

PCS 1000 Plus

Powerful disinfectants that are gentle on staff, surfaces, and the environment

Abstract

Proper cleaning and disinfection are critical in both healthcare and non-healthcare settings, but sometimes, the products that are effective on viruses and bacteria are harmful to the staff, facility surfaces, and equipment. A smarter way to clean and disinfect is to use as mild a chemistry as possible while still removing harmful pathogens.

When the SARS-CoV-2 virus emerged as a pathogen of great concern, facilities that had previously given little thought to disinfection were reaching out to their suppliers for the strongest disinfectant they could get, cleaning anything and everything with the same product. Unfortunately, many discovered that a lot of the strong disinfectants used for difficult-to-kill pathogens like *C. difficile* can also be hard on common surfaces, like tabletops, upholstery, metals, and plastics. Furthermore, these products can be irritants to the skin, eyes, and lungs of the EVS staff using them.

While it is a positive development that non-healthcare institutions have a better understanding of the need for not just cleaning, but also disinfection in their daily routines, there is a need for a more responsible chemistry that is effective against a broad range of bacteria and viruses and bacterial spores, yet is gentle to surfaces, humans, and the environment in both healthcare and non-healthcare settings.

In response to the COVID-19 pandemic, tremendous resources were spent to create new and more innovative disinfecting products. During this time, we saw the commercialization of hypochlorous acid products as Health Canada approved 11 such products on its list of disinfectants, likely to be effective against COVID-19. However, of all the products listed – even those

with hypochlorous acid – only one, PCS 1000 Plus, has both sodium hypochlorite and hypochlorous acid as the active ingredient (Figure 1).

The combined effects of both sodium hypochlorite and hypochlorous acid create safer, Category IV disinfectants with very rapid oxidization of organic soils, changing the way we look at environmental decontamination. This paper provides the evidence for safer and more effective decontamination of the healthcare environment starting with the most difficult pathogens.

PCS 1000 Plus Oxidizing Disinfectant Cleaner (DIN: 02521431) and PCS 1000 Plus Oxidizing Disinfectant Concentrate (DIN: 02521504) diluted solutions contain the same concentration of oxidizing disinfecting and cleaning solutions with identical label claims. PCS 1000 Plus products are pH-neutral disinfectants with a chemical composition of 0.13% sodium hypochlorite and 0.01% hypochlorous acid, yet they are so mild that they are listed as a Category IV disinfectants, meaning no caution or warning statements are required on the label. Furthermore, the ready-to-use format is shelf-stable for more than a year, and the on-demand diluted product can be stored for at least 30 days without losing efficacy.

NPH dispenser and process-diluted solution for PCS 1000 Plus offers the economy of a concentrate, the efficacy of hypochlorous acid, and the mildness of a Category IV disinfectant. Facilities can save up to 78% of their chemical costs by switching from the ready-to-use formulation to the dispensed on-demand system, PCS US Patent 11,103,840 B2.

Powerful Disinfecting with Gentle Physical Properties

It is estimated that 500,000 *Clostridioides difficile* (*C. difficile*) infections each year



in the United States claim about 30,000 lives and account for \$5 billion in related healthcare costs.² Proper environmental cleaning and decontamination in healthcare settings is the most cost-effective strategy to reduce the spread of *C. difficile*, but *C. difficile* spores are resistant to many hospital disinfectants and alcohol, and are extremely robust, remaining on surfaces for weeks.² By contrast, SARS-CoV-2, the virus that causes COVID-19, is very easy to remove from surfaces.³



Figure 1: Only one product approved by Health Canada for removing SARS-CoV-2 from surfaces lists both sodium hypochlorite and hypochlorous acid as its active ingredients: PSC 1000 Plus1.

In their guidance for preventing *C. difficile* transmission in acute and long-term healthcare environments, both the Public Health Agency of Canada and the Department of Health in the United Kingdom recommend cleaning all hard, non-porous surfaces in healthcare facilities with a cleaning agent with at least 1,000 parts per million of chlorine.^{4,5} Likewise, the CDC recommends that *C. difficile* transmission be controlled with List K disinfectants, many of which are chlorine-based and contain high concentrations of chemicals.⁶ Surfaces to be cleaned frequently include reusable equipment like stethoscopes, walkers, and bedpans, and high-touch surfaces, such as bed rails, light switches, furnishings, and bathroom surfaces. Unfortunately, cleaning with many chlorine-based disinfectants can cause damage to some surfaces and can also pose health risks to the end user in the form of eye and skin irritation.

A common chlorine-based disinfectant is sodium hypochlorite (i.e., bleach). Bleach solutions are widely used in public health applications to prevent cross-contamination of infectious agents via surfaces. They have strong oxidizing properties, and are therefore effective bactericides and virucides.⁷ However, their high pH is irritating to the skin and eyes at the high concentrations often required for difficult pathogen removal ($\geq 1,000$ ppm)⁸, and the antimicrobial activity of sodium hypochlorite can rapidly diminish upon contact with organic matter.⁷

Hypochlorous acid, on the other hand, is the most effective chlorine-based disinfectant available in a diluted solution, estimated to have 80 to 120 times the efficacy of sodium hypochlorite.⁹ This acid is produced naturally in the human body, and is an essential part of our immune system. As a disinfectant, hypochlorous acid oxidizes and penetrates cell walls by reacting with sulfur- and heme-containing membrane enzymes and structural proteins, thereby leading to cell death.¹⁰ Hypochlorous acid can be formulated to be safe for surfaces and the end-user; it is commonly used as a way to eradicate bacteria around the eyes.¹¹ Unfortunately, it also has a short

shelf life as it reacts rapidly, deteriorating quickly when exposed to light, air, and temperatures above 25°C, making its use in facilities impractical.¹⁰

PCS has overcome the problem of creating a hypochlorous acid solution that has a longer shelf life.

PCS 1000 Plus Oxidizing Disinfectant Cleaner (DIN: 02521431) has a chemical composition of 0.13% sodium hypochlorite and 0.01% hypochlorous acid, has a stable equilibrium, meets the requirement of EPA Category IV, meaning no caution or warning statements are required on the label, and is stable for more than one year when packaged in a ready-to-use format.

Using the PCS-patented NPH dispenser and process, PCS 1000 Plus Oxidizing Disinfectant Cleaner Concentrate (DIN: 02521504) is diluted with water and acetic acid, resulting in a solution that adjusts the pH from an alkaline value of 11 to a neutral value of 8.5. The chemical composition of the final product is also 0.13% sodium hypochlorite and 0.01% hypochlorous acid.

PCS 1000 Plus products provide a safer alternative to other chlorine-based disinfectants and is registered for use in healthcare facilities, in the community, and even for use at home.

Switching to PCS 1000 Plus products is a smart move for any facility that wants to maintain or improve its disinfection efficacy, while providing a product that is easier on staff, better for the environment, and safer for equipment and furnishings.

Specifications

Dispensing the Product

The PCS 1000 Plus solution consists of the PCS 1000 Plus Dispenser (SP9200-1000NPH-D), PCS 1000 Plus Oxidizing Concentrate supplied in 3.78L closed-loop sealed containers, and PCS 1000 Plus Neutralizing Solution, also supplied in 3.78L closed-loop sealed containers.

The dispenser has a small footprint, and is attached to the wall of a janitorial closet, similar to other chemical-dispensing systems. The unit attaches to a water source through a hose, and hoses are also attached to the bottles of concentrate and neutralizer. The unit

comes pre-set to dispense the appropriate mix of the concentrate, neutralizing solution, and water. The dispenser has proven to be very durable not requiring significant maintenance.

The solution can be dispensed into an opaque spray or squeeze bottle for use and storage for at least 30 days, or into a bucket for immediate use. For stored product, it is recommended that the solution be tested regularly with high-level chlorine test strips and pH test strips to ensure product efficacy.

Using the Product

PCS 1000 Plus Oxidizing Disinfectant Cleaner or diluted solutions of the concentrate solution can be used with most currently employed hospital processes. The product can either be applied to surfaces with disposable PCS four-sided, single-use wipes, PCS microfibre cloths, or PCS Toraysee™ cloths, or it can be squirted from a reusable spray bottle, or squirted from a bottle with a flip top lid.

To clean high-touch surfaces, apply PCS 1000 Plus RTU squirt, or PCS 1000 Plus concentrated solution diluted through the NPH dispenser to the surface and wipe dry with a microfibre or other clean, dry, absorbent cloth, or rinse or allow to dry.

To disinfect high-touch surfaces and non-critical medical equipment, apply the product to a pre-cleaned surface in sufficient quantities such that it remains wet for the following dwell times:

Human Coronavirus	2 minutes
Adenovirus Type 5	3 minutes
Staphylococcus aureus (ATCC 6538)	5 minutes
Pseudomonas aeruginosa (ATCC 15442)	5 minutes

This product is a broad-spectrum virucidal hard-surface disinfectant which is expected to inactivate SARS-CoV-2 (the virus that causes COVID-19).

Following these dwell times, wipe the surface dry, rinse, or allow to air dry.

Although PCS 1000 Plus products are not rated to kill *C. difficile* spores, independent testing has shown that using PCS 1000 Plus with PCS Toraysee™

Cleaning Cloths removes 100% of *C. difficile* spores with no transfer to other surfaces (Figure 2). Where the disinfecting specifications in a facility require *C. difficile* kill claims, such as rooms housing *C. difficile* patients, we recommend PCS 5000 or PCS 7000 Oxidizing Disinfectant Cleaner.

Storing the product

The RTU formulation is shelf-stable for more than a year. Diluted solutions can be stored in opaque bottles for at least 30 days, but product dispensed into an open bucket should be disposed of after 8 hours.

DISPOSAL: Rinse the emptied container thoroughly prior to disposal. Dispose of the empty container in accordance with municipal/provincial/territorial requirements. Offer for recycling, if available.

Metrics

Spores are among the most resistant microorganisms to disinfectants and studies have shown that sodium hypochlorite with a decreased pH due to the addition of acetic acid has a much greater sporicidal effect than sodium hypochlorite alone.¹² Sodium hypochlorite has an alkaline pH of around 11. Adding the acetic acid brings the pH down to a neutral range of 8.5, where hypochlorous acid is produced. At that pH level, the hypochlorous acid and sodium hypochlorite exist in equilibrium, maintaining optimal antimicrobial properties, while creating a formulation that is more shelf-stable than other hypochlorous acid solutions.

It should be pointed out that hypochlorous acid in equilibrium with sodium hypochlorite efficacy is formula-dependent. For example, adjusting the pH of sodium hypochlorite with either citric or lactic acid demonstrated zero sporicidal activity, while reducing the pH with acetic acid, as we do with PCS 1000 Plus, produces superior sporicidal effects.¹³ At a pH of 7.5, 50% of the solution is in the form of hypochlorous acid and 50% is in the form of sodium hypochlorite.

Diluted sodium hypochlorite with 5% acetic acid was used to decontaminate public buildings in the United States

following the anthrax attacks in 2001. Efficacy testing has shown that 0.1% sodium hypochlorite acetic acid pH-adjusted solutions are effective in killing the spores of *Bacillus atrophius* in just 30 seconds compared to 30 minutes for non-pH-adjusted 0.1 % sodium hypochlorite solutions.¹⁴ This finding is significant, as shorter dwell times for disinfection are much more practical in any clinical setting.

The case for a milder disinfectant is made by the need for products that are safer not only for the environment and staff, but also for equipment. One 700-bed facility in the United States discovered that harsh disinfectants had degraded some of their equipment, resulting in almost \$5 million in unanticipated expenses.¹⁵

PCS 1000 Plus registered active ingredients on the ready-to-use and the concentrated diluted solution labels are sodium hypochlorite 0.13 % and hypochlorous acid 0.01%. Although it seems that the low concentration of hypochlorous acid would have little impact, the pH adjustment with acetic acid and creation of even 0.01 % hypochlorous acid has produced a formulation with the ability to kill bacteria and viruses while remaining mild enough to meet the requirements of an EPA category four disinfectant that is shelf-stable for at least one year and possibly two or three. Studies have shown that hypochlorous acid at very low concentrations is still very effective.¹⁶

CREMCO Quantitative Carrier test #3 validated that the PCS 1000 Plus Oxidizing Disinfectant Cleaner cleaning process can remove 100% of *C. difficile* spores and prevent their transfer to adjacent areas (Figure 2). In a second study, a hydrogen peroxide wipe was used as the control on a mixture of staphylococcus, *Serratia*, and *C. difficile* spores; this test also confirmed 100% removal of the spores with zero transfer (Figure 3). These studies validate the superior ability of PCS 1000 Plus Oxidizing Disinfectant Cleaner when used with the recommended wiping process to remove harmful pathogens from the environment.

Practice Changes

Using less chemistry when cleaning and disinfecting is safer for staff, the environment, and facility equipment. At PCS, we believe in cleaning to a scientifically validated standard, where using the minimum amount of chemical and focusing on the physical removal of pathogens protects public health, EVS staff, and the environment.

PCS 1000 Plus can replace more caustic disinfecting chemistries in a variety of healthcare and community settings. Larger institutions will be familiar with dispense-on-demand systems, and the NPH Dispensing and mixing apparatus will install and function in a similar way, requiring only access to a water source.

PCS 1000 Plus products can be used facility wide as both a cleaner and disinfectant, simplifying the

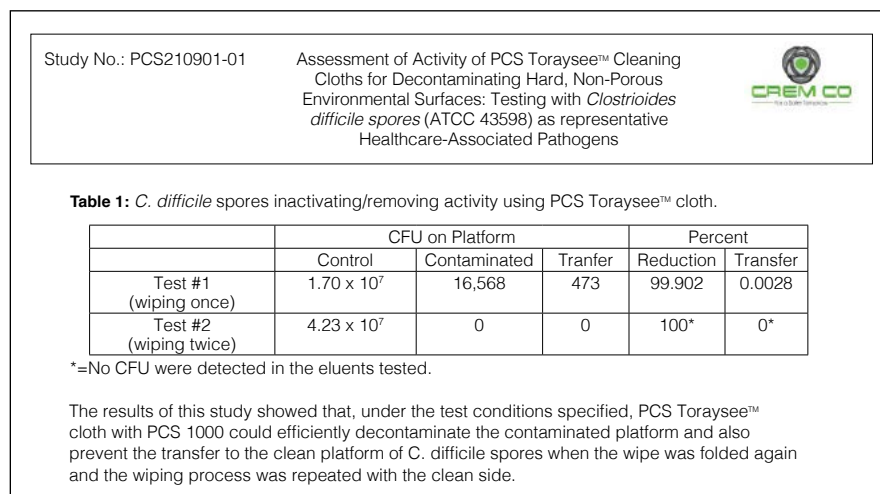


Figure 2: PCS 1000 Plus wiped twice with PCS Toraysee™ Cleaning Cloths removes 100% of *C. difficile* spores and results in zero transfer to other surfaces.

training and orientation process. As a disinfectant, EVS staff will benefit from training on appropriate wiping methods to remove or kill pathogens. PCS has a variety of evidence-based, validated cleaning processes.

Surfaces contaminated with *C. difficile* spores should be meticulously cleaned and the reality is that *C. difficile* is everywhere, not just healthcare settings.¹⁷ Most institutions purchase and use Health Canada DIN approved disinfectants with a label claim to kill *C. difficile* spores. PCS has two such disinfectants: PCS 5000 (DIN: 02314851) and PCS 7000 (DIN: 02314878). PCS believes institutions should consider facility-wide

cleaning protocols that control the spread of *C. difficile* by effectively removing them from the environment. Both killing and removing *C. difficile* have the same effect on the environment – the pathogen is no longer there to spread and infect – but removal can be done with chemistry that is kinder to the staff and equipment.

The PCS *C. difficile* cleaning process (Figure 4) with PCS 1000 Plus removes 100% of *C. difficile* spores and prevents any transfer to adjacent areas (Figures 2 and 3).


With a variety of application methods (spraying, squirting, premoistened cloths in a bucket, etc.) and drying methods (wiping, rinsing, air drying), EVS staff will experience little change to their

current routines. However, the staff will appreciate the mild formulations that are not irritating to the skin, eyes, or lungs. As a Category 4 disinfectant, there are no special warning or caution labels, and no PPE is required when either dispensing or using the products. PCS recommends all staff follow the policies and procedures set out by the institution for use of PPE. Unused product can be safely poured down the drain.

Sodium Hypochlorite Fate

The route of environmental release of sodium hypochlorite from use in cleaning products is down-the-drain, with the product and/or its by-products being treated by on-site or municipal waste treatment systems. Studies conducted with bleached laundry wash water suggest that approximately 12% of the chlorinated organic compounds. Formed are volatile and that the majority of these volatile compounds, greater than 70%, remain in solution during the wash cycle (Ong, DeGraeve, Silva-Wilkinson, McCabe and Smith, 1996). The fate of sodium hypochlorite during use and discharge to sewer systems has been investigated (FIFE-AIS, 1993; Consultative Expert Group Detergents Environment, 1989). These studies reveal that hypochlorite is rapidly consumed, predominantly through oxidation reactions, with inorganic compounds and organic substances found in wash water and wastewater, and is converted to chloride. The rapid reactivity of sodium hypochlorite with the high concentrations

Study No.: PCS212001-01 Assessment of Activity of PCS Toraysee™ Cleaning Cloths for Decontaminating Hard, Non-Porous Environmental Surfaces: Testing with *Clostridium difficile* spores (ATCC 43598), *Staphylococcus aureus* (ATCC 6538) and *Serratia marcescens* (ATCC 13880) as representative Healthcare-Associated Pathogens



TEST RESULTS

Table 1-3 summarize the result of efficacy tests.

Table 1: *C. difficile* spores inactivating/removing activity using PCS Toraysee™ cloth and HPW.

	CFU on Platform			Percent	
	Control	Contaminated	Transfer	Reduction	Transfer
PCS Toraysee™ cloth	7.67 x 10 ⁵	0	0	100*	0*
HPW	6.67 x 10 ⁵	~6.67 x 10 ⁵	2.50 x 10 ⁵	0**	37.5

*=No CFU were detected in the eluents tested.
**Almost the same number of CFU was recovered from Contaminated Carriers.

Table 2: *Staphylococcus aureus* (ATCC 6538) inactivating/removing activity using PCS Toraysee™ cloth and HPW.

	CFU on Platform			Percent	
	Control	Contaminated	Transfer	Reduction	Transfer
PCS Toraysee™ cloth	2.07 x 10 ⁷	0	0	100*	0*
HPW	1.40 x 10 ⁷	0	0	100*	0*

*=No CFU were detected in the eluents tested.

Table 3: *Serratia marcescens* (ATCC 13880) spores inactivating/removing activity using PCS Toraysee™ cloth and HPW.

	CFU on Platform			Percent	
	Control	Contaminated	Transfer	Reduction	Transfer
PCS Toraysee™ cloth	1.78 x 10 ⁷	0	0	100*	0*
HPW	1.23 x 10 ⁵	0	0	100*	0*

*=No CFU were detected in the eluents tested.

Conclusions

The results of this study showed that, under the test conditions specified, PCS Toraysee™ cloth with PCS 1000 could efficiently decontaminate the contaminated platform and prevent the transfer to the clean platform of *C. difficile* spores, *Staphylococcus aureus* (ATCC 6538) and *Serratia marcescens* (ATCC 13880). HPW could efficiently decontaminate vegetative bacteria but was not able to remove *C. difficile* spores from the contaminated platform and also transferred 37.5% of the *C. difficile* spores contaminations to the transfer platforms.

Figure 3: PCS 1000 Plus wiped twice with PCS Toraysee™ Cleaning Cloths removes 100% of *C. difficile* spores and results in zero transfer to other surfaces, compared to a hydrogen peroxide wipe, which showed no reduction in *C. difficile* spores and transfer to other surfaces.

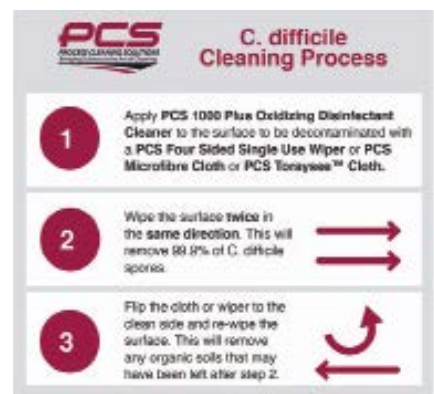


Figure 4: The PCS *C. difficile* Cleaning Process has been proven to remove 100% of *C. difficile* spores from surfaces.



of inorganic and organic materials already present in wastewater makes sodium hypochlorite safe for biological treatment plants. Unused consumer quantities of hypochlorite-containing cleaning products can be safely disposed of down the drain. Sodium hypochlorite will have reacted completely before reaching the treatment plant.

Switching to PCS 1000 Plus products throughout the facility makes sense both economically and for the health and safety of the EVS staff and the environment.

Implementation

PCS 1000 Plus products and the NPH dispensing on demand system are distributed and supported throughout Canada by distribution partners who will provide dispenser installation, and staff training and orientation to the physical properties and optimal cleaning techniques using PCS 1000 Plus Oxidizing Disinfectant Cleaner.

EVS will welcome the switch to PCS 1000 Plus products, as they are easy to use and much less caustic than other commonly used disinfecting products. With one product and one formulation, the entire facility can be cleaned and disinfected to a scientifically validated standard.

PCS offers some excellent products that act synergistically with PCS 1000 Plus:

PCS microfiber cloths, used to immediately dry a surface after application of PCS 1000 Plus, have been proven to remove greater numbers of pathogens and prevent the transfer of pathogens to previously uncontaminated surfaces.

PCS Toraysee™ cloths are used in more than 1,000 healthcare facilities,

mostly to clean medical equipment. Toraysee™ cloth is an ultra-fine microfiber cloth that traps and removes dirt particles very effectively. They are very absorbent, making it easy to remove excess liquid. To clean equipment, all that is required is Toraysee™ cloth lightly dampened with product, reducing damage to sensitive equipment from wiping with saturated cloths.

PCS is also introducing a new four-sided, single use cloth that encourages users to flip the wiper to clean sides to reduce the transfer of pathogens when using single use disposable wipes. PCS Four Sided Wipes can be dispensed dry and moistened at point of use, or entire bucket of wipes can be charged with addition of 1 quart of PCS solution.

Cost Estimate

PCS 1000 Plus RTU is packaged in 946ml bottles, 3.78L jugs, or 4.73L containers with a dispensing tap, at prices comparable to other RTU disinfection products.

Although many facilities prefer the convenience of purchasing ready-to-use products, installing and using the PCS 1000 Plus dispensing system is a cost-effective way to obtain the same effective product on demand. Using this system will give a cost savings of 78% per 946ml bottle over the ready to use price. When an entire year of use is calculated, the cost savings are significant. PCS 1000 Plus Oxidizing Cleaner Concentrate and PCS 1000 Plus Neutralizing Solutions are supplied in closed loop, sealed 3.78L jugs.

Conclusion

Surfaces contaminated with *C. difficile* spores should be meticulously cleaned

to ensure that the pathogen is no longer around to spread to other surfaces and infect people. Because *C. difficile* is everywhere and not just in healthcare settings, it is important that all public facilities are cleaned to a standard that meets this goal.

Unfortunately, the products available to kill *C. difficile* spores are also irritants to eyes and skin and can damage surfaces and equipment. Fortunately, killing *C. difficile* is not necessary if it can be effectively removed from the environment. PCS 1000 Plus products, when used with the PCS *C. difficile* cleaning process, have been proven to remove 100% of *C. difficile* spores from surfaces.

The formulation of PCS 1000 Plus, with sodium hypochlorite and hypochlorous acid in equilibrium, provides the perfect solution to removing harmful pathogens while protecting EVS staff and the facility's furniture and equipment. By using the PCS NPH dispensing system with PCS 1000 Plus Concentrated Cleaner, facilities can have the cleaning and disinfecting power they need at a reasonable price.

The COVID-19 pandemic has been an eye-opener for many facility managers, particularly in non-healthcare settings, about the need to remove viruses and other harmful pathogens from surfaces. PCS 1000 Plus products provide everything a facility needs to keep its staff and the general public safe from dangerous microorganisms on surfaces, even those that are difficult to remove like *C. difficile*, and yet it is better for the environment, easier on finishes and equipment, and gentle to the EVS staff.



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