

Commercial Cleaning Products for Chemical Decontamination: A Scoping Study

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IMPORTANT INFORMATIVE STATEMENTS

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1. Background

Following a terrorist attack or industry accident, when chemical agents including chemical warfare agents (CWAs) and toxic industrial chemicals (TICs) are released, immediate response and long-term recovery will require the decontamination. In the event of a large scale chemical emergency, although standard/specialized decontamination products are available, they may either not be readily accessible at affected sites or they may be quickly consumed. Thus, first responders and local authorities need as much information as possible on potential decontamination technologies subjected to specific chemical agents.

The project aims at assessing the effectiveness of common commercially available cleaning and neutralizing products on a variety of CBRN-contaminated surface materials. This is to find alternatives to standard CBRN decontamination technologies in case of major or remote events where such technologies may not be readily available. This will be achieved by evaluating commercially available products of proven families of products such as disinfectants, oxidizers, surfactants, and sequestering agents on known or potential CBRN agents. The primary focus is on commercially products available in large quantities to first responders as well as common products marketed for domestic use (cleaning, gardening, home renovations, etc.). The products proven efficient on target agents could therefore be used as backup/alternative decontamination agents in the event of a major or remote incident.

After an immediate response executed by first responders, a long-term decontamination will likely be carried out later by contractors. Prior to contracting the tasks, local authorities need to know commercially available cleaning products/technologies in terms of vendor information, their principles of operation, concerns for the user, advantages and disadvantages, and available services. There is a strong need to collect, analyze, update and publish such chemical incident countermeasures. A large-scale incident may require several commercial available cleaning products/technologies.

2. Project Objective

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This project aims to identify household cleaning products as alternative chemical decontamination agents in case of non-accessibility or shortage of standard chemical decontaminants at affected sites. The primary focus will be on common commercial products which are readily available to first responders.

3. Tasks Completed

The following tasks were successfully completed under this scoping study:

- Information was gathered on household cleaning products which can be potentially used as backup decontaminants.
- Information was analyzed to identify the promising household cleaning products for chemical decontamination.
- The gathered information and data were compiled to prepare a final report to CSS.

4. Results

4.1. Household cleaning products

The efficacy of household cleaning products which can be potentially used as backup decontaminants was evaluated to cleanup toxic chemical agents including various chemical warfare agents. Bleach (solution or powder), and peroxides and related agents that can easily be obtained from grocery stores, hardware stores and swimming pool supply stores, are the most efficient household commercial available cleaning products for chemical decontamination. Those two agents are the most studied worldwide, especially for military needs. Historically bleaching powders were used as the first decontaminants in World War I when Germany unleashed CWA on Allied troops at France. However, in comparison with environmentally friendly hydrogen peroxide, chlorine-based bleach is corrosive and may easily produce undesirable toxic by-products. Both bleach and peroxide have a limited shelf life. United States (US) recommends to use household bleach with shelf life of less than 1 year.

Nowadays, in US diluted household bleach is already recommended to the general public after a chemical attack, for the decontamination of personal items. Many viruses and bacteria can also be destroyed by household bleach.

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Diluted household bleach (1:10) can be used for skin decontamination (household bleach is often sold at 5-6% concentration and may injure human skin without dilution), although this approach is less favoured in a mass casualty decontamination situation than soap and water. US has also approved certain bleach products for emergency use in biological decontamination. A diluted solution of household bleach (1:10) is considered safe and effective for wiping down chemical/biological contaminants from counters and floors. For the decontamination of first responders' protective clothing and equipment, 1 minute soaking is suggested for emergency decontamination using undiluted chlorine bleach, and 15 minutes soaking for normal decontamination using diluted bleach (1:22), before rinsing with large quantities of soapy/tepid water. New thick plastic gasoline containers are recommended to be used for the preparation of bleach solutions, because household chlorine bleach may react with metal container and produce an exothermic reaction that may lead to ignition when in contact with the vapour from fuels or solvents. It is advised that the mixing of household bleach and household ammonia may release chlorine gas, chloramine and other noxious fumes.

Household bleach is registered by United States Environmental Protection Agency (US EPA) to be used in the sanitization and disinfection of household premises, animal facilities, food processing plants, and agricultural settings (EPA/600/R-05/036, March 2005). According to a report presented at 241st American Chemical Society meeting (March 2011, from the US Food and Drug Administration in Summit-Argo, III), common household bleach appears to be an effective, low-cost, and widely available way to decontaminate food preparation surfaces in homes, restaurants, and processing plants that are tainted with ricin (<http://www.acs.org/content/acs/en/pressroom/newsreleases/2011/march/household-bleach-can-decontaminate-food-prep-surfaces-in-ricin-bioterrorist-attack.html>).

Israel also conducted similar studies on the efficacy of household cleaning products as backup decontaminants to cleanup chemical/biological agents. It is recommended that when faced with suspected virulent bio-agents, household bleach without dilution may be dumped into the whole contaminated area to prevent further spread of the contaminants. It is also advised that diluted household bleach may often be effective to decontaminate people and equipment from most biological agents.

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Very recently US EPA - National Homeland Security Research Center (NHSRC) conducted several studies to evaluate the decontamination efficacy of commercial cleaners against sarin, somen, and VX. NHSRC found that common and readily available commercial cleaning products show promise for decontaminating chemical agents. Among commercial cleaners, bleach is a potential decontaminant for chemical agents. In a study “Evaluation of Household or Industrial Cleaning Products for Remediation of Chemical Agents” (EPA 600/R-11/055, 2011), four commercial cleaning products, full strength K-O-K[®] liquid bleach (5.25% aqueous solution of NaOCl), dish-washing detergent Cascade[®] with Extra Bleach Action Gel, OxiClean[®] Versatile Stain Remover Powder, and ZEP[®] Industrial Purple liquid cleaner (proprietary caustic cleaner containing surfactants) were evaluated for the chemical agents including thickened sulphur mustard, thickened soman, V-series nerve agent (VX), and sulphur mustard contacted with four indoor building materials (galvanized metal, laminate, wood flooring and carpet). Among the commercial cleaning products tested, full strength K-O-K[®] liquid bleach generally had the highest decontamination efficacy against all four chemical agents from all materials. Toxic by-products were generated when ZEP[®] cleaner and K-O-K[®] bleach were used for the decontamination of sulphur mustard and VX. No toxic by-products were found in the decontamination of VX using full strength K-O-K[®] bleach (PH > 12) instead of 10% K-O-K[®] bleach (PH < 10).

In another study “Decontamination of Residual VX on Indoor Surfaces Using Liquid Commercial Cleaners” (EPA/600/R-10/159, December 2010), two liquid decontaminants, full strength K-O-K[®] liquid bleach (5.25% aqueous solution of NaOCl) and a 25% aqueous solution of ZEP[®] Industrial Purple liquid cleaner (proprietary caustic cleaner containing surfactants), were tested on three building material coupons (galvanized metal, laminate, and carpet) treated with VX aging from 1 day to 21 days. In contrast to ZEP[®] Industrial Purple resulted in moderate decontamination, full strength K-O-K[®] liquid bleach showed high efficacy on all samples, regardless of the aging period and coupon substrate type. It was concluded that the full strength K-O-K[®] liquid bleach can be effective for both porous and non-porous materials and that decontamination efficacy may be more dependent on the initial level of contamination rather than on surface characteristics.

In the last decade U.S. Army (Edgewood Chemical Biological Center) also

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conducted studies on the decontamination of chemical warfare agents using household chemicals (Patent No. US 7,829,519 B1, Nov. 9, 2010). It was concluded that household chemicals and cleaners, i.e., Windex (ammonia window cleaners), ammonia floor cleaners, topical 3% hydrogen peroxide, rubbing alcohol (70% i-PrOH), baking soda (NaHCO_3), and washing soda (Na_2CO_3), are capable of decontaminating chemical warfare agent (CWA) such as VX, GD, and HD, especially in a combination of two to three products. These decontaminants can be easily mixed by the general public. For example, 3% hydrogen peroxide, mixed with baking/washing soda and rubbing alcohol, is quite sufficient for the decontamination of VX and HD. It is not clear whether formation of toxic by-products has been detected in that research.

Although household cleaning products are already recommended to use for decontamination in many countries, there are still major gaps to be filled before actually using such commercial cleaning products in Canada:

- Risk assessment of potential toxic by-products
- Selection tool for different chemical contaminants
- Safe to use including potential personal injury, corrosive/damage to equipment, pollution to the environment, personnel protection equipments requirement
- Temperature effect (hot/cold weather)
- Standard operation procedures
- Effectiveness of different contaminated materials including building materials, vehicle materials, soils, vegetation, etc.
- Regulations (at a federal, provincial, or municipal level)
- Waste collection and disposal
- Shelf life study
- Guideline/training for first responders, decontamination contractors, and/or civilians

4.2 Commercially available decontamination equipment/technologies

In 2007 US Department of Homeland Security published a Document 103–06 "Guide for the Selection of Chemical, Biological, Radiological, and Nuclear Decontamination Equipment for Emergency First Responders", by updating its previous version published in Oct. 2001. This guide intended to assist the first responder community in the evaluation and purchase of
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appropriate CBRN decontamination equipment. The information was collected based on literature searches, market surveys and existing test data of commercial available decontamination equipment. US Department of Homeland Security planned to periodically update this guide by subjecting available decontamination equipment to laboratory testing and conducting research to develop a series of documents such as user guides, technical reports, and national standards. In comparison, there is no similar program in Canada.

After immediate response by the first responder community to a chemical attack or industry spill, a planned decontamination will be carried out by contractors later to cleanup the contaminated area to a required level. In this stage, the appropriate treatment and disposal processes must be selected by local authority for the particular chemicals and circumstances of the release. In 1986, a Survey of Chemical Spills Countermeasures including commercially available equipment, processes and agents was published by Environment Canada as a report (Report EPS 9/SP/2). It includes proven and evaluated countermeasures only, which can be used to cleanup or neutralize chemical spills. This book provides guidance in choosing a wide variety of spill cleanup technologies including purchasing, evaluation, and implementing countermeasures. This survey provides operators with a one-stop source of information on how to cleanup contaminated sites, including controlling leakage, containment of spills on land and water, and ways to safely transfer and store the contaminants. For each listed product, data are organized under following subsections: 1) applicability; 2) description; 3) operating principle; 4) physical specifications; 5) operating specifications; 6) status of development and usage; 7) performance; 8) availability and commercial information; 9) other data and references. The survey contains two indexes, listing all products by name and the manufactures and distributors of the various products. The Survey of Chemical Spills Countermeasures was revised and updated in 1996, and published as a book in 1998 (ISBN 0-56670-313-1, CRC Press LLC). Since then, a number of new technologies have been developed and evaluated so that source of information published in these books may have been out-of-date. There is a strong need from responder community and local authorities to have a new or at least updated survey/reference manual. Following the events of September 11, 2001, it becomes critical needs in Canada to deploy new technologies following a chemical attack.

5. Significance of Results

In the scenario of major or remote emergencies, large quantities of chemical decontaminants are needed for immediate response. However, in such situations standard chemical decontaminants may not be readily available and/or may not be in sufficient quantities. There is therefore a strong need to look for household cleaning products as alternatives to standard chemical decontaminants. This can be achieved by evaluating commercially available products on known or potential CBRN agents, including monitoring potential toxic by-products during decontamination. Those selected products should be: (1) effective for the destruction/mitigation of target CBRN agents; (2) easily accessible in large quantities to first responders everywhere in Canada; (3) generating no toxic by-products. After approved by regulatory authorities, those products can be used as backup decontamination agents in the event of a major or remote CBRN incident.

There is also a strong need to collect and publish chemical spill countermeasures including commercially available equipment, processes and agents from the responder community and local authorities.

The information enhances the capability in preparedness to respond and restoration after a CBRN event or industrial incident. The information has an impact on planning of response and restoration actions by selecting alternative decontamination agents for emergency response and appropriate decontamination technologies later on from contractors.

6. Recommendations for Future Work

This scoping study reviewed the common commercial available cleaning products and technologies for chemical decontamination after terrorist attacks or industrial incidents involving toxic chemical agents.

The following future tasks are recommended:

- Small-scale evaluation/validation of household cleaning products for chemical decontamination
- Study of toxic by-products of decontamination and their formation avoidance
- Large-scale technical demonstration of household cleaning products

- as chemical decontamination agents
- Risk assessment for use in open environment
 - Update/preparation of surveys of chemical spill countermeasures (immediately decontamination by first responder community and long term decontamination by contractors, respectively)
 - Application in cold/hot weather conditions
 - Development of a guideline/tool for the selection of household cleaning products and commercial available technologies during the response and restoration phase of the incident

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