

Highly specific and advanced techniques such as nanoparticle technologies, chelation, enzymatic actions, and gel formulations may offer opportunities to complement conventional techniques. Some of the devices physically remove, neutralize, and the degrade contaminants (three in one).

24.6.1 PHYSICAL REMOVAL

Physical removal consists of the mechanical action of removing a chemical agent from the skin. This is performed by adsorptive powders, free or fixed on a substrate, but also by wipes brushes and some impregnated adsorptive tissues or plain adsorbent. This process remains conventional and essentially dry.

Dry decontamination uses adsorptive properties of powders or fabrics to passively remove contaminants from the skin surface and is especially effective for liquid contaminants.

24.6.1.1 Adsorbent Powders

Adsorptive powders are largely used in decontamination due to their specific surface area ($\text{m}^2 \cdot \text{g}^{-1}$) leading to highly adsorptive chemicals. Bleaching powders, mostly combined with adsorbing materials, provide the basis for skin decontamination (30). Nevertheless, powders are inappropriate for decontamination of mucous membranes (eyes) and wounds and may cause serious damage. Fuller earth, carbonaceous, activated or not, resins polymers mixture (XE-555), and activated alumina (A-200) are adsorbents with the capacity to encapsulate toxic agents (31).

24.6.1.2 Activated Alumina A-200/Sorbent Decon System (SDS)

Activated alumina is a potentially efficient adsorbent material for some chemicals because of its high adsorption capacity and removal efficiency at the implementation levels (32). The Sorbent Decon System is made of 65% aluminium oxide (33).

24.6.1.3 Fuller Earth (FE)

Fuller earth powder, an alumina silicate that is chemically inert, abundant in nature, and known for its adsorptive properties (35), provides decontamination opportunities for chemical, biological, radiological, and nuclear agents. Since prehistory there are indications that clays mixed with water have been used to cure wounds and soothe irritation as a method of skin cleansing (35). This might have been due to their mimicking animals e.g. pachyderms, many of which instinctively use minerals for these purposes. FE, recommended for skin decontamination, is provided as a powder in containers and prefilled gloves and may be applied onto skin after short chemical exposure (36). Clay minerals, consisting of hydrous layers of silicates, can be studied in terms of the function of their structure and composition, introducing it as a classification support tool (37). More than 20 years later, FE powder is, among other options, considered as the reference (38) in skin decontamination for mass casualties, as described in official French and European documents, and recognized as excellent for overall casualty decontaminant i.e. adsorbent for CWA (39). FE has been assessed *ex vivo* for its adsorption capacity and decontamination efficiency, comparing four different formulations in skin decontamination (27).

24.6.1.4 American Kit M291 – Carbonaceous Resins XE-555

A solid sorbent, the M291 skin decontamination kit consists of six foil-packaged, nonwoven fiber pads filled with 2.8 g of XE-555 carbonaceous resins with a total water content of 25 wt%. This nontoxic sorbent of high adsorption capacity was formulated for use where rapid decontamination is essential (40). Ambergard is a nonirritating skin decontaminant proposed by the U.S. Army for soldiers in battlefied situations (27, 28) and depends on competition between an ion-exchange resin and adsorption within the carbonaceous resin. XE-555 efficiency results may differ. Resins, made of a styrene/divinyl benzene copolymer, are composed of a high surface area carbonized macroporous styrene/divinylbenzene resin (the sorptive resin), a strong acid (sulfonic acid group) cation-exchange resin, and