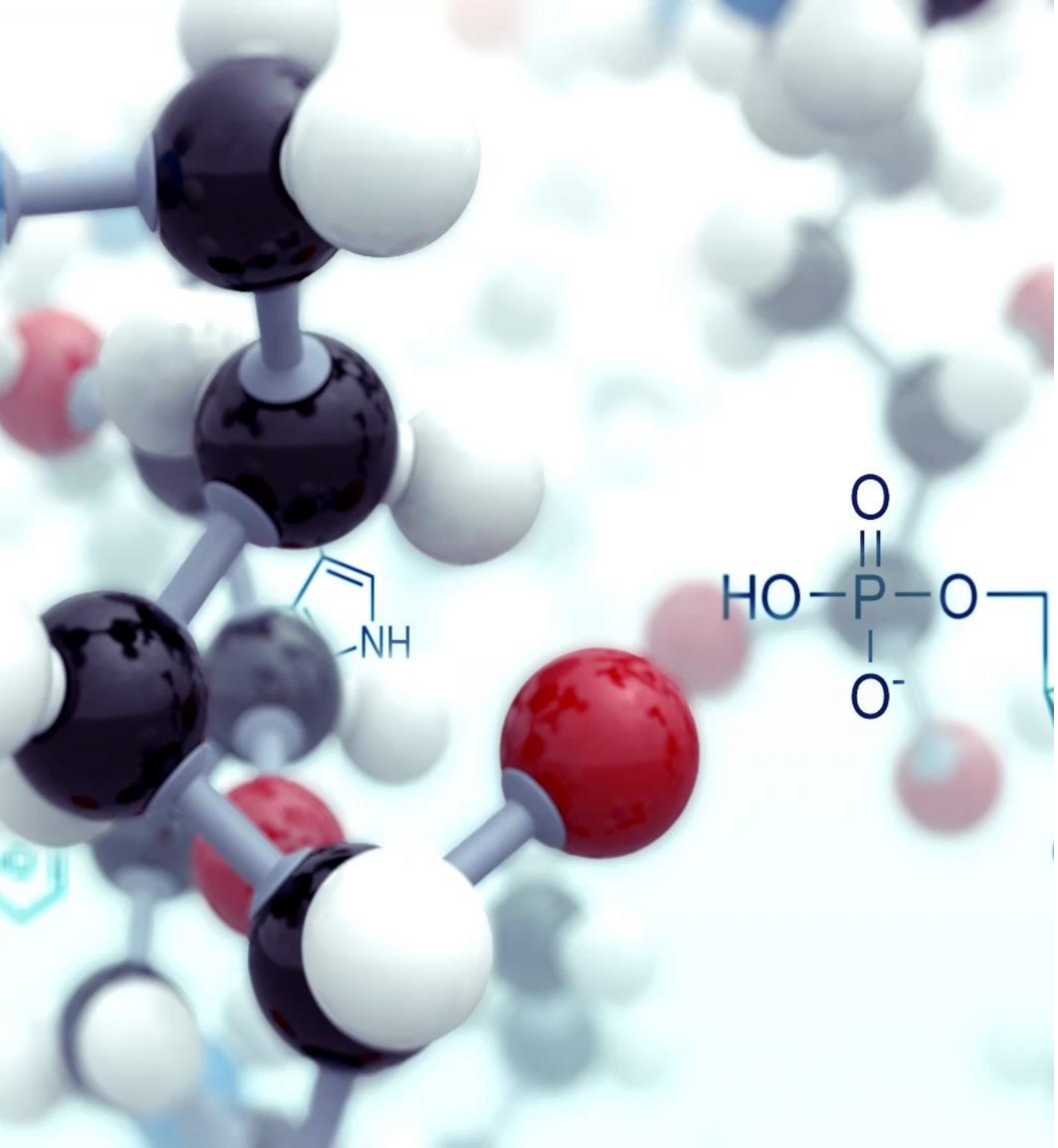

Chlorine and Advanced Peracetic Acid Stability in Real World Environmental Workflows

Liz Orr – Manager Infection Prevention

Royal Melbourne Hospital

Conflict of Interest, Declarations & Acknowledgements

- Gama Healthcare have paid for my travel expenses
- The testing was done independently

- Acknowledge Anna Denton, La Trobe Bachelor of Science Student
- Sven Denton, Aquaklar
- Sara Peterson and Caroline Marshall, RMH

Role of the floors in dissemination of pathogens

Major pathogen reservoirs

- Generally accepted that shoes and floors are contaminated with pathogens, yet correlation to clinical infection is not well established
- Perception floors and shoes are non frequently touched surfaces, therefore non critical surfaces for cleaning
- Literature focuses on frequently touched surfaces

Comparable to high-touch surfaces

- Floor contamination levels are often similar to or higher than frequently touched surfaces

Transmission pathways

- Pathogens readily transfer from floors via footwear, hands and mobile equipment, facilitating environmental spread

Cleaning alone is insufficient

- Detergent-only floor cleaning does not adequately reduce pathogen contamination and can contribute to redistribution of organisms

Disinfection reduces risk

- Use of disinfectant cleaners and improved mop practices significantly lowers pathogen burden and transmission risk

Limper, Heather M., Ashley Sier, Kathy Warye, Maureen Spencer, Peter Graves, and Charles E. Edmiston. “A Review of the Evidence on the Role of Floors and Shoes in the Dissemination of Pathogens in a Healthcare Setting.” Surgical Infections 25, no. 1 (2024): 46–55.
Donskey, C. J. (2019). Beyond high-touch surfaces: Portable equipment and floors as potential sources of transmission of healthcare-associated pathogens. American Journal of Infection Control.
Richer-Fortin, N., et al. (2025). Environmental contamination and dissemination of carbapenemase-producing organisms in patient care areas. Journal of Hospital Infection.
Donskey, C. J. (2023). Interventions to reduce transmission of pathogens from floors and sinks in healthcare facilities. American Journal of Infection Control.

Floor disinfectants: What about chlorine

Chlorine Use and Stability Concerns

Journal of Hospital Infection 155 (2025) 37–39

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Journal of Hospital Infection

journal homepage: www.elsevier.com/locate/jhin

Practice Points

Chlorine in cleaning – are we concentrating enough?

M.I. Garvey [a,b,c,*], F. Offorbuzor [a], M.A.C. Wilkinson [a,b], M. Kiernan [d], E. Holden [a]

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[b] Hospital Infection Research Laboratory, University Hospitals Birmingham NHS Foundation Trust, Queen Elizabeth Hospital Birmingham, Edgbaston, Birmingham, UK
[c] Institute of Microbiology and Infection, The University of Birmingham, Edgbaston, Birmingham, UK
[d] University of West London, Richard Wells Research Centre, London, UK

Chlorine Effectiveness in Healthcare

Chlorine inactivates bacteria, viruses, and spores, and considered to be the gold standard for hospital disinfection. TGA exempt.

Inaccurate concentrations

Mark Garvey determined 7% (28 samples) of chlorine solutions were at the correct concentration.

Degradation and Stability Issues

Chlorine degrades over time due to environmental exposure and interactions.

Impact of pH on Potency

Higher pH reduces hypochlorous acid levels, lowering chlorines antimicrobial effectiveness significantly. More neutral pH is more corrosive and compromises shelf life.

Environmental Cleaning

We use a two in one chlorine solution at RMH for terminal infectious cleans on floors and walls.

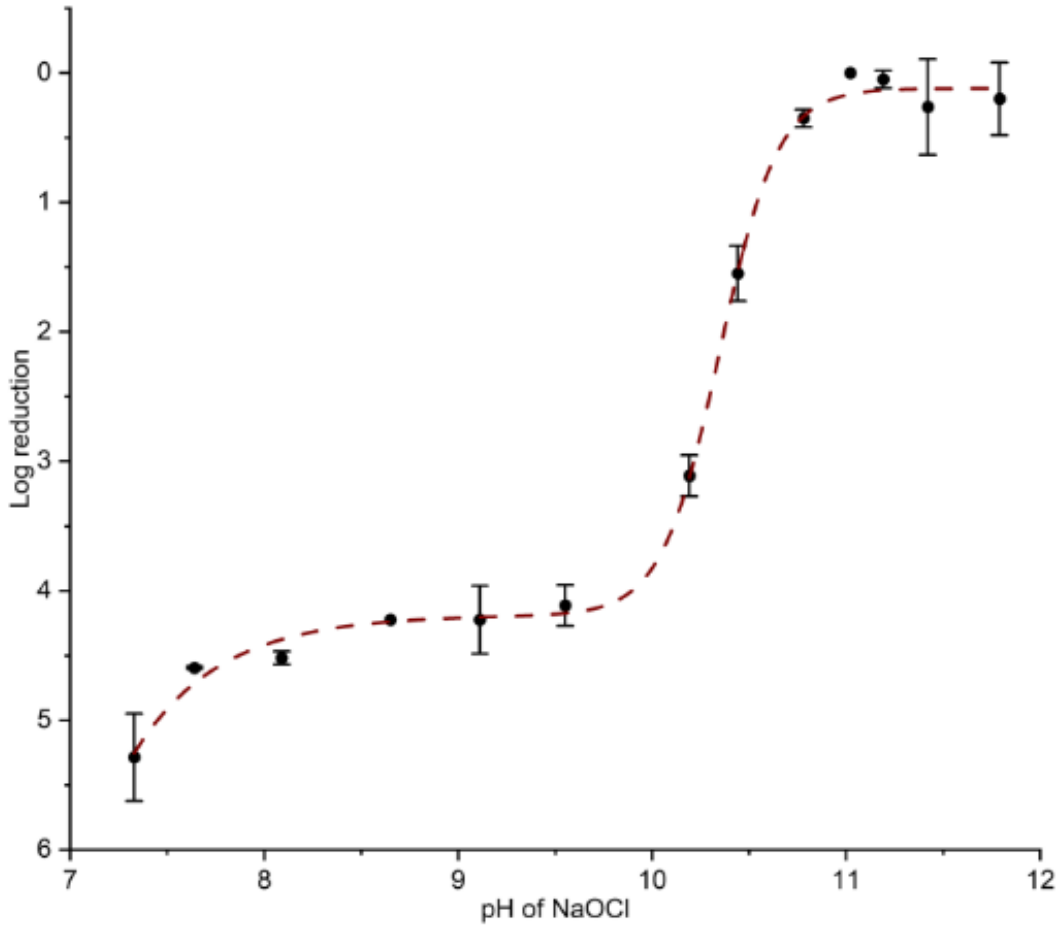


Fig. 1 Log reduction of *B. cereus* spore viability as a function of the pH of sodium hypochlorite solutions (black filled circles). At high pH, hypochlorite has a negligible effect on spore viability. Spore inactivation increases sharply between pH 11 and 9.5, with more than 4-log reductions in CFUs. A further decrease in pH to 7.5 increases the sporicidal activity by an additional 1-log. The brown dashed line is a fit of Eq. 5 ($R^2 = 0.99$), showing a typical S-shaped dose-response curve. The error bars represent the SDs calculated from at least two biological replicates, each consisting of 3 technical replicates

RESEARCH Open Access

Boosting hypochlorite's disinfection power through pH modulation

Timir Baran Sil[1], Dmitry Malyshev[1], Marina Aspholm[2] and Magnus Andersson[1,3*]

Sil, Timir Baran, Dmitry Malyshev, Marina Aspholm, and Magnus Andersson. "Boosting Hypochlorite's Disinfection Power through pH Modulation." *BMC Microbiology* 25, no. 1 (2025): 101. https://doi.org/10.1186/s12866-025-03831-w.

Study Design and Hypotheses

Aims

Chemical Stability Testing

Compare the stability of sodium hypochlorite-based chlorine solutions and advanced peracetic acid (APA™) enhanced pods solutions over time under hospital environmental cleaning conditions

Real-World Application Simulation

Simulated mop-based workflows with various microfiber mop types to assess chemical concentration loss during cleaning and over time

Chlorine dosing system testing

Evaluate chlorine dosing systems used to create standardised dilution strengths to measure dosing accuracy

Methodology

Chlorine Testing Procedures

Concentration

We manually prepared 1,000 ppm and 5,000 chlorine solutions with precise dilution and tested mop usage impacts on solution stability.

Bucket and Mop Usage Variations

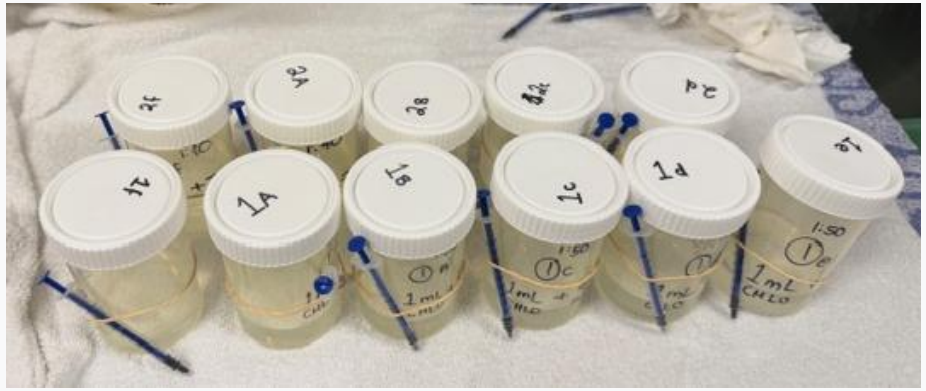
Three buckets tested included control, single-use mops, and continuous double-dip mops to study usage effects on chlorine concentration.

Accurate DPD Measurements

DPD testing was conducted multiple times until three concordant readings ensured reliable chlorine concentration data.

Methodology

Step	Description
Neat concentration measurement	Measured the neat concentration of chlorine using dilution methodology and DPD testing.
Control preparation	Prepared a 1 litre control solutions of both 1,000ppm and 5,000 using calibrated scales and syringes.
Test bucket preparation	Prepared three 9L solutions at 1,000ppm in 3 separate Rubbermaid mop buckets and the same with 5,000ppm.
Mop loading	Added 12 laundered reusable mops to each bucket to simulate daily operational use.
Timed ppm measurements	Measured ppm in all buckets at time of prep, 0.5hrs, 1hr, 2hrs, 4hrs, 8hrs & 24hrs using DPD testing.
Bucket conditions	Bucket 1 contained 12 unused mops, bucket 2 contained 12 mops that we used throughout the day, and bucket 3 contained 12 mops that were double dipped throughout the day.
Mop extraction testing	Measured ppm from liquid expressed from mops at each time point to determine concentration after use.



Methodology (Clinell Enhanced Pods / Advanced Peracetic Acid)

Step	Description
Control preparation	Prepared a control bucket with 1 Clinell Enhanced Pod in 1 litre of water as per IFU
Test bucket preparation	Prepared three 7L solutions (7 pods with 7L water) in 3 separate Rubbermaid mop buckets and added 12 laundered reusable mops to each bucket
Testing method	Measured ppm using DPD with total chlorine as marker
Timed sampling	Recorded ppm at same time points as chlorine testing
Real life scenario	Made up 1 pod in 1L in a Rubbermaid bucket with 3 mops and cleaned a room and measured ppm

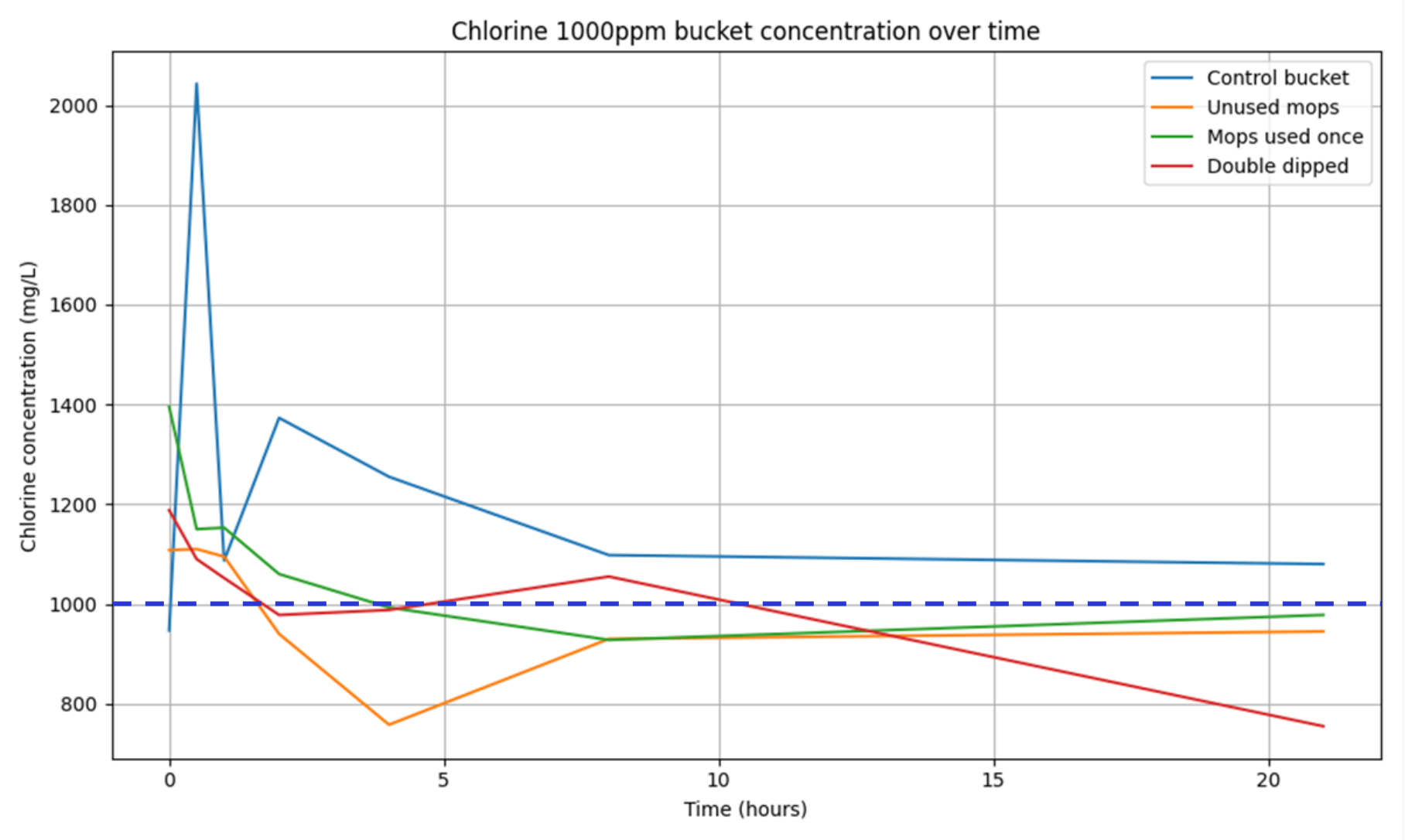
Results

Neat Chlorine Concentration

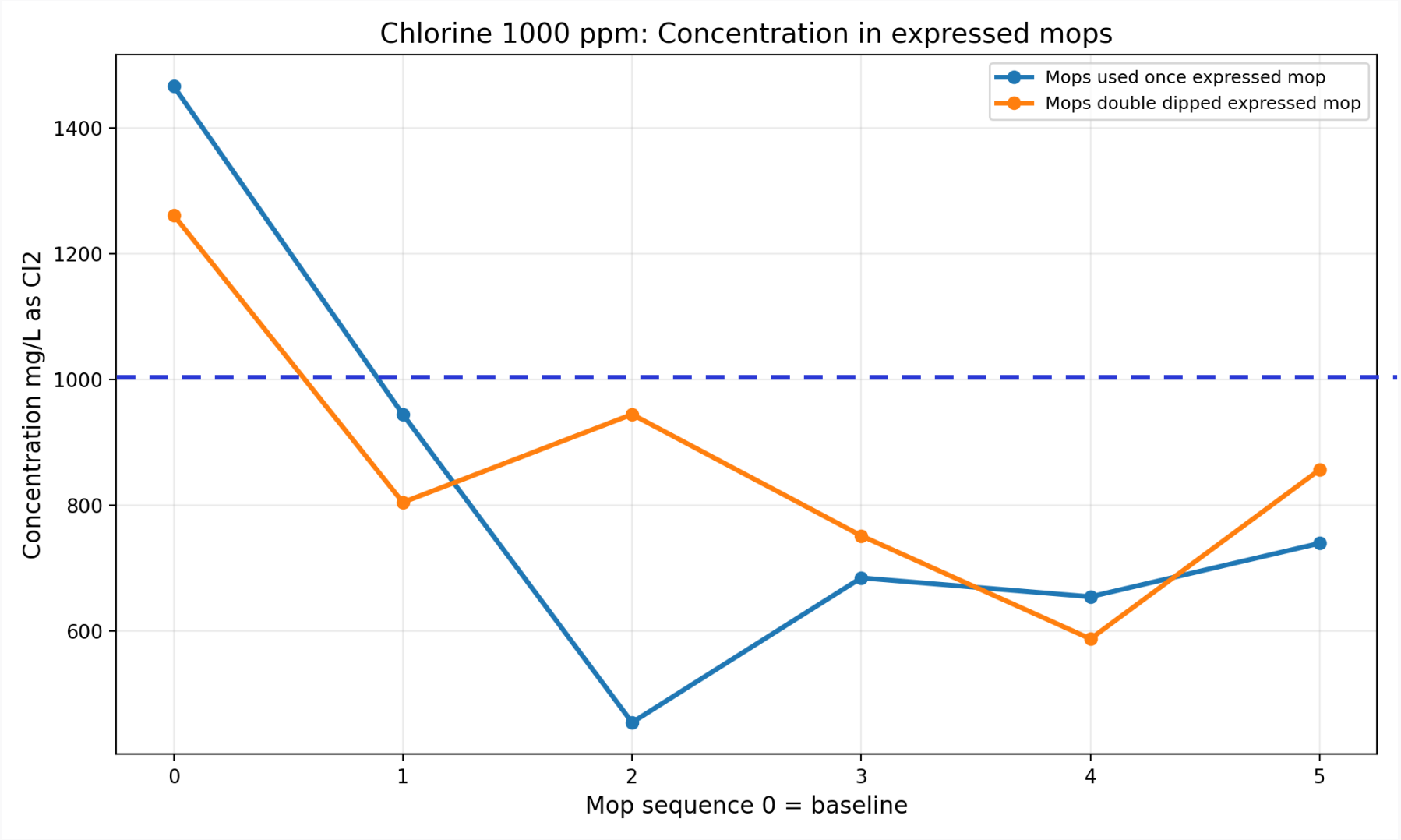
Neat concentration using DPD	**Average % available chlorine**
1 month old	5.32%
3 months old	5.58%
3 months old (same batch different location)	5.45%
Expired 10 months old	2.94% (estimated to be 2.7%)
Diluted chlorine	
pH probe reading:	12.17

Chlorine 1,000ppm

Chlorine 1,000ppm bucket concentration over time

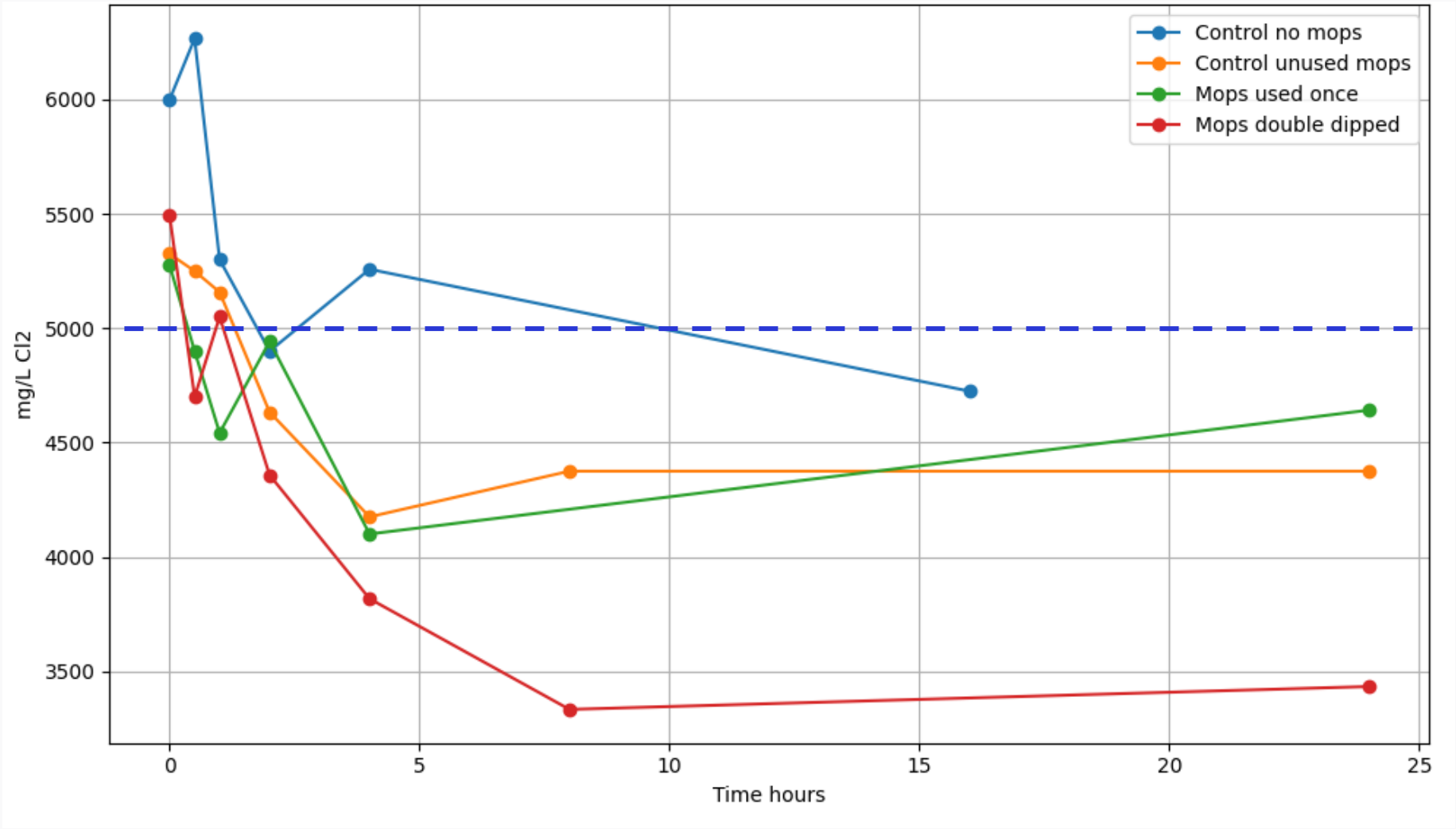


Chlorine 1,000ppm Concentration in expressed mops

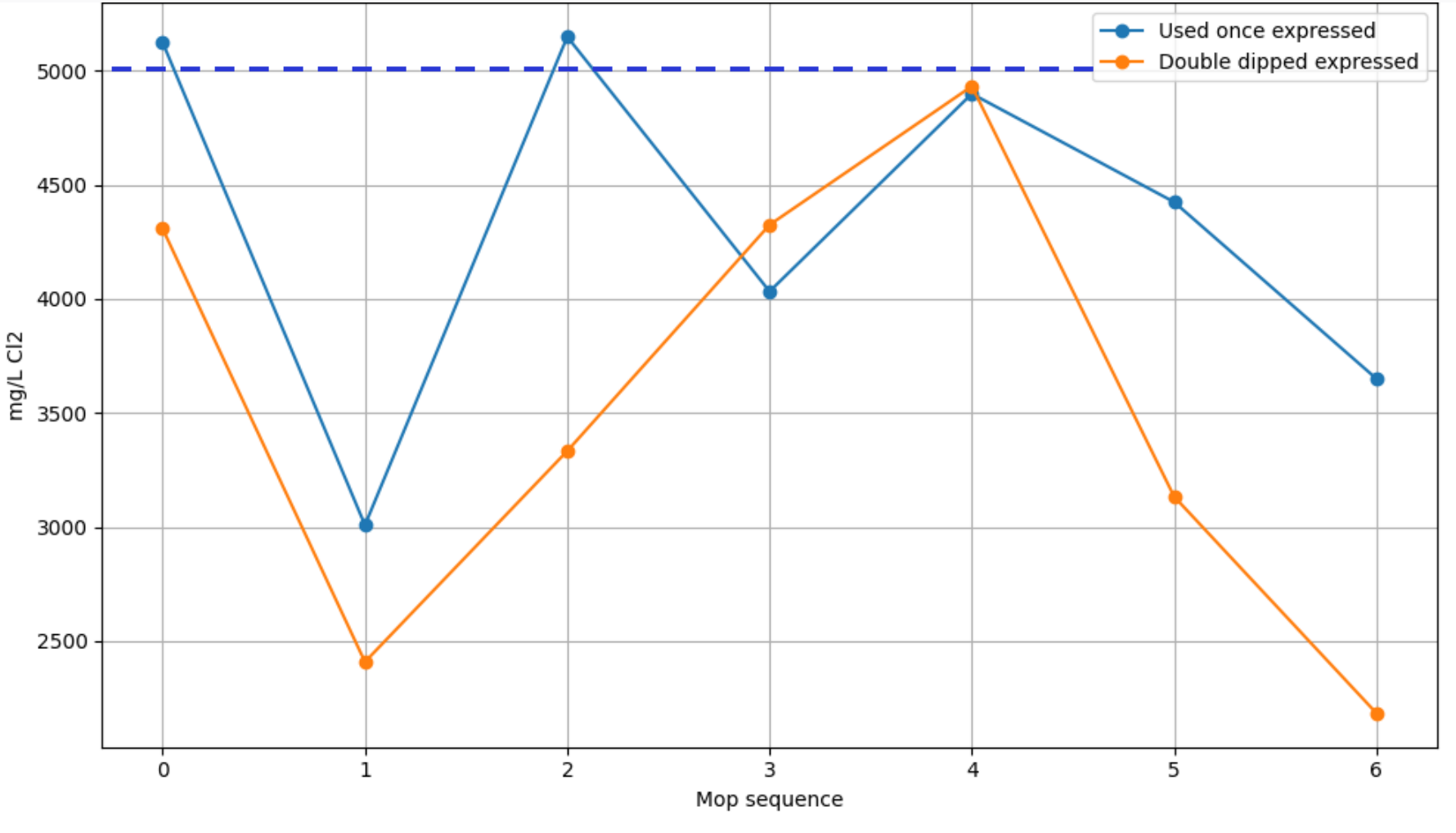


Chlorine 5,000ppm

Chlorine 5,000ppm bucket concentration summary



Chlorine 5,000ppm expressed mop summary



Summary for Chlorine

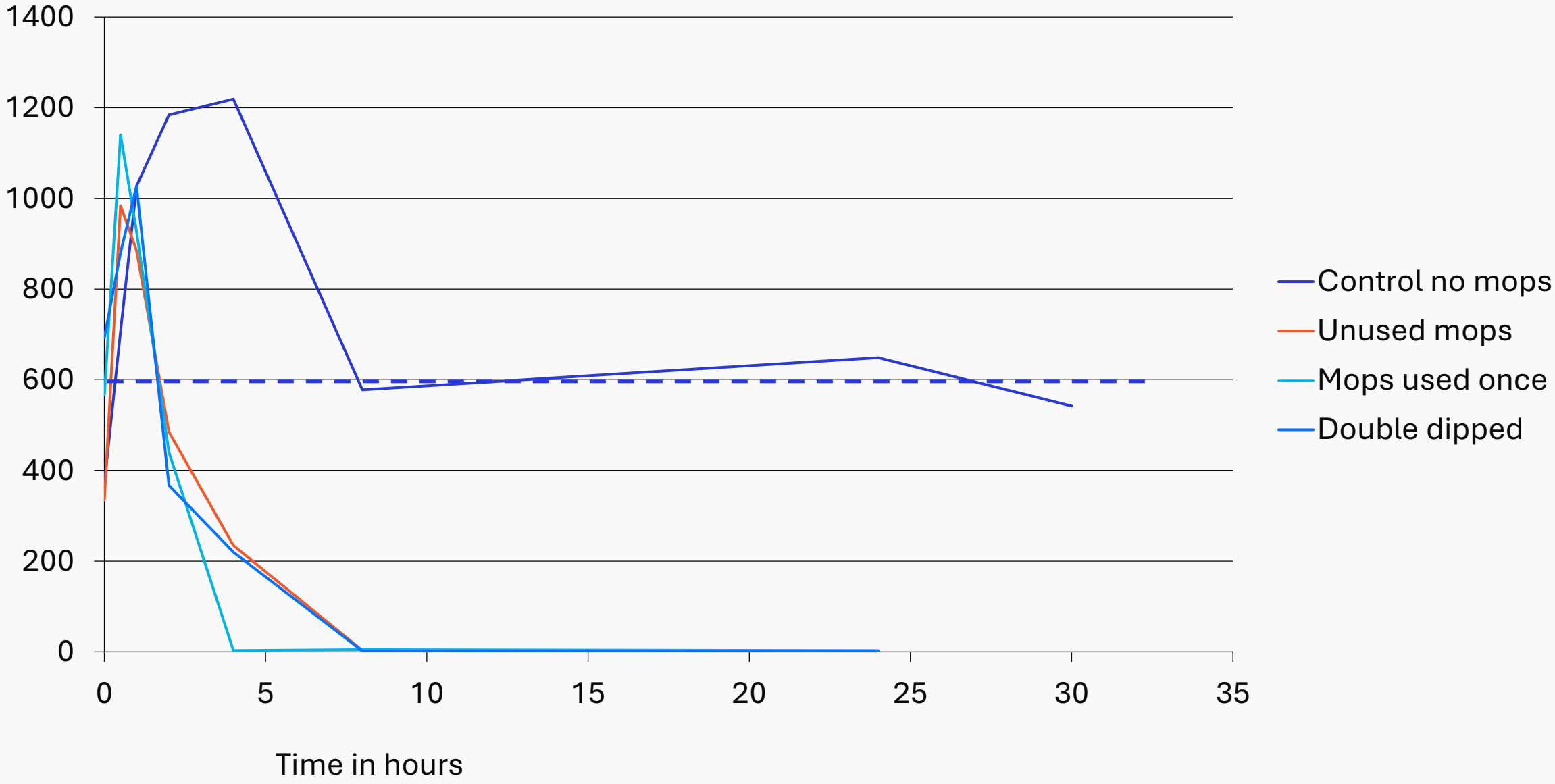
- **Overall behaviour**
  Chlorine levels fall over time in all scenarios and decline faster when mops are used
- **Bucket stability**
  Control buckets maintain the most stable concentrations
  Unused mops cause moderate loss
  Double dipping triggers the fastest depletion
- **Mop-applied chlorine**
  Chlorine inside mop heads is always lower than bucket levels which means surfaces receive less chemical than intended
  Concentration drops further with each mop used especially with double dipping
- **Practice implications**
  Avoid double dipping
  Check dosing accuracy
  Remember that bucket concentration does not reflect the true concentration delivered to surfaces

Advanced Peracetic Acid

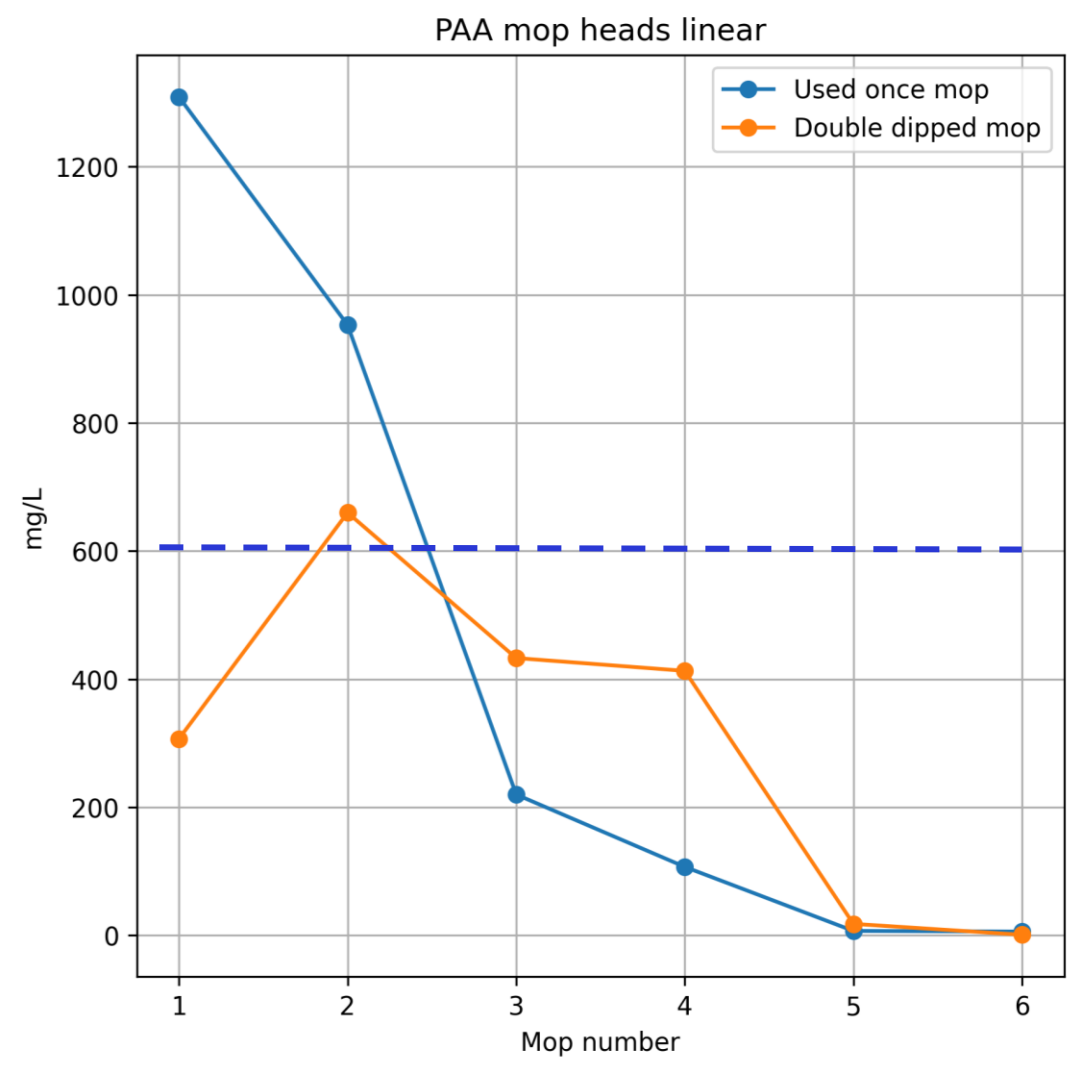
Advanced Peracetic Acid pH

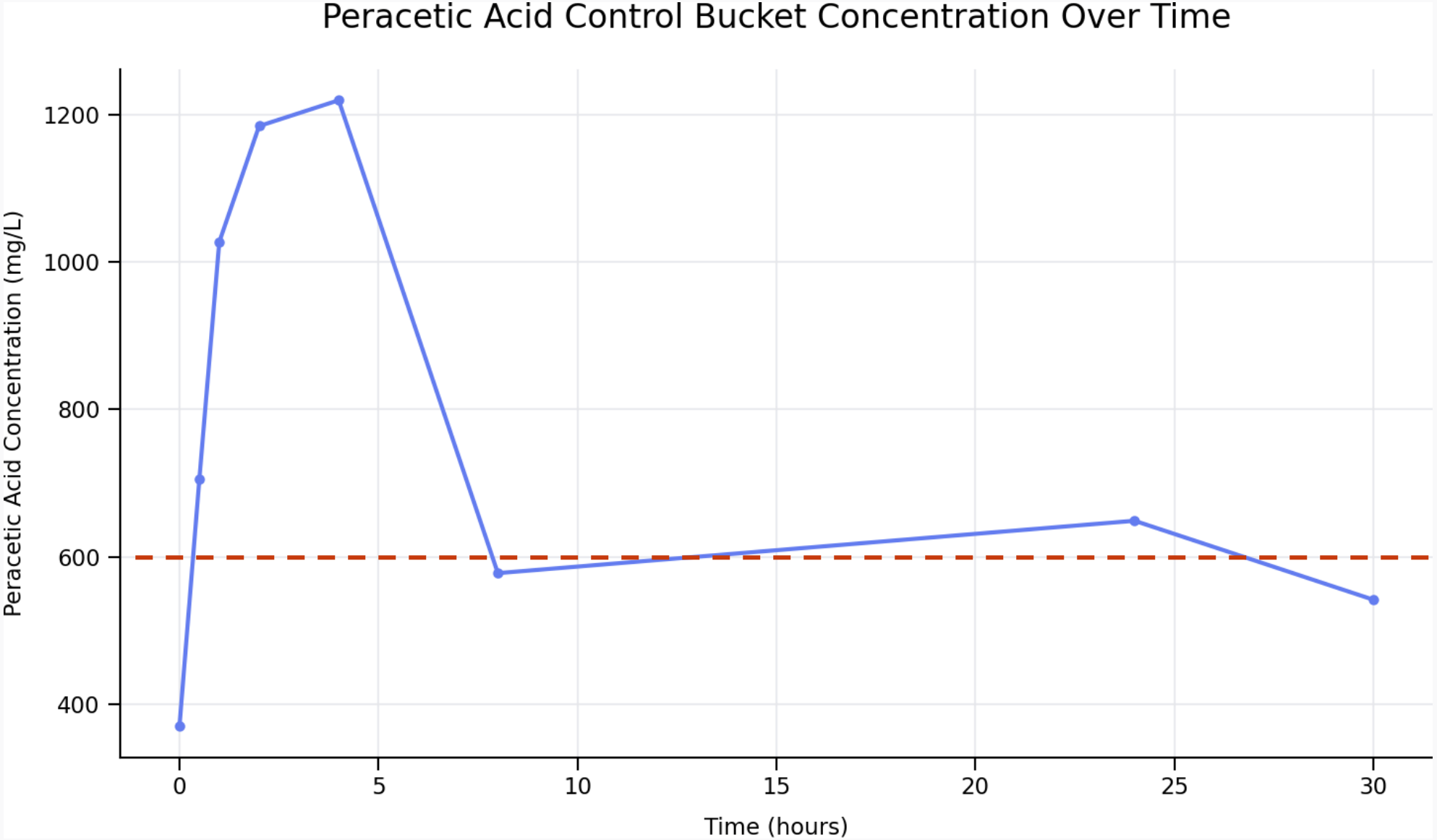
pH probe reading:	pH	6.97

Advanced Peracetic Acid Summary Chart Mop Bucket



Advanced Peracetic Acid concentration summary mop heads



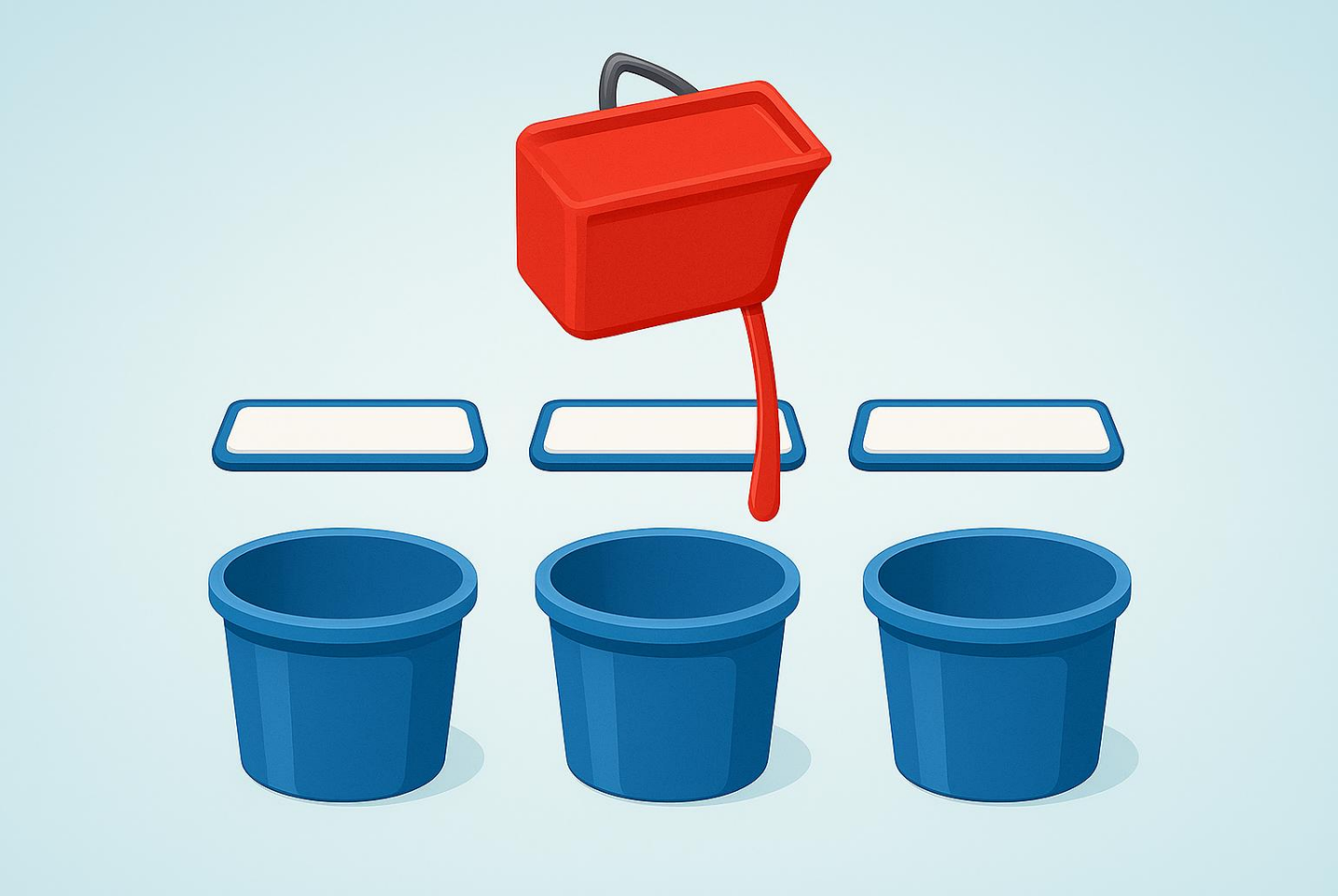

Peracetic Acid Control Bucket Concentration Over Time
Peracetic Acid Concentration (mg/L)
1200
1000
800
600
400
0
5
10
15
20
25
30
Time (hours)

Advanced Peracetic Acid Pod Additional Testing

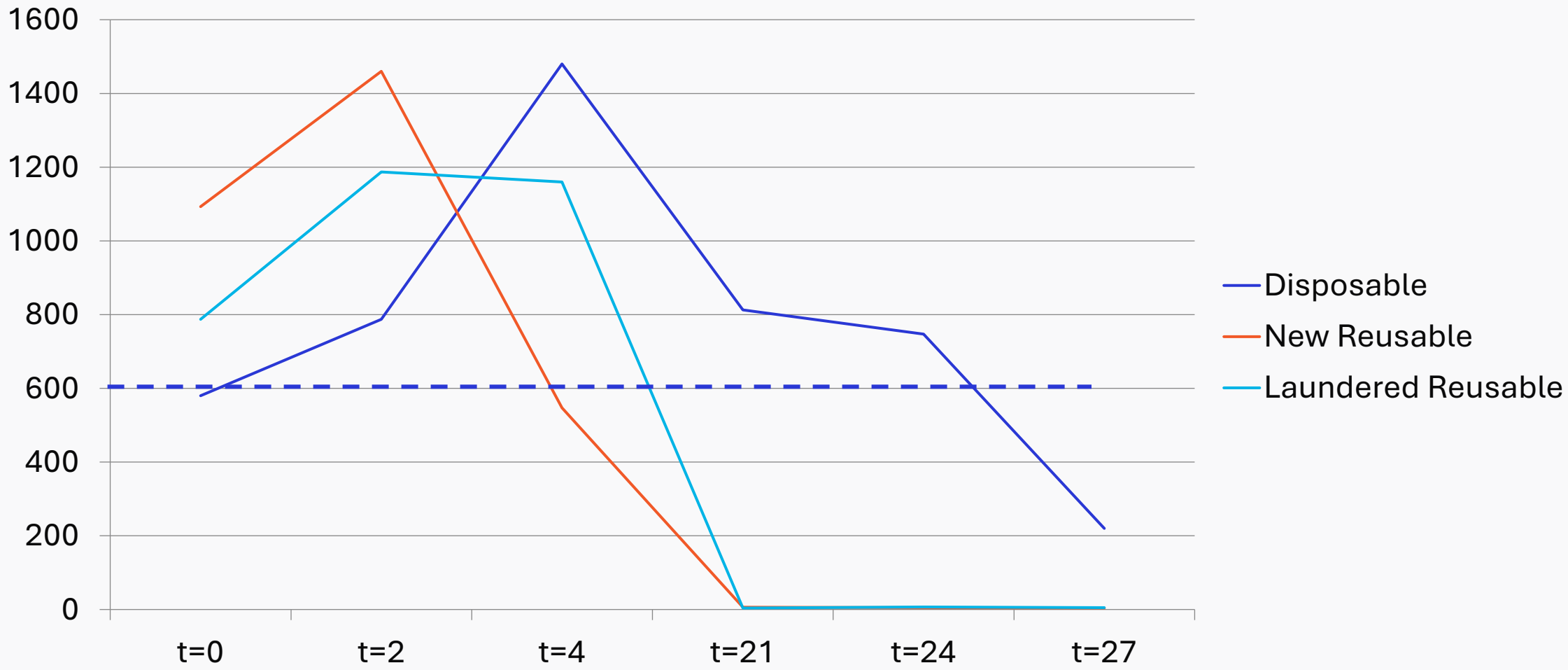
As we noticed the drop in ppm after 4 hours we added this experiment:

- 3 Bunnings buckets
- 1st reusable microfibre mop
- 2nd brand new reusable mop
- 3rd disposable microfibre mop

Made up 1 pod in 1L and poured over all 3 buckets and measured ppm over time

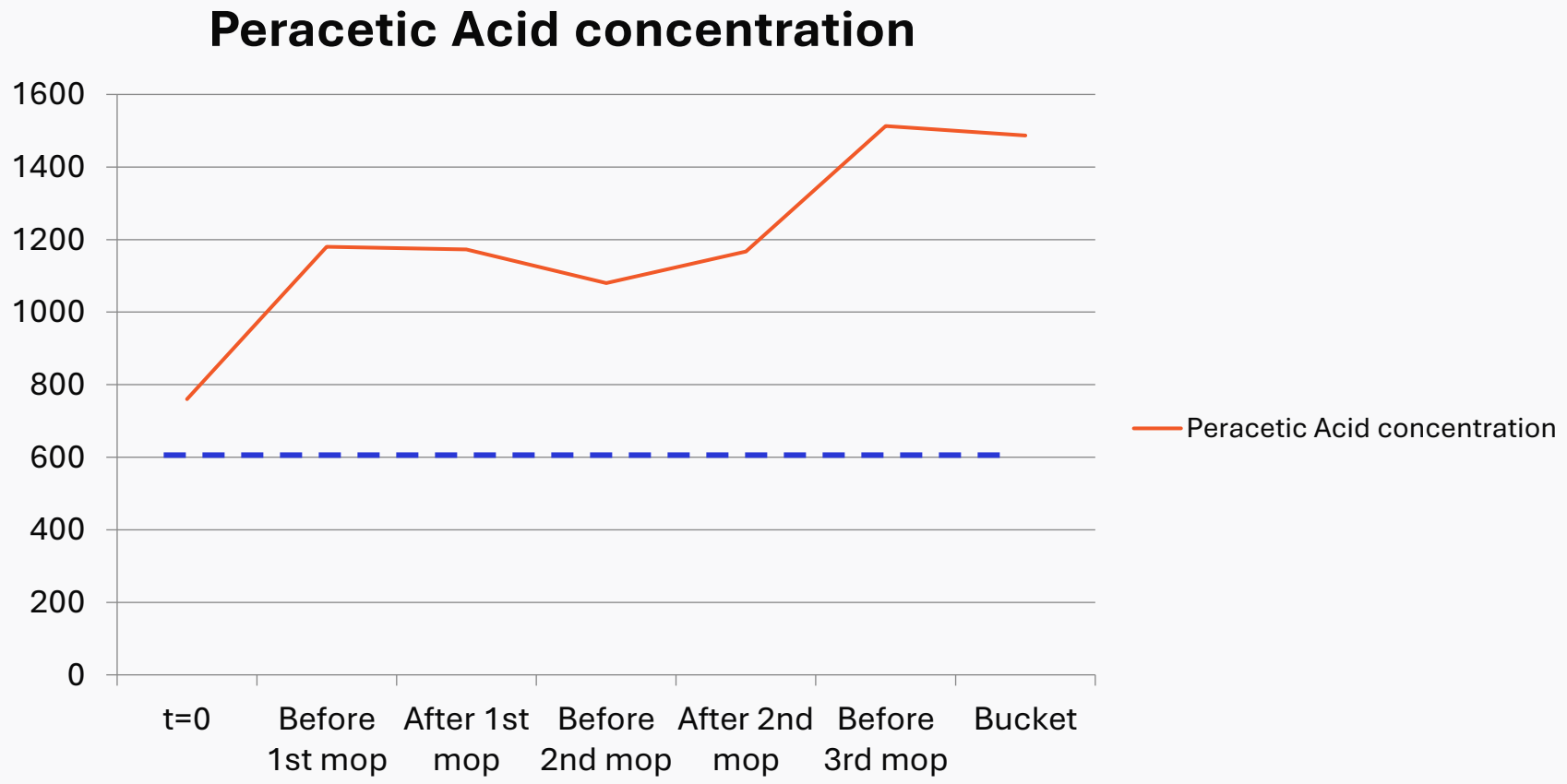


Evaluation of mop type on advanced peracetic acid



Discharge Room Cleaning Effect on Advanced Peracetic Acid – Real World

Nominal Time [t] (Hours)		Bucket solution t=0	Expressed mop head before use	Expressed mop head after use	Expressed mop head before use	Expressed mop head after use	Expressed mop head before use	Mop bucket water end of clean
Real Elapse Time:		0:04	0:30	0:40	0:43	0:47	0:50	0:54
Concentration [Cl_2] in solution	**mg/L**	**760**	**1,180**	**1,173**	**1,080**	**1,167**	**1,513**	**1,487**



Summary of Advanced Peracetic Acid

- **Overall behaviour**
  Advanced peracetic acid concentration was stable in closed containers but drops once mops are introduced especially after four hours
- **Bucket performance**
  Control buckets remain stable longer than chlorine
  Mops present in buckets significantly accelerates ppm loss
- **Mop-expressed concentrations**
  Mop heads show decline with each use and double dipping worsens the loss
- **Effect of mop type**
  Disposable mops retain concentration best
  New reusable mops cause the largest drop
  Laundered mops sit in the middle
- **Real-world use**
  Directly applying solution to mops just before cleaning maintains higher concentrations than preparing buckets in advance
- **Practice implications**
  Prepare advanced peracetic acid immediately before use or store in containers when prepared
  Avoid double dipping
  Consider mop type when planning workflows

Discussion/Conclusion

Operational Implications and Recommendations

ISSUE	IMPACT	RECOMMENDATION
Chlorine shelf-life degradation	Lower than expected ppm	Recalculate dilution based on age
Strong chlorine odour	Staff under dose solutions	Training and alternative chemistries
Chlorine concentration suboptimal	Unable to kill intended microorganisms	Select products with TGA registration or micro testing

Operational Implications and Recommendations

ISSUE	IMPACT	RECOMMENDATION
Chlorine pH	High levels of pH impacts chlorine effectiveness	Select products with more neutral pH over alkaline products
Chlorine contact time vs advanced peracetic acid pods	10-minute contact time vs 5-minute (1 pod) or 2-minutes (2 pods) for *C difficile*	Consider how the product is supplied and the likelihood of the surface staying wet for the required time

Operational Implications and Recommendations

ISSUE	IMPACT	RECOMMENDATION
Interactions with old reusable mops	Reduced effectiveness of advanced peracetic acid	Consider relaundering several times before using advanced peracetic acid or purchasing new mops – need more research
Laundering mops	Chlorine used in washing machines	Reconsider chemicals used in laundry processes
Advanced peracetic acid mop interaction	The ppm drops after 4 hours	Prepare solutions immediately before use or add to mops as needed

Limitations

ISSUE	IMPACT
Interactions with chlorine and advanced peracetic acid	Chlorine residue could impact the advanced peracetic acid performance in both the mops and buckets
Need further research	Different mop fibers, plastics and previous products used
Oversaturation of chemicals	Added 9L and 7L to each bucket with 12 mops – possibly oversaturated the mops and impacted performance

Questions??

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