas County Utilities, FL
- Utility Service Group/SUEZ
- Placer County Water District, CA
- Pittsburgh Water and Sewer Authority, PA
- American Water
- Loudoun County Water Authority, VA

~100,000 drinking water storage tanks in US...

Nearly all of them degrade the quality and consistency of the water they store...

WHY?

Unlike distribution system pipes, there is NO VELOCITY inside a water tank

As a result, water storage tanks suffer from...
- Thermal stratification
- Chemical stratification
- Short circuiting
- Elevated water/headscape temperatures
  - Accelerated corrosion
- Disinfectant residual loss
  - Nitrification in chloraminated systems
- Biofilm formation
- Sediment accumulation

Utilities spend a lot of $ dealing with the consequences of these issues

Active Mixing: Tool #1 for Distribution System Water Quality
- Eliminates stratification and reduces water age in storage tanks
- Lowers headspace temperatures in tanks in the summer
- Raises headspace temperatures in tanks in the winter
- Reduces residual demand in tanks
- Enables safe, reliable boosting of tanks
- (With active ventilation) can lower THM levels
Thermal stratification

Common inlet/outlet

Thermal stratification

Strong and persistent thermocline established

Thermal stratification

2 days old
1 day old
Thermal stratification can significantly affect water quality and treatment in water tanks. It involves the separation of water into layers with different temperatures and ages, which can lead to stratified water with varying properties.

**Stratification Examples**

- **3 days old**
- **1 day old**

Stratified tanks can have **high water age**...

**Thermal Stratification in Winter**

Thermal stratification also occurs in winter, often due to temperature differences.

**Sediment Accumulation**

Sediment can accumulate in low-velocity tanks, affecting water quality and treatment. The sediment settles at the bottom, creating a layer that can mix with incoming water.

**Sediment Arrives in Tank**

Sediment arrives in the tank through the common inlet/outlet.

**Sediment Setstle in Tank**

Sediment settles in the tank, common inlet/outlet.

**Ice Prevention Webinar**

Catch the webinar on ice prevention on December 8.
Mixing Technologies...

- 1990: Nozzles “Passive” (Only mixes during fill)
- 2000: Draft Tube “Active” (Mixing continuously)
- Today: Submersible “Active”

Active Mixing

- Circulate fresh residual-rich water to all parts of the tank
- Lower temperature in top water (and head space)
- Beat back biofilm production on tank walls
- Lower rate of sediment accumulation

Tank Mixing: Evaluating Performance

- How much mixing does my tank need?
  - Depends on shape and size of tank
    - Small, flat tanks
    - Large flat tanks, square tanks
    - Wide Standpipes
      - Narrow Standpipes
    - Massive tanks (10 MG+)

Key Performance Metric: Blend time

- \( T_B \) = Blend time
- \( T_{90} \) = time to reduce variation to 10% of its initial condition
- \( T_{95} \) = time to reduce variation to 5% of its initial condition

How much mixing does my tank need?

- Depends on Process Goal
  - Maintaining well-mixed conditions
  - De-stratification (thermal load)
  - Ice prevention (may need additional heat)
  - Blending a dose
  - Aeration

Less Power

More Power
Performance Metrics: Temperature profile

- Temperature profiles easiest to demonstrate complete mix
  - Float fixed below surface
  - Mid-level
  - 2 ft off bottom
- More data points can be used for increased resolution

Performance Metrics: Chemistry profile

- Chemistry most informative
  - Grab samples
  - Total or free chlorine
  - Top & bottom samples minimum
- More data points can be used for increased resolution

New white paper:
How to Select and Specify Mixers for Potable Water Storage Tanks

Download at www.paxwater.com

Full-Scale Utility Case Studies

Side-by-side comparison of mixing systems for thermal de-stratification – Southern CA

- 4.0MG Tanks, 132 x 40 ft
- Equal sunlight, equal water

Ideally Mixed Tank
Mixer A Results

PAX Water Mixer
Installed in 6.0MG Tank (132 x 40 ft)

Water Temperature [°C]

Surface
3 feet deep
26 feet from bottom
16 feet from bottom
2 feet from bottom

Mixer Off
Mixer On

~0.5 °C maximum stratification per day with mixer on. No consistent stratification
Stratification reduced to ~0.2 °C each night

Mixer B Results

Solar Bee -
Installed in 4.0MG tank (132 x 40 ft)

Water Temperature [°C]

Surface
3 feet deep
26 feet from bottom
16 feet from bottom
2 feet from bottom

Approx 3.0° C stratification consistent in tank despite Solar Bee

Side-by-side comparison of mixing systems for residual blending – Southern CA

Sample locations
Samples taken at each site from...
Surface
Middle
Bottom
The trial clearly showed that plumes of high Cl introduced into the tank were eliminated by the [tripod mixer] within 24 hours and were not eliminated by the [log-style mixer] after 38 hours. The differences in mixing results were significant.

Tom Smith – Superintendent (retired)
City of Camarillo Water Superintendent

“Southern CA” case study available at:
www.paxwater.com
Mixing Power makes the Difference for Ice Prevention and THM reduction

Some mixing systems are advertised to “reduce ice formation”

You don’t want “reduction” – you want ELIMINATION

Mixing Power makes the difference

A powerful active mixing system can save you $100K in tank damage

Tank #1 – Tripod mixer

Tank #2 – No mixer

A powerful mixer can reduce THMs

But you need STRONG mixing

Key take-away points:

- Active tank mixing provides value by:
  - Eliminate thermal and chemical stratification and reducing residual loss
  - Stabilize and improve residual levels
  - Lower headspace temperatures/reducing corrosion
  - (with ventilation) reducing THMs
  - Eliminating ice formation

- Select based on documented performance
  - Blend time measurements
  - Achievement of process goals
  - “Partially mixed”, “Reduction in ice formation” – don’t cut it
  - Mixer equipment costs vary by a factor of 3x
  - Mixing power varies by a factor of 12x

Your tanks are a valuable (and expensive) municipal asset…

EFFECTIVE MIXING can stabilize and improve your water quality

Mixing Power makes the difference
Next steps

• Attend our next webinar: Eliminating Nitrification in Chloraminated Water Systems November 3, 2016 Noon Eastern (9AM Pacific)
• Review our case studies at www.paxwater.com
• Contact me with questions (pfiske@paxwater.com)

Thank you!