Improving Drinking Water Quality for Small Rural Communities in Missouri

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Research Goal & Objectives

Overall goal: To improve drinking water quality for small rural communities in Missouri and help small water treatment systems meet the Stage II requirements of the EPA drinking water regulations.

Major Objectives:

- Characterized water quality at representative small systems to identify typical water quality issues;
- Develop novel, cost-effective water treatment technologies able to reduce the identified health threats;
- Transfer and implement such technologies for small drinking water treatment systems.

Technical Approach: *Objective I*

Three representative small drinking water treatment systems in rural community of Missouri using various source water were selected for this project following the selection criteria.

System	Location	Service pop. (2011)	Yield (MG/day)	Source water
System A	Western Missouri	5,300	0.58	Ground water
System B	Northern Missouri	3,900	0.22	Surface water
System C	Central Missouri	8,350	1.13	River water

Technical Approach: *Objective I*

During the period of May 2012 to March 2013, water samples were collected quarterly from the selected systems at each treatment step from source to finished water. The collected water samples were characterized using various methods to identify typical water quality issues.

System	pH (source)	pH (finish)	Cations (source) ppm	NH_3-N (source) ppm	DOC (source) ppm	DOC (finish) ppm	Total Br (source) ppb	Total Br (finish) ppb	SUVA254 (source) ($x10^{-2}$)	SUVA254 (finish) ($x10^{-2}$)
System A	7.2	9.0	Fe: 15.3 ± 1.7 Mn: 1.63 ± 0.13	1.01 ±0.12	3.1 ± 0.5	3.1 ± 0.1	152.0 ±46.7	545.8 ±102.5	5.96 ±4.23	1.70 ±0.24
System B	8.0	7.7	Fe: <1.0 Mn: <0.5	-	8.0 ± 1.2	4.6±0.6	72.0 ±35.2	140.3 ±65.1	2.07 ±0.74	0.70 ±0.11
System C	8.2	7.8	Fe: <1.0 Mn: <0.5	-	4.5 ± 0.5	3.4±0.3	104.6 ±65.3	207.0 ±145.9	2.22 ±0.71	1.40 ±0.26

Technical Approach: *Objective I.*

The 7-day THM formation potentials and dominant THM species

System	THM FP (source water) (ppb)	THM FP (finish water) (ppb)	Dominant THM species
System A	128.4 ± 9.7	116.1 ± 15.8	$CHCl_3$:$CHBrCl_2$:$CHBr_2Cl$ 52:33:15
System B	248 ± 33.9	115.1 ± 8.3	$CHCl_3$:$CHBrCl_2$:$CHBr_2Cl$ 73:22:4
System C	150 ± 8.1	94.3 ± 21.1	$CHCl_3$:$CHBrCl_2$:$CHBr_2Cl$ 73:20:7

Preliminary Findings: *Objective I.*

- High ammonia (NH_3), iron (Fe), and bromide (Br) in the ground water system;
- High source water DOC and an ineffective DOC removal during the treatment process for the surface water system;
- The 7-day TTHM formation potentials for all the finished water from the three small systems were higher than EPA MCL, with $CHCl_3$ and $CHBrCl_2$ as the dominant THM species.

Technical Approach: *Objective II.*

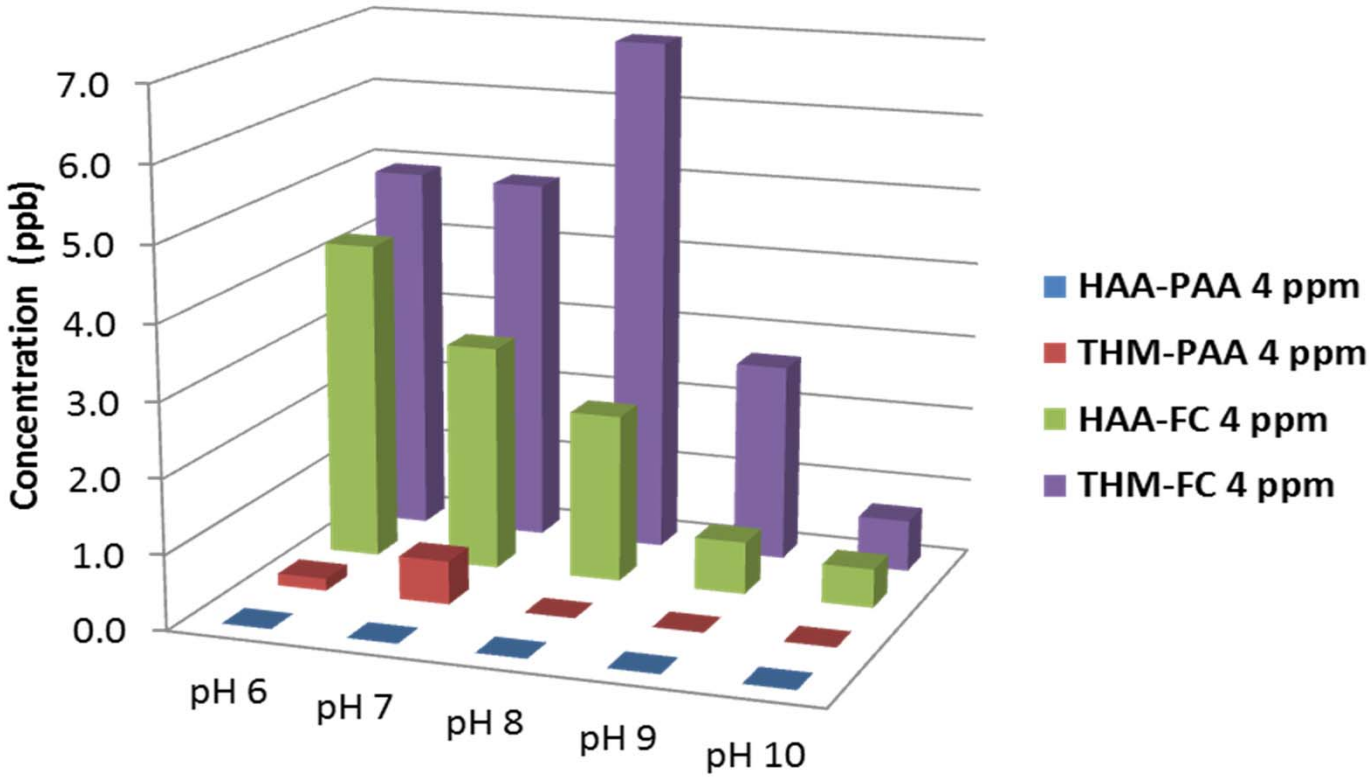
1. Peracetic acid study:

In an effort to address the issue of elevated THM in finish drinking water, peracetic acid (PAA) has been studied as an effective disinfectant for its effectiveness to reduce the TTHM contents.

It was hypothesized that PAA can be used as an effective drinking water disinfectant, which will result in lesser or no disinfection by-products (DBPs) in finished drinking water.

Technical Approach: *Objective II.*

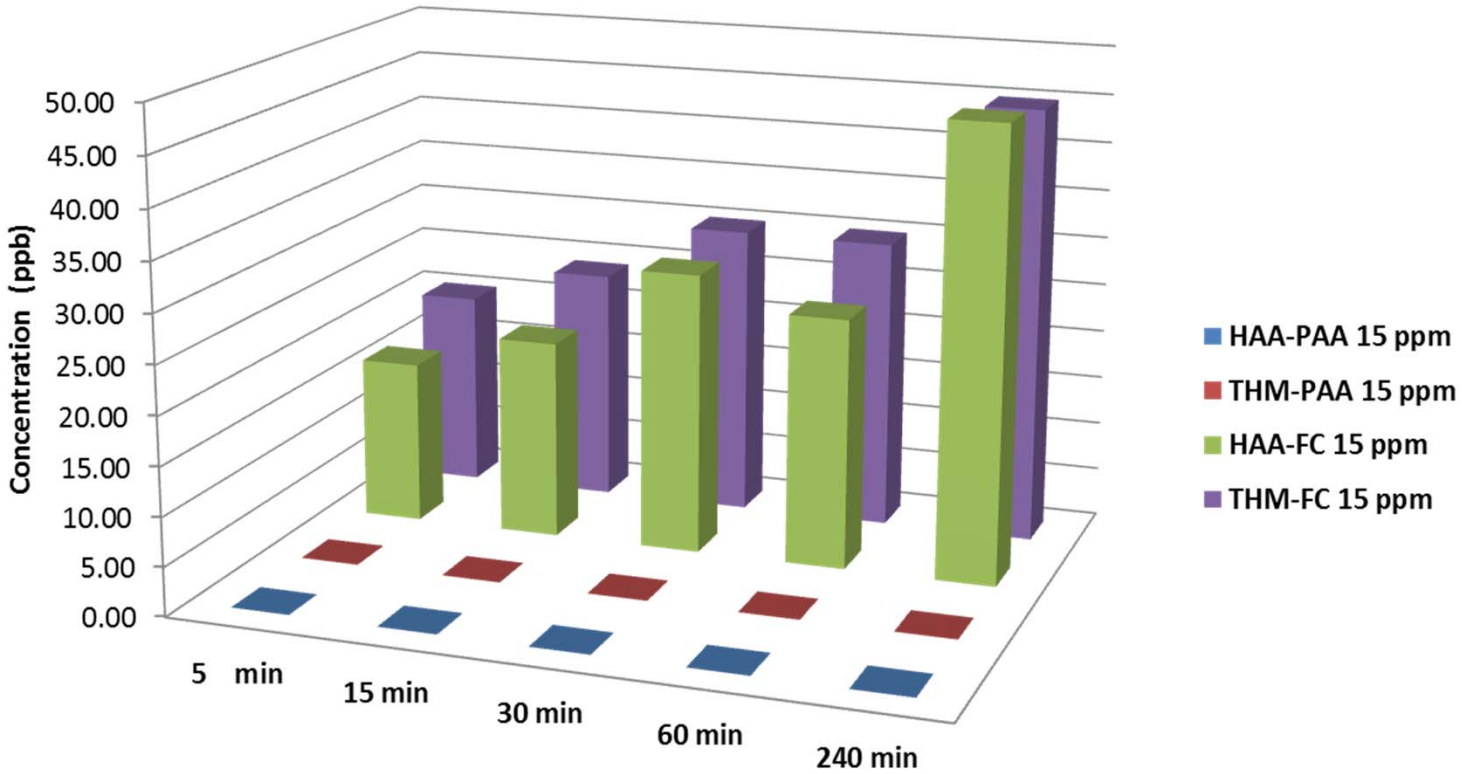
1. Peracetic acid study:



HAA and THM formation by PAA (4 ppm) and FC (4 ppm) disinfection at different pH conditions.

Technical Approach: *Objective II.*

1. Peracetic acid study:



HAA and THM formation by PAA (15 ppm) and FC (15 ppm) disinfection at different reaction times.

Preliminary Findings: *Objective II.*

1. Peracetic acid study:

- PAA, as a drinking water disinfectant, is highly effective with a concentration as low as 0.5 ppm, and the disinfection is very rapid (<5 min).
- No significant DBPs were formed by PAA treatment while THMs and HAAs formed under the same condition by free chlorine (FC) treatment.
- PAA may be a green alternative disinfectant for drinking water disinfection.

Technical Approach: *Objective II.*

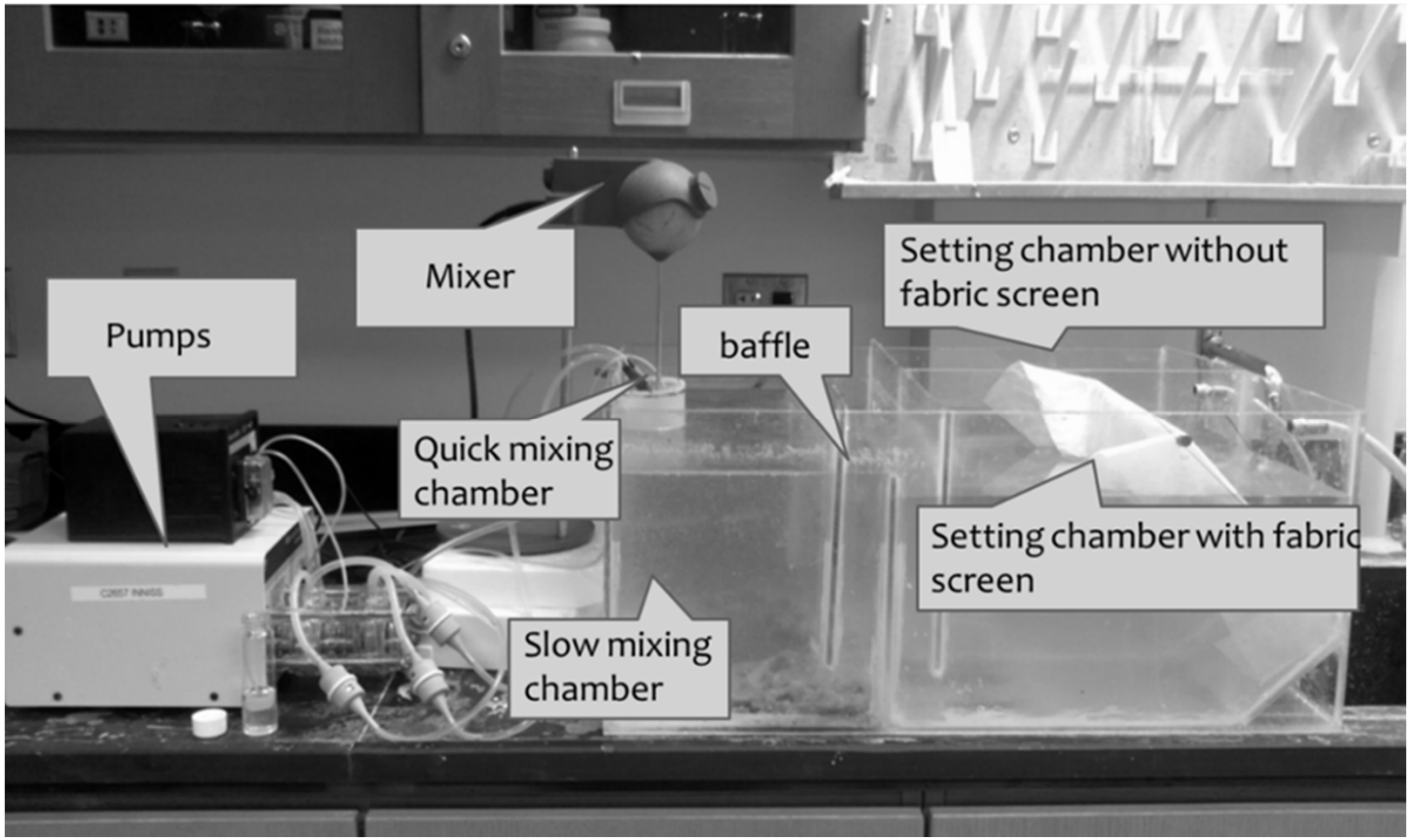
2. Fabric settling screen study:

In an effort to address the issue of elevated DOC in source water, the fabric inclined settling screen concept is developed through enhanced solids contact. The technology combines fabric filters with the traditional inclined plate.

Fabric material performance and serviceability was evaluated by exposure to a drinking water treatment environment and then turbidity, total dissolved organic carbon, and UV254 measured.

Technical Approach: *Objective II.*

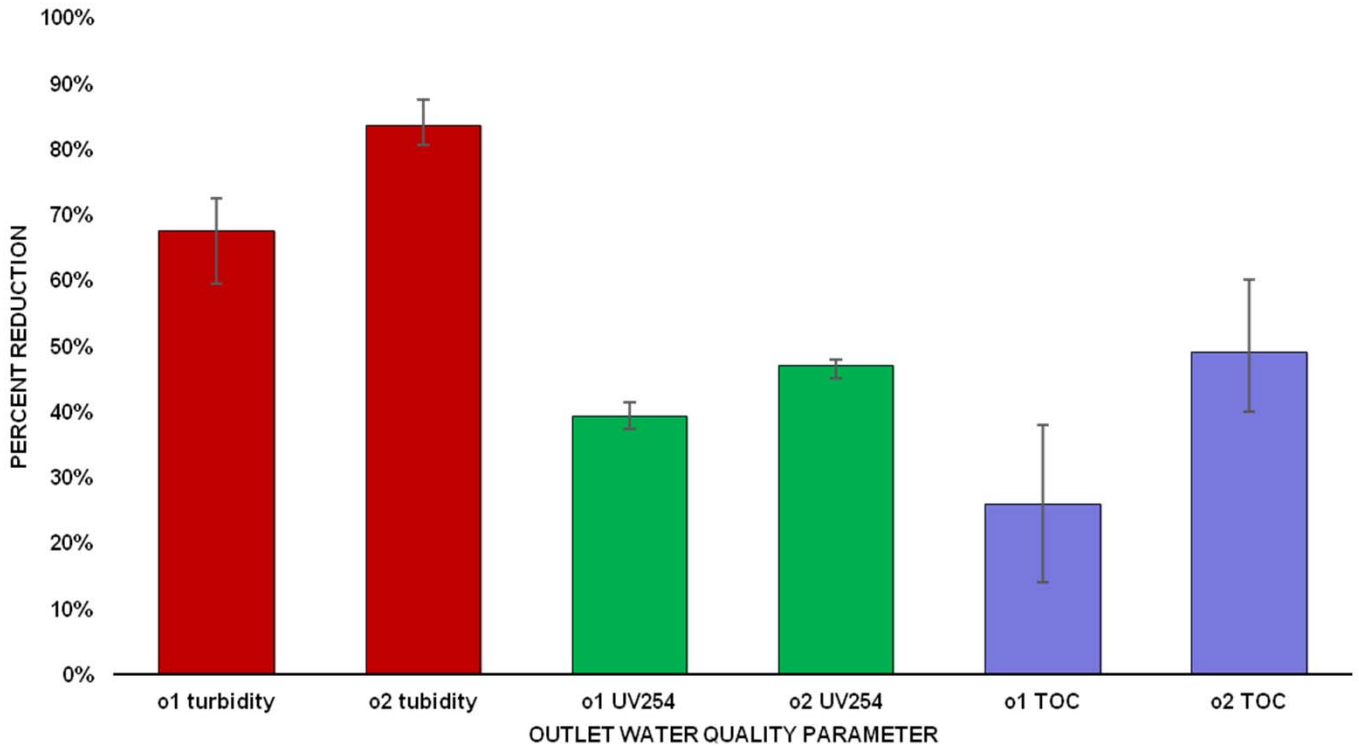
2. Fabric settling screen study:



Experimental set-up with two outfalls without and with fabric screen.

Technical Approach: *Objective II.*

2. Fabric settling screen study:



Comparison of water quality (turbidity, UV254, and TOC) through outfall without (o1) and with fabric screens (o2).

Preliminary Findings: *Objective II.*

2. Fabric settling screen study:

- Polyester material is more appropriate in acidic and neutral conditions while rayon-like material more appropriate in basic conditions.
- Fabric screen improved turbidity, UV254, and TOC reductions by 15%, 5%, and 20%, respectively.
- Real-world application of this technology could yield measurably lower disinfection by-product (DBPs) precursors.

Future Efforts.

- Advanced oxidation (Fe-H_2O_2) for enhanced DOC and DBP precursor removal.
- Enhanced activated carbon adsorption (powder vs. granular; coal vs. wood vs. coconut-based).
- Performance tests of fabric screen materials (not yet NSF/ANSI standard 61 certified) in a bench and pilot scale drinking water treatment process.
- Outreach activity and workshop.
- If successful, technology transfer and implementation.

Slide 15

h1 I think bench scale test is same with lab scale test. Is it should be tested in a pilot scale?
honglan, 8/10/2013

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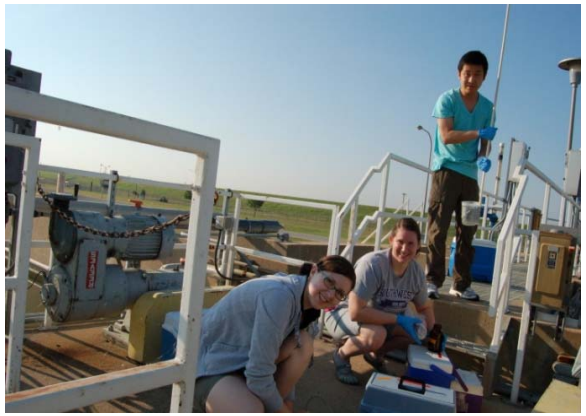

Thank you!

Questions?