

progress will be made in the Committee on the basis of these achievements.

German Democratic Republic Working Paper Submitted to the Conference of the Committee on Disarmament: Catalytic Detoxification of Organophosphorus Chemical Warfare Agents, July 6, 1976¹

I. Introduction

The questions of banning the development, production and stockpiling of CW agents are closely related to the problem of detoxification of available stockpiles of CW agents. This problem has both scientific and technological implications.

From the scientific standpoint as well as from the technological one there exist quite different possibilities for the variety of CW agents to be converted into compounds of lower toxicity, or into completely non-toxic substances harmless to man and to the environment.

The problems have more intensively been studied for vesicants of the yperite type. Much experience relating to this type of CW agent has already been gathered because after World War I and II considerable quantities of these CW agents had been destroyed, detoxified or burned. But as to our information catalytic processes for detoxification had so far not been applied to these CW agents.

II. The detoxification of organophosphorus CW-agents by non-catalytic methods

However, the experience gained so far with organophosphorus CW agents is rather limited in regard to finding the most convenient method for detoxification on a technical scale.

The literature regarding both the military and chemical problems of detoxifying or destroying organophosphorus CW agents describes only those methods and processes which are suitable for either laboratory or special field use.

As to the destruction, or elimination of large stockpiles, or overstocked stockpiles of organophosphorus CW agents we have only press information on the United States action of submerging Sarin-filled shells in the Atlantic Ocean as well as on the burning of several thousand tons of "G-agents" (Tabun/Sarin/Soman-group). However, there were no additional technical details available worth generalizing.

Regarding the chemically possible reactions for detoxifying organophosphorus CW agents of the G- and V-type the splitting of esters in aqueous-alcoholic media by means of alkalis appears technically to be the most convenient method (apart from burning).

¹ CCD/506, July 6, 1976.

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Chemical reactions for detoxifying organophosphorus and V-type the splitting of esters by means of alkalis appears technically feasible (apart from burning).

Apparatus and equipment as well as chemicals required for detoxification are technically available although there remain some problems of corrosion and labour safety.

From the aspect of materials and resources it would be worth considering whether or not the use of many thousand tons of detoxicants, solvents and other chemicals required for neutralization reactions and other follow-up processes could be drastically reduced. Therefore, it is obvious to take into consideration catalytic processes of detoxification more than ever before.

III. *Detoxifications of organophosphorus warfare agents by catalytic methods*

It would be especially advisable to use catalytic reactions for the organophosphorus CW agents of the G- and V-type because all these CW agents are esters. Ester splitting is in general a catalytically easily influenced chemical reaction. In case of toxic organophosphorus esters the process of ester splitting is tantamount to their almost complete detoxification since the decomposition products show only slight, in some cases no, biological effects.

Among the theoretically possible methods of catalytic ester splitting there are three reactions which are essentially applicable to organophosphorus CW agents.

1. HYDROPEROXIDE CATALYSIS

The ester splitting of these organophosphorus CW agents catalyzed by hydroperoxide proceeds some 50 times faster compared with the alkaline hydrolysis of these compounds. The final products obtained through this reaction are only slightly toxic. The reaction is almost quantitative. However, the hydroperoxide catalysis implies the need as a homogenous catalysis, for an aqueous, or aqueous-alcoholic, or with water mixable organic reaction media, as an essential condition. The direct reaction of the concentrated CW agent is possible only in a 10 per cent hydrogen peroxide solution or less, or adequate hydroperoxide compounds solutions. Special equipments would be necessary to guarantee the required dilution and the best mixing conditions so that this process would need more technical research.

Nevertheless the catalytic splitting of organophosphorus CW agents by hydroperoxide constitutes a technically suitable reaction to destroy such CW-agents.

2. HYPOCHLORITE CATALYSIS

The splitting of organophosphorus CW agents catalyzed by hypochlorite is suitable for a number of detoxification processes provided these processes can proceed in diluted aqueous solutions. From the literature it is well known that this method is already tested in detoxification of corrosion-resistant objects through washing and in detoxifying small quantities of organophosphorus CW agents in drinking and non-potable water. The use of hypochlorite for the detoxification

of highly concentrated solutions of CW agents, or of undiluted CW agents necessitates more work in technical safety and adequate basic research.

3. METAL-CATALYZED DECOMPOSITION

The catalytic splitting of organophosphorus esters especially by heavy-metals has been known for some 20 years. The first observations were made in connexion with the loss of effect of phosphoric ester preparations in cupriferous containers. Apart from it, biochemical studies have shown that organophosphorus esters are catalytically splittable by a number of metals, e.g. even by lanthanides. Especially the hydroxy-aquo complex as well as the aminohydroxo and alkyl-amino complexes of copper have shown to be extraordinarily effective for splitting acyl-substituted phosphoric and phosphonic esters.

In this field the highly effective tetraalkyldiamino-copper complexes are practically important.

It is suggested by the rapidity and completeness of catalytic ester splitting achieved by these copper complexes, because the solubility of such complexes and the possibility of fixing these compounds to carriers should promote investigations of detoxification for concentrated CW agents of the G- and V-type.

IV. *Final remarks*

It should not and cannot be recommended here which of the mentioned catalytic detoxification methods of highly toxic organophosphorus CW agents would be especially convenient technically and economically.

However, in assessing the measures for CW disarmament required, the catalytic processes of detoxification deserve at any rate greater attention than the so far employed processes using an excessive surplus of detoxicants.

Upon concluding it should be stressed that the possibilities of catalytic splitting exemplified by organophosphorus CW agents can also be extended to other groups of CW agents. Research into this direction, in our view, could have promising prospects for obtaining technically usable results.

Czechoslovak Working Paper Submitted to the Conference of the Committee on Disarmament: Some Medical Aspects of the Chemical Weapons Problem and Its Perspectives, July 8, 1976¹

Much effort has been undertaken to elaborate an exact definition of CW agents.

¹ CCD/508, July 8, 1976.