Treatment Capability of UV and Peracetic Acid: Implementation of Emerging Technologies

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Who Am I?

- Graduate student at Arizona State University
  - B.S.E degree in Civil Engineering (Environmental)
  - Pursuing M.S degree in Environmental Engineering
  - Accepted into graduate school through 4+1 program
  - Specifically interested in water/wastewater treatment

- Project Engineer at Valentine Environmental Engineers
  - Over 2 years of experience at Valentine
  - Worked on a variety of water and wastewater projects
Overview of Presentation

- Peracetic Acid and UV Technology Summary
- Advantages and Significance of Technology
- Pilot Study at Global Water Palo Verde Water Reclamation Plant
- ASU UV and Peracetic Acid Research
Peracetic Acid and UV Disinfection Technology

- **Ultraviolet (UV) disinfection**— Ultraviolet irradiation accomplished through short wavelength (UV-C) ultraviolet light that inactivate microbes by disrupting bacterial cell replication
- Inject disinfecting chemical upstream of UV reactor to promote further disinfection:
  - Chosen chemical is **peracetic acid (PAA)**
    - Approved by U.S EPA as a primary disinfectant in 2007
    - Made up of acetic acid and hydrogen peroxide
    - Strong oxidant
    - According to research, only low doses of PAA required when used in combination with UV
Technology Analysis: Advantages and Disadvantages

- Particular UV unit chosen (Neotech Model D860).
- **Advantages of the UV system:**
  - lower power consumption (up to 10 times better operating efficiency)
  - lower footprint
- **Advantages of peracetic acid (PAA):**
  - PAA to chlorine feed ratios 1:7
  - No known adverse disinfection by-products
  - Dechlorination not required
  - Potential to clean UV sleeves (reduce maintenance)
  - Potential of chemical to degrade endocrine disruptors through advanced oxidation (breaks down into hydrogen peroxide ($H_2O_2$) and further down into hydroxyl (OH) radicals.)
Significance of Technology

- Chlorine disinfection is currently popular type of disinfection in wastewater treatment:
  - Produces harmful disinfection by-products.
  - Maintaining chlorine residuals and dechlorination can produce added costs.

- Peracetic acid and UV may decrease operating costs:
  - Use of peracetic acid upstream of UV reactor could cut down on power costs by allowing lower UV intensities.
  - Peracetic acid requires smaller doses than chlorine, may cut down on chemical costs.

- Potential benefit of degrading contaminants that could cause adverse health effects in exposed wildlife/humans.
Pilot Study: Set-Up

- Pilot study conducted by Valentine Environmental Engineers and Hennesy Mechanical
- UV system alone and combination of UV system/PAA dosing evaluated in study
- Pilot UV unit received filter effluent via two inlet and two outlet connections.
- 4 UV Intensity Sensors
- 8 low pressure mercury vapor UV lamps

Neotech UV unit rated for 350 gpm
- Dimmer provided to shunt power to unit and simulate failing lamps (lower UV intensities)
- PAA injection prior to UV unit via chemical feed pump
- Inlet sampling port and outlet sampling port
Performance evaluated based on disinfection (total and fecal coliforms from sampling) at:
- 4 flowrates (250 gpm, 375 gpm, 750 gpm, and 1,000 gpm)
- 4 PAA doses were tested and were 0.5 mg/L, 1.0 mg/L, 1.5 mg/L, and 2.0 mg/L
- 100%, 75%, and 50% UV intensities (simulate fouling)
- Inlet/outlet turbidity (NTU), temperature, UVT (%), pH, chlorine residual also monitored
Pilot Study: Results

- All inlet/outlet turbidity (NTU) < 2 NTU
- No significant change in pH, temperature, UVT between inlet and outlet
Pilot Study: Interpretation of Results

- Lower flowrates easier to achieve adequate disinfection (meet Class A+ requirements)
- Higher flowrates could likely achieve adequate disinfection (to meet Class A+ requirements) with at least 1.5 mg/L PAA dosed
- Issues with pilot study included:
  - Low amounts of chlorine residual detected in several tests (plant needed to chlorinate filters at times)
  - Power issues (unintentional lower UV intensities)
  - Unable to fully understand capability of PAA to clean sleeves due to issues with equipment
From Pilot Study to ASU Research Idea

- Working on the pilot study inspired my research idea
- Wanted to look at UV unit on a smaller scale and analyze other water quality:
  - Inactivation of other microbes:
    - Legionella
  - Removal of chemical compounds:
    - NDMA or N-Nitrosodimethylamine (Emerging Contaminant)
Research—Methods

- **PRIMARY GOAL:** Determine treatment capability by measuring both inactivation of microbes as well as degradation of chemical contaminants

- **How will this be done?**
  - Utilize small bench-scale UV reactor. One has been provided by Neotech Aqua Solutions, Inc. (smaller version of pilot study UV reactor)
    - Enclosed reactor has reflective coating on inside of vessel to supposedly provide additional treatment
  - Pump water through enclosed UV chamber via piping with peracetic acid injection port prior to inlet of UV system
  - Collect samples at both inlet (prior to peracetic acid injection) and outlet and compare inlet to outlet for log inactivation of bacteria and percent removal of pertinent contaminants.
Research – Results (so far)

High and Low Flow *E.coli* Log Removal (UV Only)

- Test 1 Low Flow
- Test 2 Low Flow
- Test 3 Low Flow
- Test 1 High Flow
- Test 2 High Flow
- Test 3 High Flow

- Need to continue increasing flow through unit
Thank you! Questions?