

Validating Virus Removal By Advanced Treatment Technologies

Luisa Ikner (UA-WEST) and Ian Pepper (UA-WEST)



ARIZONA WATER INNOVATION CHALLENGE

Goal: To provide an innovative solution for water sustainability
in southwest Arizona

- The University of Arizona WET Center was part of the winning team, along with:
 - Pima County Wastewater Reclamation Department (project lead)
 - Tucson Water
 - Marana Water
 - Carollo Engineers
 - CH2MHill
 - AquaTecture
 - Clean Water Service
- Prize = \$302,500 funded by Arizona Community foundation and Water Now Alliance

PROJECT OBJECTIVES

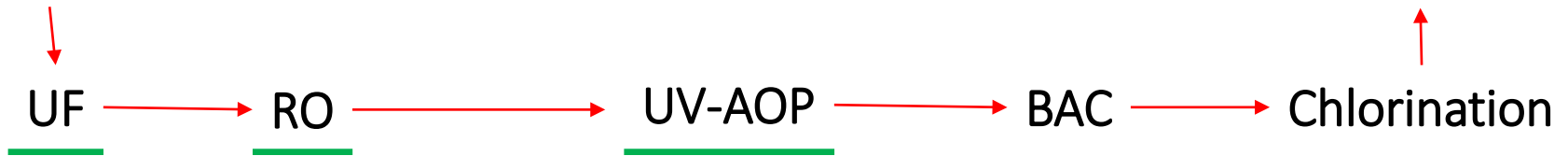
- Enhance public perception of reclaimed water for potable reuse
- Treat effluent from WWTPs using advanced treatment processes to obtain water of potable quality
- Convert the product water into beer (**AZ Pure Water Brew Challenge**)
- Ensure that the product water was free of chemical and microbial contaminants (WET Center focus)



APPROACH

Reclaimed
Water

Potable
Water for Beer

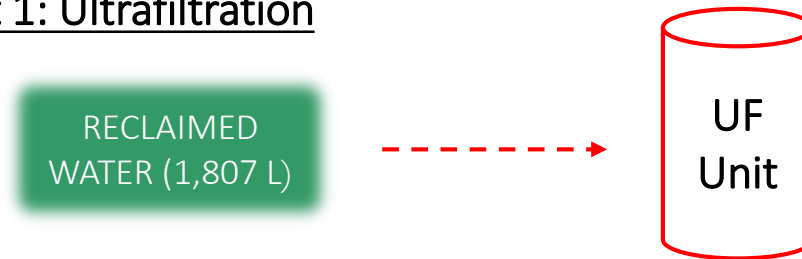


GOAL: Establish \log_{10} reduction credits for advanced treatment processes → 12- \log_{10} for viruses

CHALLENGE TESTING: PARAMETERS

Test Organism	MS2 bacteriophage 15597-B1
Host Bacterium	<i>Escherichia coli</i> 15597
Target Inoculum for MS2	5E+07 PFU per mL

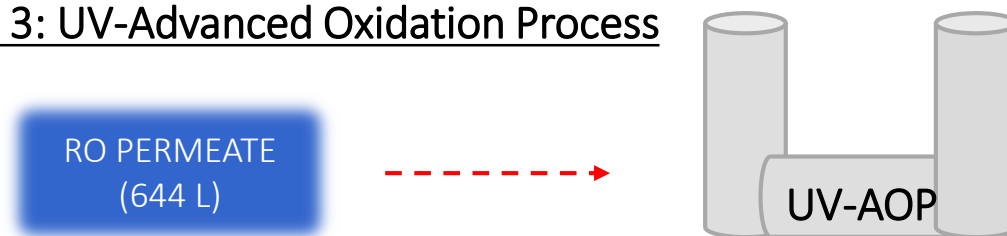
Advanced Treatment Test 1: Ultrafiltration



Advanced Treatment Test 2: Reverse Osmosis



Advanced Treatment Test 3: UV-Advanced Oxidation Process



UF CHALLENGE TESTING:

22 June 2017

(Flow rate: 9.5 -10.0 GPM)



MS2 Challenge Testing Data and Reductions by Sample: Ultrafiltration Treatment of Reclaimed Water

Feed Water Samples		Post-Treatment Water Samples ^a		Reductions by Sample #	
Sample #	Mean PFU per 100 mL	Sample #	Mean PFU per 100 mL	Log ₁₀ Reduction	Percent Reduction
1	1.62E+09	1	2.19E+04	4.87	99.998%
2	1.54E+09	2	3.17E+05	3.69	99.98%
3	1.57E+09	3	3.65E+07	1.63	97.7%
4	1.61E+09	4	1.03E+06	3.19	99.94%
5	1.33E+09	5	8.60E+05	3.19	99.94%

^aWater treatment system defaulted to "Backflush Mode" during time interval between collection of Samples 2 and 3; Sample 3 collected after system reset to normal operational conditions, and after 9 to 10 GPM flow rate achieved.

RO CHALLENGE TESTING: 22 June 2017 (Flow rate: 6.5 -7.0 GPM)



MS2 Challenge Testing Data and Reductions by Sample: Reverse Osmosis Treatment of UF Filtrate Water

Feed Water Samples		Treated Water Samples		Reductions by Sample #	
Sample #	Mean PFU per 100 mL	Sample #	Mean PFU per 100 mL	Log ₁₀ Reduction	Percent Reduction
1	1.31E+09	1	6.30E+05	3.32	99.95%
2	1.27E+09	2	7.55E+02	6.22	99.99994%
3	1.29E+09	3	1.00E+01	8.11	99.999992%
4	1.40E+09	4	5.00E+00	8.45	99.999996%
5	1.46E+09	5	1.35E+02	7.03	99.999991%

UV-AOP TESTING:

21 June 2017

(Flow rate: 3.0 – 3.5 GPM)



MS2 Challenge Testing Data and Reductions by Sample: UV-AOP Treatment of RO Permeate Water

Feed Water Samples		Treated Water Samples		Reductions by Sample #	
Sample #	Mean PFU per 100 mL	Sample #	Mean PFU per 100 mL ^a	Log ₁₀ Reduction	Percent Reduction
1	1.39E+08	1	≤ 1.00E+00	≥ 8.14	≥ 99.9999993%
2	4.20E+08	2	1.00E+00	8.62	99.9999998%
3	4.95E+08	3	≤ 1.00E+00	≥ 8.69	≥ 99.9999998%
4	2.25E+08	4	1.00E+00	8.35	99.9999996%
5	1.19E+09	5	≤ 1.00E+00	≥ 9.08	≥ 99.99999992

^a"≤": MS2 levels below limit of detection (1 PFU per 100 mL)

RESULTS: Log₁₀ Reduction Credits

Advanced Treatment Process	Log ₁₀ Reduction (Conservative)	Log ₁₀ Reduction (GeoMean)
Ultrafiltration	1.63	3.31
Reverse Osmosis	3.32	6.63
UV-AOP	8.14	8.56
Total Reduction Credits Granted =	13.09	
GeoMean-based Reduction =		18.50

GOAL

Establish log₁₀ reduction credits for advanced treatment processes

→ 12-log₁₀ for viruses → **ACHIEVED**

Thank you!

Questions?