NaDCC Tablets for Disinfection

Strong cleaning and disinfection ("C&D") products such as those containing bleach and quaternary ammonium compounds ("quats") are increasingly used as microbicides for infection prevention and sanitation of environmental surfaces in various settings; for example, in health care, childcare, schools, food service and production facilities, dairies and breweries, and many other industrial facilities.

C&D is an important infection prevention and sanitation strategy, as various microorganisms can be dangerous to immune-compromised and other vulnerable populations. However, there are concerns about the respiratory health of workers and the general public. There is increasing scientific evidence that C&D is associated with respiratory illness, including asthma.[1] The Association of Occupational and Environmental Clinics designates both sodium hypochlorite (the active ingredient in bleach) and benzalconium chloride quats as sensitizer-induced asthmagens.[2,3]

The human health and environmental concerns of strong C&D products call for less harmful, yet effective, alternatives. NaDCC disinfection tablets are considered such an alternative to bleach.

The purpose of this fact sheet is to outline both advantages and disadvantages of NaDCC tablets as documented in the literature and summarized in test results from the cleaning laboratory at the Massachusetts Toxics Use Reduction Institute (TURI), as published under separate cover.

Active ingredients and uses of NaDCC disinfection tablets

The active ingredient in the NaDCC tablet is **sodium dichloroisocyanurate** (CAS: 2893-78-9), abbreviated as NaDCC. The product also contains at least two other inactive ingredients to form a bubbly, acidic solution when the tablet is dissolved in water.[4] NaDCC tablets are dissolved in water to prepare a disinfecting solution for hard, non-porous surfaces. USEPA has approved the use of NaDCC as a hard-surface disinfectant for hospitals and manufacturing facilities when used in accordance with the label.[5,6]

NaDCC compared to bleach

A solid, tablet-form disinfectant is practical to use, handle, and store compared to liquid, aerosol, or finely powdered disinfectants. As a biocide, NaDCC is considered a stable source of free available chlorine ("FAC") in the form of hypochlorous acid (HClO) when dissolved in water. Sodium hypochlorite (the active ingredient in bleach) is also a source of FAC as HClO when dissolved in water. The difference is that bleach immediately releases all of its chlorine as FAC, whereas NaDCC releases only about half its chlorine initially and releases the remaining chlorine after the original FAC has been used up.[7,8]

For all disinfectants that release chlorine, HClO is the microbicidal agent.[7,9,10,11] The disinfection effectiveness of chlorine-releasing agents is known to decrease in alkaline pH levels and increase in acidic pH levels.[9] Bleach and other hypochlorites are alkaline and tend to increase the solution pH level, which in turn promotes the dissociation of HOCl to hypochlorite (ClO^-) and hydrogen (H^+).[7,12] NaDCC tablets provide an acidic solution—the reduced pH promotes the formation of undissociated HOCl. Compact and stable NaDCC tablets can be mixed with water more accurately and safely, resulting in less misdosing and spillages as compared to mixing liquid bleach with water.[7,12]

Tests have shown that NaDCC shelf life in temperate and even tropical climates is five years, whereas the recommended shelf life for bleach is six months after opening the container.[7] NaDCC is also resistant to degradation from sunlight—this is another factor that makes NaDCC a stable source of FAC.[9,13]
The disadvantage of NaDCC is the relatively high cost.[13]

The TURI lab has conducted performance testing of NaDCC tablets on behalf of several food and beverage facilities, and individual results can be found in the written case studies found at https://www.turi.org/Our_Work/Business/Industry_Sectors/Food_and_Beverage.

Safety, health, and environmental concerns of NaDCC and bleach

Although there are advantages to using a tablet-form disinfectant, NaDCC tablets have health and environmental hazards. There are a number of hazards to be aware of, and more scientific studies are needed to evaluate acute and chronic human health effects of NaDCC more comprehensively. Both NaDCC and bleach are oxidizers, corrosive, and hazardous to the environment.[14,15] In addition, chlorine gas and sodium hypochlorite are designated by The Association of Occupational and Environmental Clinics (AOEC) as sensitizer-induced asthmagens.[16]

When comparing airborne chlorine gas exposures, TURI laboratory analyses showed that bleach solutions resulted in higher average and peak chlorine exposures as well as more recordings at or above the limit of detection (0.1 ppm) than those solutions with similar FAC concentrations made of NaDCC tablets. The highest airborne chlorine gas exposure recording for any NaDCC solution in the lab tests was 0.1 ppm, whereas for bleach it was 0.7 ppm. Therefore, while the NaDCC solution still produces some airborne chlorine exposure, it is less than for similar-strength bleach solutions.

To date, three health-related case reports on NaDCC have been published in the scientific literature, and highlight potential hazards of concern. They include adult asthma, reactive airway dysfunction syndrome, atopic dermatitis, and a child's lung injury from inhaling the NaDCC solution.[17,18,19]

Summary comparison of NaDCC and bleach

There are pros and cons to using bleach and NaDCC tablets, as summarized in the table below.

	Pros (+)	Cons (-)
NaDCC tablets	• Practical to use • Stable source of HOCl prolongs the microbicidal effect • Acidic water solution increases the disinfection effectiveness • Shelf life up to 5 years • Resistant to sunlight • Reduced exposure to chlorine; TURI laboratory test results found that airborne chlorine gas concentrations did not exceed 0.1 ppm	• Product price • Limited human health effects studied and published in the scientific literature • Generates FAC, which is a respiratory irritant and an asthmagen • Strong oxidizer and can intensify fire • Corrosive • Hazardous to environment in tablet form
Bleach	• Product price • Effective • Easy to obtain	• Bleach-water solutions are not a stable source of HOCl • Alkaline water solution decreases the disinfection effectiveness • Shelf life about 6 months after opening the container • Decomposes in sunlight • Respiratory irritant and asthmagen • Strong oxidizer and can intensify fire • Corrosive • Hazardous to environment • Higher exposure to chlorine; TURI laboratory tests recorded a concentration of 0.7 ppm

[1] Quinn MM, Henneberger PK. National Institute for Occupational Safety and Health, National Occupational Research Agenda Cleaning Disinfecting in Healthcare Working Group, Braun B, Delclos GL, et al. Zock JP. Cleaning and disinfecting environmental surfaces in health care: Toward an integrated framework for infection and occupational illness prevention. *Am J Infect Control*. 2015; 43(5):424-34. DOI: 10.1016/j.ajic.2015.01.029. PMID: 25792102.
[2] Association of Occupational and Environmental Clinics. Benzalkonium chloride. AOEC Exposure code 322.321. Available at: http://www.aoecdata.org/ExpCodeLookup.aspx. Accessed: June 18, 2019.
[3] Association of Occupational and Environmental Clinics. Sodium hypochlorite (bleach). AOEC Exposure code 322.10. Available at: http://www.aoecdata.org/ExpCodeLookup.aspx. Accessed: June 18, 2019.
[4] Stafford U. A tablet composition (a patent). World Intellectual Property Organization. 2010. Available at: https://patents.google.com/patent/WO2010113144A2/en. Accessed: June 6, 2019.
[5] US EPA Pesticide registration 1677-255 Ecolab, Inc for Sodium Dichloroisocyanurate SHC-S hard surface disinfectant. 2016. Available at https://www3.epa.gov/pesticides/chem_search/ppls/001677-00255-20160629.pdf. Accessed March 27, 2020.
[6] US EPA Pesticide registration 71847-7 Label Amendment Medentech Ltd for Klorkleen 2. 2018. Available at https://www3.epa.gov/pesticides/chem_search/ppls/071847-00007-20180806.pdf. Accessed March 27, 2020.
[7] Clasen T, Edmondson P. Sodium dichloroisocyanurate (NaDCC) tablets as an alternative to sodium hypochlorite for the routine treatment of drinking water at the household level. Int J Hyg Environ Health. 2006; 209(2):173-81. DOI: 10.1016/j.ijheh.2005.11.004. PMID: 16387550.
[8] Jain S, Sahanoon OK, Blanton E, Schmitz A, Wannemuehler KA, Hoekstra RM, Quick RE. Sodium dichloroisocyanurate tablets for routine treatment of household drinking water in periurban Ghana: a randomized controlled trial. Am J Trop Med Hyg. 2010; 82(1):16-22. DOI: 10.4269/ajtmh.2010.08-0584. PMCID: PMC2803503. PMID: 20064989.
[9] Dychdala G. *Chlorine and chlorine compounds*. In: Block S, editor. Disinfection, Sterilization and Preservation. 5 ed. Philadelphia, PA, USA: Lippincott Williams & Wilkins; 2001. p. 135–57.
[10] Karsa DR. *Biocides*. In: Johansson I, Somasundaran P, editors. Handbook for Cleaning - Decontamination of Surfaces. Burlington, The Netherlands: Elsevier Science & Technology; 2007. p. 593-623.
[11] Rutala W, Weber D. Guideline for Disinfection and Sterilization in Healthcare Facilities. The Healthcare Infection Control Practices Advisory Committee (HICPAC). US Department of Health and Human Services, Centers for Disease Control and Prevention (CDC), 2008. Available at: https://www.cdc.gov/infectioncontrol/pdf/guidelines/disinfection-guidelines-H.pdf. Accessed: March 27, 2020.
[12] Coates D. A comparison of sodium hypochlorite and sodium dichloroisocyanurate products. *J Hosp Infect*. 1985; 6(1):31-40. PMID: 2859320.
[13] Lantagne DS, Cardinali F, Blount BC. Disinfection by-product formation and mitigation strategies in point-of-use chlorination with sodium dichloroisocyanurate in Tanzania. *Am J Trop Med Hyg*. 2010; 83(1):135-43. DOI: 10.4269/ajtmh.2010.09-0431. PMCID: PMC2912590. PMID: 20595492.
[14] European Chemicals Agency. Brief Profile: Troclosene sodium. European Chemicals Agency, 2019. Available at: https://echa.europa.eu/brief-profile/-/briefprofile/100.018.880. Accessed: Jun 21, 2019.
[15] European Chemicals Agency. Brief Profile: Sodium hypochlorite. European Chemicals Agency, 2019. Available at: https://echa.europa.eu/brief-profile/-/briefprofile/100.028.790. Accessed: Jun 28, 2019.
[16] Association of Occupational and Environmental Clinics. Chlorine. AOEC Exposure code 030.02. Available at: http://www.aoecdata.org/ExpCodeLookup.aspx. Accessed March 27, 2020.
[17] Wiel E, Sicot J, Leteurtre S, Binoche A, Nisse P, Assez N. [Sodium dichloroisocyanurate-induced acute lung injury in a child]. *Arch Pediatr*. 2013; 20(4):375-7. DOI: 10.1016/j.arcped.2013.01.011. PMID: 23433843.
[18] Goverdhan S, Gaston H. Sanichlor-induced atopic dermatitis and asthma in ophthalmologists. *Eye (Lond)*. 2003; 17(1):108-9. DOI: 10.1038/sj.eye.6700228. PMID: 12579187.
[19] Hannu TJ, Riihimaki VE, Piirila PL. Reactive airways dysfunction syndrome from acute inhalation of a dishwasher detergent powder. *Can Respir J*. 2012; 19(3):e25-8. DOI: 10.1155/2012/150919. PMCID: PMC3418100. PMID: 22679618.