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## LATEST TECHNOLOGIES SUITABLE FOR CHEMICAL DECONTAMINATION OF SENSITIVE EQUIPMENT AND INTERIOR FOR THE HUNGARIAN DEFENSE FORCES

### *Abstract*

*NATO's Strategic Concept exactly determines that the proliferation of chemical weapons and other weapons of mass destruction may cause incalculable consequences for global stability and prosperity. The immediate CBRN hazard control can sustain the operational capability and preserve the survivability of troops. One of the most significant part of hazard control is the chemical decontamination which can reduce the contamination level of the military equipment, combat vehicles and personnel. The sensitive equipment and interior CBRN decontamination technologies represent modern innovation which can reduce harmful effect of chemical warfare agents effectively. The Hungarian CBRN decontamination system has not possessed these technologies yet, but their deployments are urgently needed.*

*A NATO stratégiai koncepciója egyértelműen meghatározza, hogy a vegyi fegyverek és más tömegpusztító fegyverek elterjedése beláthatatlan következményt jelentenek a világ gazdasági konjunktúrájára és stabilitására. Az ABV veszélyhelyzetek gyors kezelése a műveleti képesség és a csapatok túlélőképességének megőrzéséhez járul hozzá. Az ABV veszélyhelyzet kezelés egyik legmeghatározóbb része a vegyimentesítés, amely csökkenti képes a katonai felszerelések, harcjárművek és személyi állomány szennyezettségi szintjét. Az érzékeny eszköz és belső tér ABV mentesítő technológiák jelképezik azokat a modern újításokat, melyek hatékonyan csökkentik a vegyi harcanyagok káros hatásait. A magyar ABV mentesítő rendszer nem rendelkezik ezekkel a technológiákkal, de műveleti alkalmazásuk egyre sürgetőbbé válik.*

**Keywords:** *CBRN defence, chemical decontamination, decontamination solution, vacuum based decontamination technology, sensitive equipment decontamination ~ ABV védelem, vegyi mentesítés, vákuum alapú mentesítési technológia, érzékeny eszköz mentesítés*

## INTRODUCTION

If hazard control procedures and hazard precaution are not effective, decontamination of personnel, equipment and sensitive materiel can be necessary. Decontamination is the reduction or removal of chemical agents from contaminated surfaces or inner sections. Chemical decontamination may be carried out by removal of chemical warfare agents by physical means or by chemical neutralization or detoxification.

The chemical decontamination is the process which can provide safety environment for contaminated military equipment, combat vehicles and personnel by absorbing, destroying, neutralizing, and making harmless chemical contamination. [1]

The main purposes of the chemical decontamination can be for avoiding the cross contamination, controlling the spread of contamination, sustaining the operational capability, protecting support personnel and reestablishing combat assets.

New chemical decontamination technologies have appeared which can reduce the duration of decontamination and improve the effectiveness of hazard management.

The most critical parts of chemical thorough decontamination procedures are to handle sensitive equipment and vehicle interiors which capabilities are absent from the Hungarian Defense Forces' CBRN decontamination system. Some alternative modern worldwide leading chemical decontamination technologies exist which can mean trustable solution for ensuring full aspect decontamination procedures including chemical decontamination of sensitive equipment and vehicle interiors.

### PROBLEM FRAMING OF SENSITIVE EQUIPMENT AND VEHICLE INTERIOR DECONTAMINATION

Traditional decontamination of chemical warfare agents means use of "wet" solutions, such as chemical mechanisms decontamination. Two types of chemical mechanisms have been used during the sensitive equipment<sup>1</sup> decontamination: oxidation and acid/base hydrolysis. Mustard<sup>2</sup> and the persistent nerve agent VX contain sulfur molecules that can step in oxidation reactions. VX and other nerve agents contain phosphorus groups that can be hydrolyzed. The most of the chemical decontaminants are designed to oxidize HD and VX and to hydrolyze nerve agents.

The most important category of chemical oxidative decontamination reactions is oxidative chlorination. This term covers the "active chlorine" chemicals like hypochlorite. Hypochlorite solutions can be effective universally against the organ phosphorus and mustard agents. The VX and HD contain sulfur atoms which are readily effect to oxidation.

Alkaline hydrolysis is often initiated by the nucleophilic clash of the hydroxide ion on the phosphorus atoms which can be found in VX the G agents. Hydrolysis is a chemical reaction in two possible environments, acidic or alkaline. Hydrolysis rates depend on chemical structures and reaction conditions such as pH, temperature, the kind of solvent used, and the presence of catalytic reagents. Acidic hydrolysis is less important for agent decontamination because the hydrolysis rate of most chemical agents is slow, and the sufficient acid catalysis is mostly not observed. [2]

The traditional decontamination requires storage, transport, and waste management of huge amount of hazardous chemicals. One of the typical problems, that this traditional decontamination procedures demand the release of large amounts of chemicals into the environment. Highest research efforts are going on to find environmental friendly methods to

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<sup>1</sup> Sensitive equipment can not resist against corrosive decontamination solutions. Personal computers, GPS, radio transmitter, optics and electronics are listed here.

<sup>2</sup> Chemical warfare agents are usually assigned what is termed a military symbol. H - mustard gas, HD - distilled mustard, GA - tabun, GB - sarin, VX - VX nerve agent

avoid useless environmental pollution. Another major problem is that current decontamination solutions are strongly corrosive to all kinds of materials (plastic, metal, rubber) and cause severe damages on the surface and inside of sensitive equipment. For this reason “wet” decontamination methods are not suitable for use on sensitive equipment, restricting their use in critical mission areas, such as vehicle interiors. In addition, long decontamination chemical reaction times, typically 20 - 30 min, are needed for wet methods to be effective.

A replacement decontamination technology is needed that is capable of selective and quick destruction of chemical warfare agents, is preferably all-dry, does not require mass storage, is easily transported, does not affect sensitive equipment and does not menace with dangerous environmental pollution. [3]

Potential alternatives can be the vacuum based decontamination technologies which can meet all requirements to be safe and effective decontamination procedures.

### **SENSITIVE EQUIPMENT DECONTAMINATION TECHNOLOGY**

A lot of military equipment and combat devices are non-protected against corrosive decontamination solution and their electronic circuits may be damaged easily. The surface and inside of sensitive equipment is generally difficult to decontaminate due to location of equipment, features of materials or construction characteristics. One of the most worldwide leading chemical decontamination technologies, as a possible solution for this problem is the vacuum based chemical decontamination technology.

The vapor pressure is the physical parameter which determines the persistency, volatility, and mobility of the chemical warfare agents. The chemical decontamination of sensitive electronic equipment can be carried out in a special vacuum chamber. This vacuum chamber can provide vacuum and thermal energy as special conditions for removing chemical warfare agents from the sensitive equipment without any corrosive or harmful effects.



**1. Figure.** The Kärcher Decontamination System for Sensitive Material (DSSM). [4]

The vacuum based chemical decontamination is accomplished by the following procedures:

- Temperatures: up to 70 °C which is limited by the storage temperature range of the sensitive equipment,

- Vacuum: down to 1 Pa<sup>3</sup> which can remove chemical warfare agents by evaporating and desorbing from the surface and interior of the equipment and electric instruments.

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<sup>3</sup> Vapour pressure of VX: 14 Pa at 20 °C

This way, the pressure in the chamber will be reduced below the vapour pressure of the agents to enable them to desorb and evaporate. Since desorption and evaporation is enhanced by increased temperatures and is responsible for the cooling down of the surfaces the process is supported by heating. In regard to the volatility of the agents they will be removed immediately to prevent condensation due to saturation of the atmosphere in the chamber. To ensure effective decontamination, the whole process is program controlled. The relevant parameters are kept within defined limits, temperature decrease due to evaporation is compensated and evaporating chemical warfare agent is removed out of the chamber by suitable program steps. [5]

### **Sensitive equipment detoxification technology**

The detoxification multiphase system contains a pressurized aerosol container ready to use. This pressurized system consists of a sorbent solvent-co-solvent propellant which is part of a kit including a special vacuum device. If this system is applied directly to sensitive surfaces, it can immediately contact and absorb the contaminant, and then solidifies to form a white powder which is evacuated into the vacuum receptacle. Chemical warfare agents are neutralized by detoxification powder and the waste material is contained for disposal. There is no chemical or thermal reaction just the mechanical removal of the contaminant.



**2. Figure.** The CRISTANINI sensitive equipment detoxification SX34 decon vacuum in use. [6]

#### *Advantages of detoxification technology:*

- Very flexible system which can provide rapid response,
- It can remove wide range of chemical warfare agents with high efficiency,
- The product can be stockpiled without any restriction for long time duration,

#### *Decontamination Procedure:*

- Detoxification powder is sprayed directly on the surface to be decontaminated like an aerosol paint,
- The surface will be covered by a thick compact white layer of powder,
- After waiting of the reaction time (20 – 30 sec) it is possible to remove the powder layer by means of the appropriate vacuum device,

The contaminant toxic agent compound diffuses into the porous solid system of the vacuum receptacle where it becomes trapped. The chemical decontamination solution which is the part

of the kit is able to neutralize chemically the aggressive agents, thanks to its oxidation and hydrolization action.

The decontamination is successful on the surface when there are no any signs of chemical warfare agent presence which is controlled by chemical agent monitor. If the decontamination is not efficient the decontamination procedure has to be repeated.

### INTERIOR DECONTAMINATION TECHNOLOGY

The most significant disadvantage is the gasoline driven jet engine decontamination technology which has limited operation possibilities in closed space, sensitive military establishments and areas with special explosion-proof restriction. The Hungarian Defence Forces CBRN Defence Battalion has been operating gasoline driven jet engine interior decontamination technology since 2012 but the operating experience is not satisfied. The portable fogging device a lightweight cold fogger without any electrical or gasoline driven engines are much more suitable for interior decontamination such as vehicle interiors, containers and buildings decontaminations because low volumes of the decontaminant can be spread homogeneously.



**3. Figure.** The FOGBOOSTER is the new generation of decontamination and disinfection fogging devices. [7]

The portable fogging device can be operated by the micro-film based on GD-6 decontamination solution which can be used on all surfaces, even penetrating cracks and detoxifies all common chemical warfare agents. Scientific experiments have proved the detoxification capability of GD-6 regarding highly toxic nerve agents Soman, VX and blister agent S-Mustard.

By using compressed air combined with a specially designed nozzle, the highly effective microscopically atomized decontamination fluid can produce a dry mist or fog. The aerosol produced by the OWR GmbH made “FOGBOOSTER” can cover the surface of a 20 feet ISO container within 90 seconds. The aerosol can sustain its stability for at least 15 minutes. The operation time of the “FOGBOOSTER” is approx. 30 minutes in its standard configuration. [8]

## SUMMARY

The quick elimination of any contamination means remarkably high importance for deployed forces. Different kinds of highly sensitive equipment can be involved during the mission and in case of contamination this lack of capabilities is not easy to replace in the field which is critical for the highly sophisticated modern soldier and first responder. Therefore, the contaminated sensitive equipment needs to be decontaminated. But, most of the sensitive equipment is not chemically hardened and cannot be decontaminated using conventional wet-chemical or thermal decontamination methods. [9] The vacuum based decontamination technology is able to handle the contamination very effectively without corrosive effect concerning sensitive equipment. This kind of technology can provide safe environment to avoid cross contamination and the waste management difficulties are solved as well. The detoxification multiphase system is able to remove wide range of chemical warfare agent with high efficiency and the pressurized system is very flexible which can provide rapid response. The portable fogger is widely useable in military tasks and it is independent during operations. The main advantage of this technology is the absence of electrical or gasoline driven engines which makes it suitable for interior decontamination and it can use in highly dangerous dedicated environment.

These introduced decontamination technologies have not been the part of Hungarian Defense Force CBRN decontamination system yet but the participation in NATO Response Force rotation will require revising their deployment in the future. The vacuum based and the detoxification multiphase sensitive equipment decontamination technologies can replace the obsolete calcium hypochlorite decontamination method which is currently used by Hungarian Defense Force CBRN units. Unfortunately, the Hungarian CBRN decontamination system can not handle contamination inside the building or vehicle at present that is why establishing interior decontamination technology can mean a great achievement.

It should be noted that in the near future the new challenges to methods of decontamination of sensitive equipment together with the changes of military equipment modifications demand the modernization of combat methods and other operational activities and adequate training programmes for these new procedures. At the same time this decontamination process has to be introduced into the education. [10]

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