Analyses Of Dioxins And Other Highly Toxic Substances Formed During Dismantling Of Mustard Gas Storage In The City Of Kambarka (Udmurtia) In 40-60-S

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Abstract

The analyses of possible ways of formation of dioxins and other highly toxic substances and the products of its oxidation under the condition of open burning of mustard gas have been performed. The open burning of mustard gas took place during dismantling of its storage in the city of Kambarka (Udmurtia) in the years between the 40s and the 60s. The net equations of the corresponding chemical reactions with the formation of dioxins and dibenzofuranes have been given.

Introduction

As it is known there is one of the largest storages of the poisonous substance containing arsenic - lewisite, close to the city of Kambarka (Udmurtia). Till 60-s on the territory of the same military division besides lewisite mustard gas was stored as well. The dismantling of the storage of mustard gas has being performed since the end of 40-s.

The technology of dismantling of the storage was clarified when some participants who still live in Kambarka were interviewed. Mustard gas was stored in the capital brick reservoirs, the so called "glasses". The reservoirs size usually was height - 8 m, diameter - 12 m, thickness of brickwork - about 1,2 m. On the outside the "glass" was covered with the layer of water glass and bitumen. The lower half of the "glass" was in the ground. In total there were about 20-30 of

such "glasses". The total amount of mustard gas in such a reservoir was about 400 tons.

The dismantling of the storage was performed as follows. The mobile fraction of mustard gas was pupmed out of the "glasses" and fed into tank cars. The main amount of such mustard gas was brought for destruction to Kazakhstan (railway station Aryis). The thickened fraction of mustard gas remained in the "glass". The general amount of it was about 20% from the original mass. The "glass" was filled in with chlorinated lime, then the brickwork was taken apart and the reactive mass was set on fire. The "glass" was burning out during 2 days. Then it was covered with the layer of earth which thickness was 1,5-2 m.

Results and Discussion

Based on the consideration of this method of dismantling of the storage of mustard gas the possible ecological damage can be evaluated as follows:

1. As far as the burning was performed on the surface of the reactive mass the completeness of burning out of the mass was complicated by the presence of hard products of calcium compounds after chlorinated lime had been used that were on the surface of the reactive mass as well. So there is no guarantee that the result of this process is complete destruction of mustard gas. At the place of the storage of mustard gas the bural formed, which can contain highly toxic substances.

2. In the process of burning in the open air of the reactive mass the formation of highly toxic substances, such as dioxins, for example, took place. As the result the territory around the storage of mustard gas was polluted with these substances.

3. Being exposed to heat the lower underground part of "glass" could have been destroyed and as the result the highly toxic substances could have penetrated into ground water, and diffusion of these substances into ground around the bural could take place.

To study the consequences, mentioned in paragraph 1 and 3, it is necessary to perform examination of the territory of the formed storage of mustard gas and around it in order to check the presence of highly toxic substances. At the same time we are able to perform qualitative analysis of the

reactions that take place when mustard gas is being burnt and also the analysis of the products of the oxidation process of mustard gas in order to confirm the statement 2.

The reaction of mustard gas (2,2'-dichlordiethylsulphide) burning in the excess of oxygen can be written as follows:

$$(C_2H_4Cl)_2S + 7O_2 = 4CO_2 + 4H_2O + Cl_2 + SO_2 \quad (1)$$

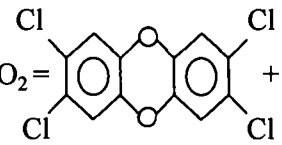
But if oxygen is in deficiency the reaction can be as follows:

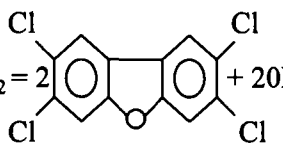
$$(C_2H_4Cl)_2S + 5O_2 = 3CO + COCl_2 + 4H_2O + SO_2 \quad (2)$$

Depending on the condition the following reaction can take place as well [1]:

$$Cl_2 + H_2O = 2HCl + 0{,}5O_2 \quad (3)$$

Besides under the condition of oxygen deficiency and at relatively low temperature the reaction can proceed with the formation of dioxins and dibenzofurans [2]. The reactions causing the formation of the most toxic substances, such as 2,3,7,8 - tetraclordibenzo-n dioxin and 2,3,7,8 - tetrachlordibenzofuran, can be written in the following way:

$$3(C_2H_4Cl)_2S + 9O_2 = \text{  } + 10H_2O + Cl_2 + 3SO_2 \quad (4)$$

$$6(C_2H_4Cl)_2S + 17O_2 = 2\text{  } + 20H_2O + 2Cl_2 + 6SO_2 \quad (5)$$

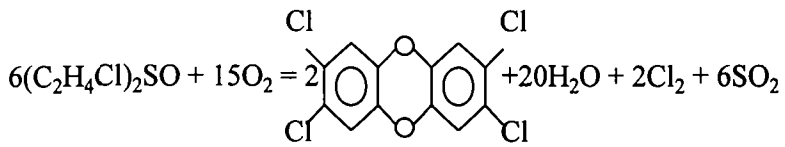
Besides these reactions results in the formation of halogenalkene and chloride of sulphur [3] and also in the formation of S-analogs of dioxins and dibenzofurans [2]. In general, when the direct burning of mustard gas is taking place not less than 15 substances are formed [4]. When the thickened mustard gas was processed by chlorinated lime it was oxidized to 2-chlorethylsulphoxide and 2-chlorethylsulphon. This reaction is strongly exothermic and under certain conditions self-ignition of unreacted mustard gas can occur [3]. The reaction of 2-chlorethylsulphoxide burning can be written in the following way:

$$(C_2H_4Cl)_2SO + 13O_2 = 8CO_2 + 8H_2O + 2Cl_2 + 2SO_2 \quad (6)$$

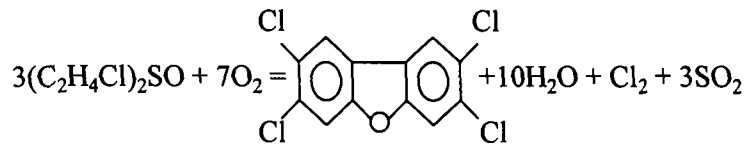
If there is deficiency of oxygen then the following reaction can occur:

$$2(C_2H_4Cl)_2SO + 9O_2 = 6CO + 2COCl_2 + 8H_2O + 2SO_2 \quad (7)$$

Same as with mustard gas sulphoxide can form dioxins and dibenzofurans. The reactions when the most toxic substances can be formed can be written as follows:



(8)



(9)

So when mustard gas and its products are burnt in the open air under the condition when the amount of oxygen and the temperature of the process are not controlled the reaction of oxidation of mustard gas could produce highly toxic (carbon monoxide, phosgene, dioxins, dibenzofurans and others) and cancerogenic (dichlorethane, chloroform, etc.) substances.

Literature Cited

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