New Technologies and Decontaminants
for highly mobile CBRN Decontamination Systems

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Abstract

The new family of decontamination agents clearly represent the state of the art in the area of CBRN decontamination and meets the urgent need for environmentally more compatible decontaminants, which has been present for decades due to the enormously increased environmental awareness. The CBRN decontaminants can be used within the temperature range of approx. -30 °C to +49 °C, e.g. including under harsh winter conditions.

The non-aqueous C decontaminant is intended for the quick and effective detoxification of all known chemical warfare agents (including thickened chemical warfare agents).

The B decontaminant system is based on a special thermally stable peracetic acid and is applied in the form of an aqueous foam for the decontamination of biologically contaminated surfaces. Studies carried out at independent test institutes confirm the distinct biological decontamination effect (including against anthrax and bird flu viruses) even at low temperatures.

The RN decontaminant is highly effective due to its specific combination of an aqueous surfactant solution system with appropriate complexing agents, oxidants or other auxiliary substances.

The chemical and biological decontamination of sensitive optical and electronic equipment as well as components which cannot be treated using humidity or aggressive decontamination chemicals is carried out in a special vacuum chamber.

On the basis of the new family of CBRN decontaminants and the vacuum CB decontamination technologies the most modern and most efficient highly mobile decontamination systems are currently available with outstanding worldwide leading technology.

Keywords: CBRN decontamination; vacuum decontamination technology; decontamination of sensitive material

1 Introduction

For the future it can be assumed that radioactive, biological or chemical warfare agents will not be used predominantly in masses, but undercover against selected targets and on a low level. Apart from this, terrorist attacks or nuclear accidents, disasters in the chemical industry, sabotage or the targeted release of highly toxic industrial matters in the framework of military operations can cause collateral damage which are totally comparable to those of an attack involving NBC weapons, and the events in relation to BSE, foot and
mouth disease, SARS and bird flue are only a vague hint on the possible effects following
the use of biological weapons.

Against this background, it is of essential importance that the decontamination of persons,
material, clothing, and personal equipment, etc. is carried out as soon as possible in order to
ensure the survival of the affected personnel and to be able to continue work at a
minimized residual risk without wearing personal CBRN protection equipment. The
objective of the investigations carried out was the development of new vacuum
decontamination technologies and of a complete family of highly effective rapid action
CBRN decontaminants.

2 New Family of highly effective CBRN Decontaminants

Contamination prevention is always of top priority. But if CBRN contamination of persons
and material could not be avoided this danger can only be eliminated by effective
decontamination. At first sight, the application of decontamination agents and methods
which are supposed to be universally effective against C, B and RN contaminants seems
very interesting and congenial from a logistics point of view. However, it does not
withstand critical scrutiny with regard to its underlying responsibility for the health and
survival of the concerned persons.

For the removal of radioactive contamination, the inactivation of relevant pathogenic
micro-organisms and the detoxification of extremely toxic chemical warfare agents it was
developed a complete family of highly effective rapid-action CBRN decontamination
agents. Together with high decontamination efficiency this agents ensure a sufficiently
high level of storage stability, agent handling safety, and good compatibility with the
material to be decontaminated. This family of decontamination agents also meets the urgent
need for environmentally more compatible decontaminants, which has been present for
decades due to the enormously increased environmental awareness. Moreover,
environmental compatibility is also an important pre-requisite for the use of
decontamination technologies and agents in peace-time in the case of accidents involving
highly toxic hazardous materials, nuclear accidents, epidemics, etc.

The new decontamination agents clearly represent the state of the art in the area of CBRN
decontamination, are biologically degradable and suitable for application even under harsh
winter conditions. The agents present the basic prerequisite for the conceptual design of
many decontamination systems, including the highly mobile compact TEP 90
decontamination system and different light, air-transportable systems for special forces
acting in the framework of international missions.

2.1 C Decontaminant

The GDS 2000 is a non-aqueous decontamination agent based on alkoxides and is intended
for the quick and effective detoxification of all known chemical warfare agents (including
thickened chemical warfare agents) on the surfaces of different materials within the
temperature range of approx. -30 °C to + 49 °C, e. g. including under harsh winter
conditions. GDS 2000 is manufactured industrially, available ready for use, and can be
stored for more than 10 years.

Compared to other decontaminants (aqueous decontamination solutions, decontamination
emulsions or foams) GDS 2000 is readily available so that technical systems for the
production under field conditions are not required, and only application units are needed.
This reduces the failure susceptibility of the respective decontamination systems while the reliable availability is considerably increased. The comparatively high reactivity of GDS 2000, even at low temperatures, minimises the required reaction time. This leads to a drastic reduction of the necessary decontamination times and enables increased throughput of the vehicles, equipment, etc., to be decontaminated.

The tests carried out at different independent test institutes verify the distinct detoxification efficiency of the GDS 2000 decontaminant against all relevant chemical warfare agents with and without thickeners (HD, THD, GD, TGD, and VX) on CARC an NCARC panels (challenge 10 g/m²). With the required amount of decontamination agent (approx. 0.1 to 0.2 l/m²) for a complete decontamination and a reaction time of approx. 5 to 10 minutes on the surface to be decontaminated, combat tanks and other armoured vehicles can be fully detoxified using 10 to 20 litres of GDS 2000.

GDS 2000 meets the requirements for the OECD 28-day Ready Biodegradability Tests and has a biodegradation of 88 % within 28 days. The ecotoxicity is approx. 20 times lower than comparable C decontaminants at the basis of hypochlorites. In the meantime GDS 2000 is replacing the old DS2 decon solution in different armed forces.

2.2 B Decontaminant System

The BDS 2000 biological decontaminant system is based on a special thermally stable peracetic acid and is applied in the form of an aqueous foam for the decontamination of biologically contaminated surfaces, alternatively the active peracetic acid component is distributed by means of a thermal aerosol generator for the biological decontamination of compartment air (interior rooms). Peracetic acid is the only active agent which does not show any gaps in the spectrum of activity against any kind of microbial pathogens.

The studies carried out at independent test institutes confirm the distinct biological decontamination effect of the BDS 2000 system and its efficiency against anthrax and the highly pathogenic A-type bird flu viruses even at temperatures down to -30 °C.

Concerning the decontamination of anthrax spores the reduction factors are excellent. Using the BDS 2000 B decontamination foam (with a 2 % peracetic acid concentration and an exposure time of 30 minutes) the log reduction after surface decontamination was more than 7 (in 75 % of the tests measurements more than 7.5).

Influenza A virus was destructed in relative low concentrations and within very short contact times, not only in suspensions, but also on absorbent, porous, protein loaded surfaces like wood germ carrier. Reduction of temperature from 0 °C at to minus 5 °C did not affected virucidal activity. After the reduction of temperature onto minus 30 °C, minor losses on effectiveness were observed. Against this background, after properly cleaning (pre-treatment) the recommendation for the decontamination (disinfection) of influenza viruses is to use the BDS 2000 decontamination foam at least in a quantity of 0.4 litres per m² with a concentration of approx. 0.2 % peracetic acid with an exposure time of 15 minutes (at 0 °C) or 30 minutes (at minus 5 °C and minus 30 °C).

The BDS 2000 is free of residues and ecologically harmless. It disaggregates into acetic acid, water, and oxygen.
2.3 RN Decontaminant

The RDS 2000 radioactive decontamination agent was developed together with the Bundeswehr Research Institute for Protective Technologies and NBC Protection as part of a cooperation project, and is highly effective due to its specific combination of an aqueous surfactant solution system with appropriate complexing agents, oxidants or other auxiliary substances.

With regard to environmental compatibility, RDS 2000 meets the requirements of water pollution class 1 (low hazard for water). It is sufficiently stable during storage and ensures an optimal co-action of conventional cleaning, decontamination effect and userfriendly handling.

Tests carried out with the new RDS 2000 decontaminant prove its distinct effect in the radioactive decontamination of different radio-nuclides adhering to various types of painted and unpainted surfaces compared to other radioactive decontaminants used up to now. Using the RDS 2000 decontaminant, it is possible to improve the decontamination effect by up to 40 to 70 % compared to conventional RN decontamination agents.

3 Vacuum based CB Decontamination Technologies

The CB decontamination of sensitive optical and electronic equipment as well as components which cannot be treated using humidity or aggressive decontamination chemicals is carried out in a special vacuum chamber.

The vapour pressure is the physical parameter which defines the volatility, persistency and mobility of the chemical warfare agents. The conditions for removing chemical warfare agents from sensitive equipment are established by treating the objects to be decontaminated with vacuum and thermal energy.

The BC decontamination is based on the following procedures:

C decontamination:
- removing chemical warfare agents
  by evaporating and desorption from the surface of the equipment and
- immobilization e.g. in NBC-Filter units:
  - Temperatures: up to 70 °C
    (limited by the thermal resistance of the sensitive electronic equipment)
  - Vacuum: down to 1 Pa
    (Remark: Vapour pressure of VX: 14 Pa at 20 °C)

B decontamination:
- by degrading biological warfare agents and vectors (insects etc.)
  by pressure induced impact of gaseous B decontaminants
  - Temperatures: up to 70 °C
    (limited by the thermal resistance of the sensitive electronic equipment)
  - Vacuum: down to 1 Pa
  - B decontaminants: dosing of gaseous B decontaminants, depending
Complicated geometrical housing structures and surface sections that cannot be accessed by wet chemical decontamination are also reliably decontaminated in this way. Tests carried out show that the content of residual warfare agent and the acceptable desorption rate can be below the valid NATO test criteria depending on the equipment properties, kind of warfare agent to be decontaminated and decontamination conditions (vacuum, temperature), the vacuum based chemical decontamination technology represents practically a chemical-free “dry” decontamination of chemical warfare agents. Logistically complicated storage, transport and problematic handling of decontamination agents is not necessary. After the filling of the vacuum chamber the decontamination procedure runs practically automatically so that the personnel requirement is low in comparison.

With the new generation of vacuum technologies for B and C decontamination, integrated in the decontamination system TEP 90 and HEP 90 and tested at the Bundeswehr Research Institute for Protective Technologies and NBC Protection, decontamination systems for sensitive equipment are offered which defines the state of the art in this area and which fulfil the today's needs of modern NBC defence troops.