



Safer Chemicals Do Work

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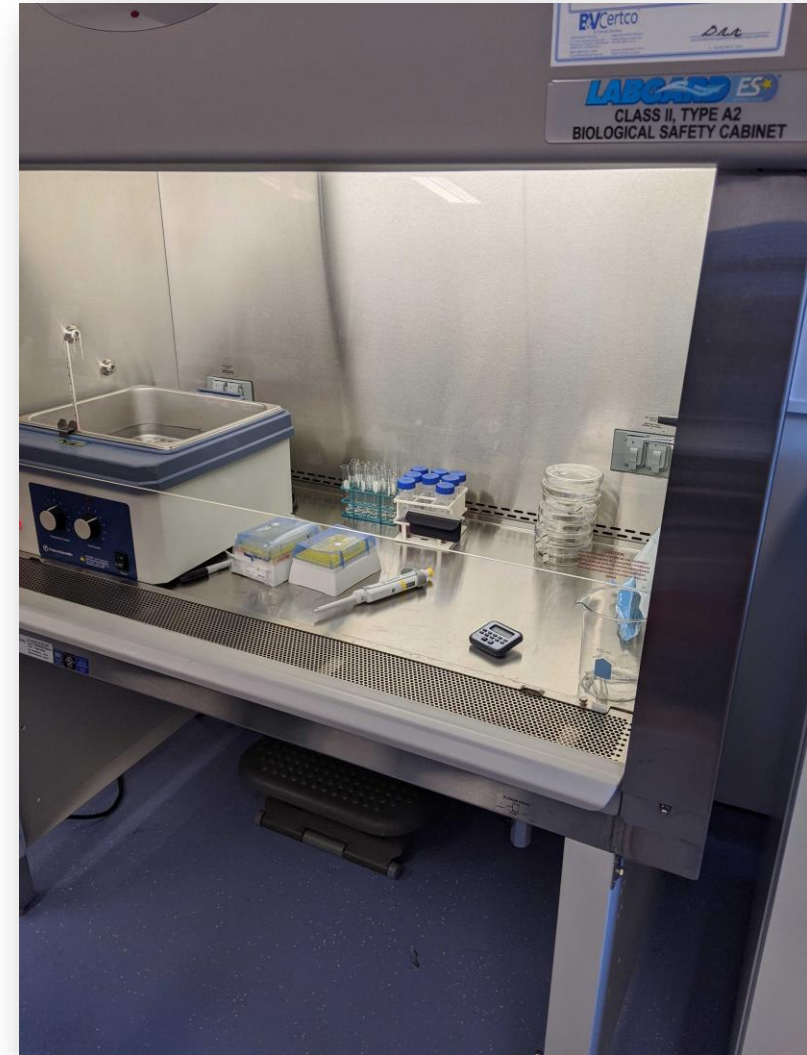
UMass Lowell

978-934-3889



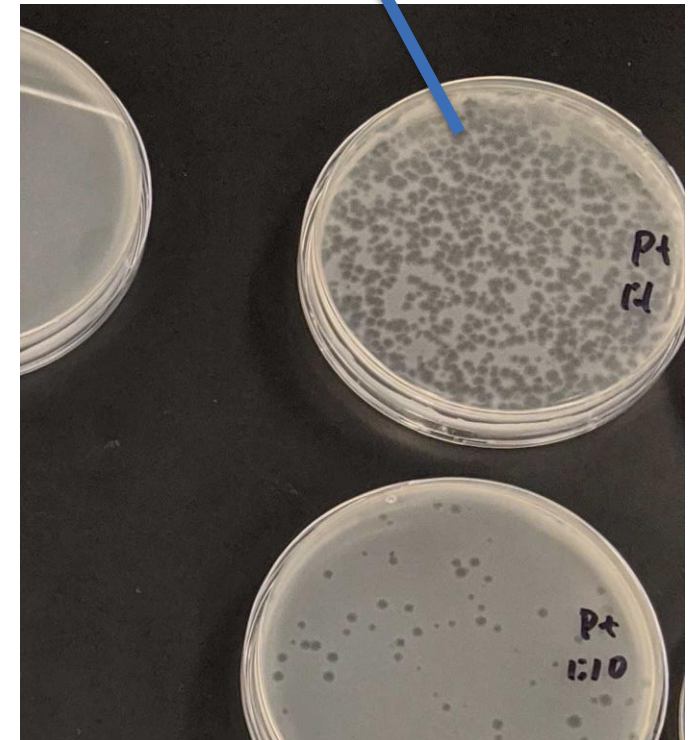
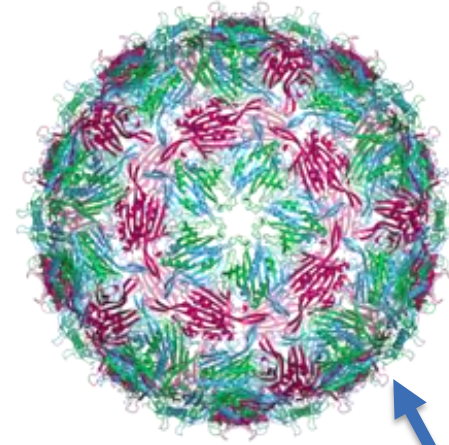
TURI Lab COVID-19 Disinfection Testing

- Research safer cleaners and disinfectants that can be used to inactivate (kill) COVID-19 virus
 - Test common household all-purpose cleaners
 - Disinfection equipment
 - Steam cleaners, UV light
 - Safer disinfectants and EPA N-List Ingredients
 - Ozone, Citric Acid, Lactic Acid, Hypochlorous Acid, Hydrogen peroxide, Caprylic Acid, Dichloroisocyanurate
- Testing with Bacteriophage
 - MS2 Bacteriophage




What is MS2 Bacteriophage?

- Small non-enveloped virus
 - 23-28 nm in diameter
- Biosafety Level (BSL) -1
 - Low-risk microbes; noninfectious
- MS2 requires a bacterial host
 - Rapid replication compared to mammalian host cells
 - Infects "male" Escherichia coli (E.coli)
 - E.coli 15597



How Can MS2 Bacteriophage Relate to COVID-19 Disinfection Testing?

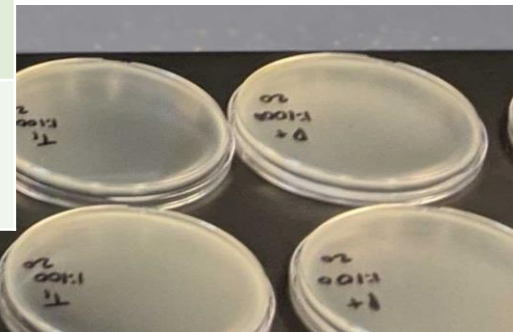
Ease to Kill	Type of Virus	Virus	Other Examples
Difficult  Easy	Small non-enveloped	MS2 Bacteriophage	Poliovirus; Rhinovirus
	Large non-enveloped		Adenovirus; Rotavirus
	Enveloped	Covid-19	Influenza; Herpes

- Recognized by EPA as viral representative
 - Used to gauge the initial efficacy of a product before moving to a mammalian virus testing
- How TURI is using MS2 to gauge effectiveness of products:
 - If product kills MS2, then it will kill Covid-19
 - If product doesn't kill MS2, doesn't mean it won't work
 - More testing needed on an enveloped virus

Preliminary Products Tested: All-Purpose Cleaners

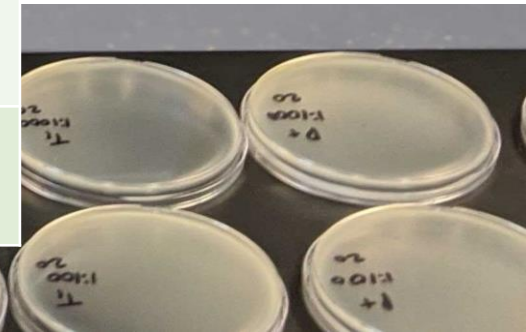
Substrate: Stainless Steel Coupon; Contact Time: 1 Minute

Product	Type/ Ingredients	Concentration %	Amount Applied	Log Reduction (% Reduction)	# of Colony Forming Units (CFUs)	Average % Reduction
Castille Soap (All-Purpose Recipe)	Acidic/Neutral Aqueous; Citric Acid	1/4 cup in 1 quart	1 Spray (1mL)	Log 0-1 (0-90%)	1,000,000 – 10,000	89
Multi-Purpose Cleaner Product 1	Acidic Aqueous; Vinegar	100%	1 Spray (0.5mL)	Log 1 (90%)	100,000	94
Multi-Purpose Cleaner Product 2	Listed Active Ingredient: Alkyl C12-16 Dimethylbenzyl Ammonium Chloride (Quat)	100%	1 Spray (1mL)	Log 6 (99.9999%)	1	100
All-Purpose-Cleaner Product 3	Neutral aqueous; Citric acid	100%	1 Spray (1mL)	Log 6 (99.9999%)	1	68
All-Purpose Cleaner Product 4	Alkaline Aqueous; Benzisothiazolinone; methylisothiazolinone	100%	1 Spray (1mL)	Log 0-1 (0-90%)	1,000,000 – 10,000	75
All-Purpose Cleaner Product 5	Alkaline Aqueous; hydrogen peroxide, vodka, frankincense	100%	1 Spray (1mL)	Log 2 (99%)	10,000	95



Preliminary Products Tested: Other Products/Devices

Product	Type/ Ingredients	Concentration % / ppm	Contact Time (Seconds)	Amount Applied	Log Reduction (% Reduction)	# of Colony Forming Units (CFUs)	Average % Reduction
Ozone Spray	Ozone; Tap Water	0.2ppm (General Cleaning Level)	60	5 sec spray – (1 mL)	Log 0-1 (0-90%)	1,000,000 – 10,000	75
Ozone Spray	Ozone; Poland Springs	0.5ppm (Disinfection Level)	60	5 sec spray – Direct Spray	Log 3 (99.9%)	1,000	99
ECA	1 Capsule/ 400 ml/ 1 Cycle	350ppm Total Chlorine	60	1 Spray - (550µl)	Log 6 (99.9999%)	1	100
ECA	1 scoop salt/ 400ml/ 1 Cycle	250ppm Total Chlorine	60	1 Spray – (1mL)	Log 6 (99.9999%)	1	100
Bleach	Sodium hypochlorite 6%	0.1% 1000ppm Total Chlorine	60	1 Spray – (1mL)			
Steam Cleaner with Microfiber Towel	Tap Water (Around 170°F)	100	30	Direct Contact	Log 6 (99.9999%)	1	100
Bleach	Sodium hypochlorite 6%	0.1% 1000ppm Total Chlorine	30	1 Spray – (1mL)			



Electrical Chemical Activation (ECA) Measurements: Water Measurements of Total Cl & pH

- Instruments used:
 - Lovibond MD 100 - CLHR for Total Cl
 - APERA Instrument for pH



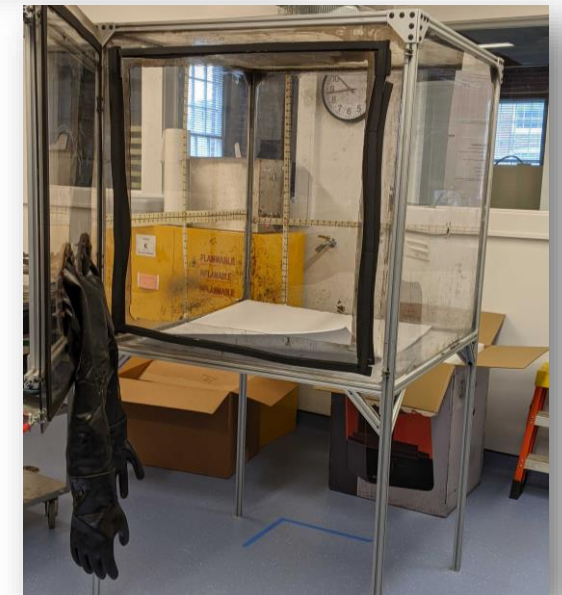
Lovibond MD 100



APERA pH Instrument

Preliminary ECA Measurements: Air Measurements (PPM)

- How we measured it:
 - Calibrated the ToxiRAE Pro Photoionization Detector (PID) for Chlorine (Cl_2)
 - Placed measured markers within an old glove box to keep air monitor at same distance and height
 - Measured in glove box after two-minute spray in space
 - Timed how long a measurement would take to get back down to 0ppm



ECA Devices Overview

Force of Nature

- Provides capsule with salt and vinegar mixture

Ecolox

- Add 1 scoop salt (1-1.5 grams)

Skrubbr

- Add 1 scoop salt (1-1.5 grams)

Aviair

- Add 1 scoop salt (1-1.5 grams); or 1ml of vinegar/1 scoop salt

EcoLox

- Add 1 scoop salt (1-1.5 grams);

GenEon

- Add provide packet salt solution

Preliminary ECA and NaDCC Water and Air Measurements Results

Device	Amount Used	Average Total Cl in Water (ppm) Range	Average pH Range	Two Minute Spray Cl2 PPM Air Measurements
ECA Device 1	1 Capsule/ 350 ml tap water 1 Cycle	336 - 424	6.49 - 7.12	0.6 (1 minute until 0ppm)
	Used Improperly: 1 Capsule/ 350 ml tap water 0.5 Cycle	136 -188	5.17 - 5.34	N/A
ECA Device 2	1 scoop salt/ 400ml tap water 1 Cycle	93 - 107	3.98 – 4.33	0
	Used Improperly: 2 scoops salt/ 400ml tap water 1 Cycle	136 - 204	8.53 - 8.85	N/A
ECA Device 3	1 scoop salt/ 400ml tap water 1 Cycle	82 - 114	8.14 – 8.64	0
	Used Improperly: 2 scoops salt/ 400ml tap water 1 Cycle	134 - 155	8.49 – 8.76	N/A
ECA Device 4	1 packet -71 ml/ 2.5 Liters tap water 1 Cycle	1064 - 1296	7.37 - 7.46	1.5 - 2.8 (3 minutes until 0 ppm)
ECA Device 5	5 ml vinegar/ 1 g salt 1 Liter tap Water/ Setting 3 (8 mins)	162 - 196	4 – 4.44	N/A
NaDCC Tablet	½ tablet in 2 quarts water	292 - 300	6.19 - 6.30	0

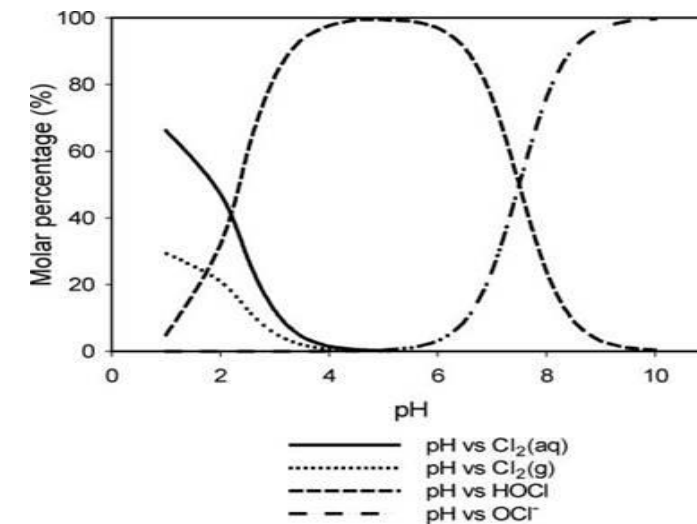
HOCl or OCl⁻? What is potentially being produced?

Device	Average pH Range	Prediction of What Is Mostly being Generated Based on pH Ranges
ECA Device 1	6.49 - 7.12	HOCl/OCl ⁻
	5.17 - 5.34	HOCl
ECA Device 2	3.98 - 4.33	HOCl
	8.53 - 8.85	OCl ⁻
ECA Device 3	8.14 - 8.64	OCl ⁻
	8.49 - 8.76	OCl ⁻
ECA Device 4	7.37 - 7.46	HOCl/OCl ⁻
ECA Device 5	4.00 - 4.44	HOCl
NaDCC Tablet	6.19 - 6.30	HOCl

Table 1. Percentages of HOCl and OCl⁻

pH	% HOCl 32°F	% OCl ⁻ 32°F	% HOCl 68°F	% OCl ⁻ 68°F
4	100.0	0.0	100.0	0.0
5	100.0	0.0	97.7	2.3
6	98.2	1.8	96.8	3.2
7	83.3	16.7	75.2	24.8
8	32.2	67.8	23.2	76.8
9	4.5	95.5	2.9	97.1
10	0.5	99.5	0.3	99.7
11	0.05	99.95	0.03	99.97

<http://wcpnline.com/2009/06/13/chlorine-chloramine-removal-activated-carbon/>



<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1853323/#:~:text=Methods%3A%20Stabilized%20HOCl%20is%20in,range%20of%203%20to%206>

Next Steps with Testing

Continue Phase I: ECA / NaDCC Disinfection Testing

Active Ingredient	Generation Method	Concentration or FAC Level	Application	Duration of Use (Dwell Time)
HOCl	Force of Nature	Low (< 200 ppm)	Spray	Short
	GenEon	Medium (300 - 750 ppm)	Wipe	Medium
	EcoLox Tech	High (750< ppm)	Immersion	Long
	Aviair		Fogger	
	Skrubbr		Electrostatic Spray	
	NaDCC Tablets			
Sodium hypochlorite	Manual Dilution			

Phase 2 : Devices & Active Ingredient Safer Disinfectants Testing

- Citric Acid
- Caprylic acid
- Hydrogen peroxide
- L – lactic acid
- Ethanol
- Isopropanol
- Peroxyacetic acid
- Sodium bisulfate
- All Purpose cleaners
- Probiotic solutions
- UVC light
- Steam

What are your needs?



What would you like to see tested?



What issues are you running into?

Take Home Points

- You can use safer cleaners, disinfectants, and devices
 - Steam appears to work (preliminary results indicate 100% Log 6 reduction in 30 seconds)
- Use any product as directed
- Don't need harsh chemicals to disinfect
- COVID-19 is an easy virus to kill

Contact TURI Lab for Help

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