Chemical Warfare Essay, Research Paper

Chemical Warfare

1.0 What are Chemical Warfare Agents?

Chemical weapons include any chemical substance, whether in a gaseous, liquid, or solid state, which can be used to cause loss of performance, permanent injury, or death in humans. These chemicals are commonly man-made toxicants, however, there is increasing research in the use of natural biological toxins as chemical warfare agents.

Many thousands of chemicals produced by humans are highly poisonous, however, only about seventy of these have been used in this century as chemical warfare agents. The reason for this lies in the criteria which a chemical must meet in order to be used as one of these warfare agents. These criteria include;

-the agent must be toxic enough to cause the desired effect, but must not be so toxic that it is too hard to handle,

-the agent should be able to be stored for relatively long periods of time without losing it s potency,

-it must be resistant to environmental conditions such as rain and oxygen,

-finally, it must be able to withstand a great deal of heat as the dispersal of these agents is usually accomplished with some type of bomb.

2.0 History of Chemical Warfare

The introduction of chemical warfare can be attributed to German chemist Fritz Haber who played a leading role in the development of poison gas during World War One. After much convincing he persuaded the Central Powers (i.e Germany, Turkey, etc.) to use chlorine gas to break through enemy lines. The Germans awarded him with an Officers rank and he went on to direct the first gas attack in War history. This attack which occurred on April 22, 1915, was the first of nearly 200 chemical attacks during the First World War. The Germans headed by Haber, discharged 180,000 kg of chlorine gas which either killed or caused the retreat of thousands of allied soldiers (Britian, France, Canada, etc.) thus creating a 8 km gap in the enemy line. Two days later in Ypres the Germans struck again with similar results, but this time on Canadian soldiers. Deaths over this two day period were estimated to be 5,000 with another 10,000 disabled.

In response to these gas attacks the allies called upon Major Charles Howard Foulkes of the Royal Engineers to develop a counter-attack. On September 25, 1915 the allies responded to German gas attacks with one of their own. Unfortunately the wind changed course and some of the gas made its way back to their own trenches, killing thousands of soldiers. The remaining gas however reached the German trenches proving lethal for numerous Germans as well. On December 9, 1915, with the winds again on their side, the Germans launched another gas attack on the Allied lines using chlorine gas and a new gas called phosgene. Phosgene was another chemical Fritz Haber and his colleges recognized as a effective weapon. Its lethal concentration was nearly 20 times as lethal as chlorine. Fortunately the Allies had anticipated the use of this chemical and had manufactured millions of gas masks referred to as P- Helmets. This foresight by the Allies saved millions of soldiers from inevitable death. Although several other types of gas were used chlorine and phosgene gas were the primary ones utilized by both the allies and central powers during the majority of the war.

It wasn t until July 12, 1917 that another prominent chemical weapon was introduced. The Germans attacked the Allies with what is commonly referred to as mustard gas . This weapon proved even more effective than the chlorine and phosgene and was the most lethal gas used during World War One. The Allies and Central Powers swapped gas attacks for the duration of the war killing nearly 100, 000 soldiers and injuring over a million others. The unfortunate part is neither the Allies or Central Powers gained any recognizable ground through usage of this war tactic.

3.0 Methods of Delivery

3.1 Charged Cylinders

The first poisonous gases utilized by Germany during the war were discharged from charged cylinders installed in their trenches. The success of such gas attacks depended upon a favorable wind which would carry the gas in high concentration slowly over the trenches of the unprotected allied troops. In order to discharge these gas filled cylinders soliders had to manually release the valve. Chlorine the first gas used, being denser than air, followed the topography of the land . Because of this hands on approach many self-contamination deaths occured using this delivery method.

3.2 Projectors

Projectors replaced the charged cylinder method. Explosives were put in the bottom of these cylinders and the gas placed on top. The cylinders were placed at an angle of 45 degrees in a trench or in some special area that offered protection. A large number of these projectors were placed in series and fired simultaneously using electricity. This permitted the discharge of a large quantity of poisonous gas on a relatively small target. A successful projector attack produced very serious results, and it could be carried out without much regard to wind velocity and direction. During nighttime attacks enemies could see the flash from the explosives thus giving ample warning to prepare by putting on gas masks and it also gave away the location of the attacker. Consequently, this method of using gas at a relatively short range limited attacks to daylight hours.

3.3 Hand Grenades

Hand grenades were used for delivering gas under certain situations, such as close combat fighting, but their use was so restricted that they did not account for many deaths.

3.4 Gas Shells

The modification which placed gas warfare on a very important military plane was the construction of the gas shell and the distribution of these shells by the use of artillery. All types of gases were being used in gas shells and the weather conditions had very little effect on delivery. Another benifit the gas shell had over all previous methods of delivery was its long range capabilities. After the use of gas shells had been brought into existence it was difficult for the soliders to determine if only high explosives were being used or whether a gas attack had also been launched. For this reason the soliders were forced to wear gas masks as soon as they were subjected to an air attack, and this in itself signifagantly reduced their fighting effectiveness.

4.0 Categories of Chemical Warfare Agents

Chemical warfare agents can be classified into one of seven groups dependant upon their chemical composition and the effects they have on humans. These seven categories are ( in order of seriousness); nerve agents, mustard agents, hydrogen cyanide, arsines, tear gases, psychotomimetic agents, and finally toxins.

4.1 Nerve agents

Nerve agents gain their name from the fact that they all affect the transmission of nerve impulses. The majority of these agents arose out of research begun in 1934 dedicated towards development of new pesticides. The preliminary result of this research was the discovery of organo-phosphorus compounds which turned out to be very effective in killing pests. Unfortunately, they were equally effective at killing humans. The military suddenly became interested in these compounds, and subsequently continued with the research into these deadly chemicals. In the end, over two thousand new organo-phosphorus compounds were developed. Of these, four were developed further to be used as chemical warfare agents.

Tabun was the first to be developed. It is the easiest and cheapest of all nerve agents to manufacture. For these reasons, it is the chemical weapon of choice for developing countries. Sarin and Soman were next to be developed and proved to be even more deadly than Tabun. Finally, in 1958 the most deadly of the nerve gas family was produced, namely VX. VX was not only more deadly, but was also more persistent and sticky , thereby remaining on anything it contacted.

All of these agents are colorless liquids in the pure state and have the same mechanism of action. The nerve agent can be either in gas, aerosol, or liquid form, and enters the body through both inhalation and dermal absorption. Generally, the agent works faster when it is absorbed through the respiratory system. VX gas is an exception to this rule as its effects occur more rapidly through dermal absorption. Regardless, the toxic effects are arrived at in the same manner, as these agents all inhibit the functioning of the enzyme acetylcholinesterase which is responsible for the breakdown of acetylcholine at neural junctions. Thus, acetylcholine builds up and eventually overloads the system. An outcome of death is almost certain and is usually due to paralysis of respiratory muscles. Other symptoms which may occur prior to death include cramps, vomiting, running eyes, convulsions, and involuntary discharge of urine and feces. The lethal dose and lethal concentrations are as follows;

LC50(mg.min/m3) LD50(mg/individual)

Tabun 200 4000

Sarin 100 1700

Soman 100 300

VX 50 10

4.2 Mustard Agents

Mustard agents are generally classified as blistering agents as the formation of blisters is a common effect. These agents can, however, also have serious effects on eyes, respiratory system, and various other internal organs. These agents were used for the first time during World War I to flush troops out of trenches, as mustard gas has a density greater than air.

Mustard gas does not smell like mustard, which is a common misconception. In fact, in its pure state it is colorless and almost odorless. The action of this agent is dependant upon its site of contact and its ability to covalently bond with other substances within the human body. It s blistering affects are also not usually immediate, and in fact, these symptoms are usually delayed between two and twenty-four hours after contact. Death from exposure to mustard agents is usually not due to the exposure itself, but is rather due to lung complications which develop later. One other serious effect associated with mustard agents is the development of cancer. These agents have the ability to break and bridge different sequences of DNA. If natural repair mechanisms are overwhelmed, uncontrolled cell growth may result in tumor formation.

The toxicity of mustard gas is as follows;

LC50- 1500mg.min/m3

LD50- 10000mg/individual

4.3 Hydrogen Cyanide

Hydrogen cyanide is a colorless liquid which has a high toxicity and rapidly leads to death in those exposed to it. Although it can be absorbed through the skin, the most important route of poisoning occurs through inhalation.

Hydrogen cyanides toxic effects are a result of its ability to bind and inhibit metal containing enzymes. For example, hydrogen cyanide inhibits the functioning of the enzyme cytochromoxidase which is necessary for the utilization of oxygen during cellular respiration. Since it is inhibited, normal cellular respiration ceases and cell death results. Although this action generally results in fatality, mild exposures may result in which symptoms such as vomiting, convulsions, headache, and giddiness appear. The effects and concentrations are as follows;

Concentration (mg/m3) Effect

300 Immediate death

200 Death in 10 min.

150 Death in 30 min.

120-150 Fatal in 30-60 min.

50-60 Endurable for 20-60 min. with few effects

20-40 Light symptoms after several hours of exposure.

4.4 Arsines

The main arsinic compound used as a chemical warfare agent is named Lewisite. Lewisite is a colorless liquid which smells like garlic. The symptoms which develop are very similar to that of mustard agents. In fact, Lewisite was invented by the Americans near the end of World War I to retaliate against the Germans use of mustard gas. The main difference is that unlike mustard agents in which symptoms can be delayed between two and twenty-four hours, the effects of Lewisite are immediate. Thus, development of effects may be more severe with mustard gas as the person may be unaware of what is occurring to their body.

4.5 Tear Gases

Tear gases, also known as lacrimants, are a group of compounds which incapacitate a person by inflicting pain to the eyes, and an uncontrollable flow of tears thus making it impossible to keep the eyes open. Three such gases have been used as chemical warfare agents, namely CN(chloroacetophenone), CR(dibenz b,f-1,4-oxazepine), and most commonly CS(ortho-chlorobenzlidene-malonitrile). All of these compounds exist as white solids and are dissolved in organic solvents to be dispersed as aerosols.

The action of tear gases is immediate, causing pain in the eyes, flow of tears, and ultimately cramping of the eyelids. These gases in high concentrations, however, can also affect the nose, throat, airways, and skin. All of these effects are dependent upon the agent acting upon the nerves found within mucous membranes and skin. Here, the agent causes uncontrollable nerve firing, and hence uncontrollable tear production.

Although serious injury and death could occur at certain concentrations, these are so high that these effects are made highly unlikely. Also, these compounds are not believed to have any negative effects on genetic material of fetal development. For these reasons, the terms threshold concentration (TC) and intolerable concentration (IC) are generally used rather than lethal concentration and lethal dose in expressing the efficiency of tear gas as a chemical warfare agent. A TC50 therefore implies the concentration at which 50% of those exposed show a perceivable effect. The IC50 refers to the concentrations at which 50% of those exposed feel the effects to be intolerable. The TC50 and IC50 for the three main tear gases given above are as follows;

CN CS CR

TC50 (eyes) 0.3 0.004 0.004

TC50 (airways) 0.4 0.023 0.002

IC50 20-50 3.6 0.7

4.6 Psychotomimetic Agents

Psychotomimetic agents are a relatively small class of chemical warfare agents which have generally lost interest over the years. These agents are substances which essentially make those which are exposed high , leading to symptoms of rigidity, hallucinations, loss of feeling, etc. Although these compounds can possibly lead to death through respiratory depression, their purpose is to temporarily incapacitate their victim. One example, Phencyclidine, causes symptoms of disorientation, loss of body control, loss of feeling, etc. at relatively low doses. At very high doses, however, the exposed can slip into a coma, respiratory depression, and death.

4.7 Toxins

Toxins are those chemical compounds which are produced naturally by living organisms such as fungi, bacteria, algae, etc. Although these compounds are place at the bottom of the list for seriousness in relation to chemical warfare agents, they are among the most deadly chemicals in the world. Often, these compounds have a toxicity many times greater than the most serious and deadly man-made chemical warfare agent, namely the nerve agents. Why then are they placed at the bottom? The reasoning is that these toxins are hard to produce in large enough quantities to be used as chemical warfare agents. This may change, however, as advances in biotechnology occur.

With the advent of new techniques of modifying the genes of living organisms to obtain new end products came the ability to also induce the production of more end product. As an example, botulism toxin produce by the bacteria Clostridium botulinum is the most toxic substance to man, with less than one microgram causing certain death. Within recent years, this bacteria has been modified to produce much larger quantities of the toxin such that it can be gathered and marketed as a chemical to aid in squinting, muscular disorders, and even cosmetically for reducing the appearance of wrinkles. This same toxin could also be gathered and used as a chemical warfare agent. Therefore, although natural toxins are still at the bottom of the list, in the very near future they may indeed move to the very top.

5.0 Conclusion

Human kind has throughout all of history used poisons as a method to incapacitate or kill enemies. It was not until this century, however, that deadly chemicals were used on such a large scale to aid in the winning of wars. Over the years after these wars, our understanding and discovery of these deadly poisons has increased greatly. With this, so too has the potential lethality of these chemicals. It is unfortunate that this knowledge which can also be used for good purposes can also be used as a weapon of great lethal force.