Arsenicals

Some arsenic based compounds such as Lewisite, Adamsite and other arsines were used during the first world war and still others were investigated during World War II. Some arsenicals have also been manufactured as insecticides, but have now been banned in many countries because of toxicity persistence in the environment. The toxicity of arsenic and its compounds is not readily destroyed even through chemical reactions or incineration. Eventually some toxic residue must be returned to the environment. This problem is also common to many mining and smelting operations and a great deal of research into means for disposal of arsenic residues has been carried out. Arsenicals are normally roasted to AS_2O_3 and stored, usually underground. A few arsenic compounds have found commercial uses, and conversion of some warfare stocks to useful materials might be possible. Recently some uses have also been found for elemental arsenic.

Mustard

This compound is quite persistent in the environment. It is hydrophobic and does not tend to migrate within the soil. It is not readily attacked by soil micro-organisms. Examples are still being found of soils contaminated with mustard during World War II that yield potent vapour when freshly turned. Mustard is heavier than water and non-miscible and so forms a layer under it. Any hydrolysis which may occur at the interface is rapidly quenched by the acid formed. As a result mustard which has been disposed at sea will not be destroyed by the sea water should the container leak. It will tend to form a layer at the bottom. If released in deep water, it will presumably be incorporated eventually into the sea-bed as normal bottom deposits grow. However in shallow water, currents may move it towards shore or wave action could bring droplets to the surface. Munitions may be washed up on beaches or caught in fishing nets.

Mustard may be hydrolyzed above pH10 with heating and agitation but the disposal of the foul smelling products remains a problem. The Canadian experience with this technique will be described later in this paper. Mustard may be readily burned. In the atmosphere, this produces heavy black smoke filled with hydrogen chloride and sulphur acids. Perhaps the most reasonable disposal method is through contained incineration with good effluent scrubbing to remove the acids. Salts formed by neutralization are sufficiently harmless to be released to the environment. Useful incinerators are now commercially available and an incineration process is used in the United States Chemical Agent and Munitions Disposal System (CAMDS). A description of the CAMDS processes was provided during a visit to the Toole facility by the 6th Pugwash Workshop in CW disarmament May 1978 and copies of the Final Environmental Impact Statement, March 1977 containing technical details were distributed to its members. A further description of CAMDS was presented at the experts seminar held by the Ad Hoc Working Group on Chemical Weapons in June 1980.

Protein Toxins

This class of compound is derived from natural sources (puffer fish, shellfish, venoms, micro-organisms, castor bean, etc.) and contains the most toxic materials known, some of them orders of magnitude more toxic than the nerve agents. Most are untreatable. However they are normally solids which must be ingested for effect so have not been generally adopted for chemical warfare. Those of microbiological origin may be spread using the micro-organism as a vector in which case they are classed as biological agents and toxins in general are included under the biological warfare convention. Toxic proteins may be readily denatured and detoxified with heat usually above 100°C.