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CHEMICAL WARFARE

After learning about Nuclear and Biological warfare, lets now understand Chemical warfare. Chemical warfare (CW) involves the use of toxic properties of chemical substances as weapons. Chemical agents are inorganic substances used in warfare to attack the organs of the human body in order to prevent the human body from functioning at all or to hinder its normal functioning. The results are usually disabling to a varying degree, or fatal. However, with proper protective equipment, training, and decontamination measures, the primary effects of chemical weapons can be overcome.

As per UN conventions, use of chemical weapons is banned. In recent incidents in Syria, chemical weapons affected a number of civilians. Even though there is a convention and ban on its use, chemical weapons can be used by countries. Therefore, it is important that we learn about chemical weapons and means of defence against it.

Objectives

After studying this lesson, you will be able to:

- classify the chemical agents on the basis of criteria and types;
- know the factors on which the duration of effectiveness depends;
- explain the types of chemical agents based on their effectiveness;
- identify the effects of chemical agents on the body;
- explain the characteristics and symptoms of agents like Merue agents, Blister agents, Blood agents and choking agents;
- take protective measures against the various main groups of chemical agents and
- appreciate the requirements of a good chemical warfare agent.

14.1 Types of Chemical Agents

Chemical warfare includes the use of toxic chemical compounds in warfare as also the methods of combating such agents. Chemical warfare is as dreadful as nuclear warfare.

It is imperative for the modern soldier to be able to understand the hazard of chemical weapons and the protective measures required to be able to survive in such an environment to be able to continue fighting effectively. The capability to wage chemical warfare is well within the means of several nations that cannot afford a nuclear armory and this poses a serious threat.

14.1.1 Types of Chemical Agents

Chemical agents are classified according to the following criteria: -

(a) Military use and Effects on the body

(b) Duration of effectiveness.

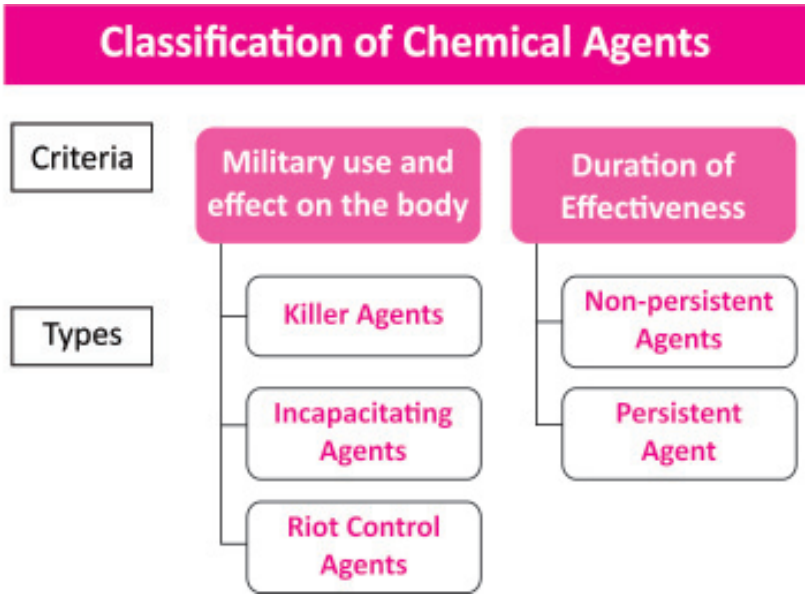

Table 14.1 - Classification of Chemical Agents

14.2 Duration of Effectiveness

The duration of effectiveness, that is the time for which the effects lasts, depends on many factors such as: -

(a) The physical characteristics of the agent.

(b) The amount of agent delivered and its physical state.

(c) The weapon system used.

(d) The weather in the target area at the time of the attack and afterwards.

Note

14.3 Types of Chemical Agents Based on Effectiveness

Have you seen dew on grass or leaves in the morning? The dew is water droplet, which forms on leaves due to condensation in the atmosphere. Consider the dew drops as chemical agents. Then some chemicals disappear quickly like the dewdrop. These agents are called non-persistent agents. Other chemical agents remain in the atmosphere and on the objects where it was sprayed. These agents are called persistent agents. From the point of view of duration of effect the agents may be classified as follows: -

(a) **Non-Persistent Agents:** These agents disperse rapidly after release and present an immediate short duration hazard e.g. G agents (Nerve Agent), Hydrogen Cyanide (Blood Agent) etc.

(b) **Persistent Agent:** These agents continue to present a hazard for a considerable period after delivery by remaining a liquid contact hazard and by continuing to produce vapour by the evaporation of the liquid e.g. V agents (Nerve Agents), Sulphur Mustard (Blister Agent).

14.4 Effects on the Body

The third method of classification is to group agents by their action and effect on the body. Such groups are as follows:

(a) **Killer Agents:** These agents are used to kill humans and are deadly/ fatal. These are further classified as:-

(i) **Nerve Agent:** These interfere with the nervous system and thus disrupt essential body functions like breathing, muscular control and vision. E.g., TABUN (GA), SARIN (GB), SOMAN (GD) and V agents.

(ii) **Blister Agents:** These agents cause inflammation, blistering of the skin and superficial destruction of contaminated internal tissue, e.g., the lining of the breathing passage. Although classified as killers, blister agents do not cause death except in extreme cases. Examples are Mustard Gas (HD), Nitrogen, Mustard (HN 1 to HN 3) and Lewisite (L).

(iii) **Blood Agents:** These prevent body tissue from using the oxygen in the blood. E.g., Hydrogen Cyanide (AC), Cyanogen Chloride (CK) and Arsine (SA).

(iv) **Choking Agents:** These attack the breathing passage and lungs. E.g., Phosgene(CG), Di-phosgene (DP) and Chloropicrin (PS).

(b) **Incapacitating Agents:** These agents cause temporary incapacitation of individuals. They affect the normal human body functioning for a short duration.

Note

They are further classified as:-

(i) **Nose (Vomiting) Agents:** These cause irritation in the nose and throat, which can lead to vomiting.

(ii) **Mental Incapacitates:** These cause temporary mental disturbances, usually preceded or accompanied by physical effects.

(iii) **Physical Incapacitates:** These cause temporary effects such as fainting or paralysis, unaccompanied by mental effects.

(c) **Riot Control Agents:** Agents selected and approved for use when giving aid to the civil power and in similar operations. These are mostly the incapacitating agents such as CS. These are also referred to as 'tear' agents. These cause irritation of the eyes, flow of tears and a stinging sensation.

Intext Questions 14.1

1. Fill in the blanks.
   (a) The criteria used to classify the chemical agents are _____, _____ and _____.
   (b) _____ agents are used when giving aid to the civil power and in similar operations.
   (c) From the point of view of duration of effect, the agents may be classified as _____ and _____.
   (d) The most dangerous of the lethal chemical agents are the _____ agents.
   (e) _____ agents cause inflammation, blistering of the skin and superficial destruction of contaminated internal tissue, e.g., the lining of the breathing passage.
2. Differentiate between persistent and non-persistent chemical agents.

14.5 Characteristics of Agents

The main groups i.e., the Nerve, Blister, Blood, Choking and Incapacitating (Vomiting Agent) are discussed in the succeeding paragraphs.

I. Nerve Agents: The most dangerous of the lethal chemical agents are the nerve agents. These act in the body by blocking the enzyme system, which is concerned with the nervous control of the brain. The known agents are classified as either V (Persistent) or G (non-persistent) agents.

(a) V Agents: The persistent nerve V agents are colourless and relatively in

Note

volatile liquids, which slowly emit an odorless toxic vapour. Their viscosity is same as that of a light lubricating oil and their persistency is such as to make them extremely hazardous as a liquid or as an aerosol, which can be inhaled, absorbed through the skin or swallowed with contaminated food or water. The standard persistent agent is VX.

(b) **G Agents:** The non-persistent G agents, which are also colourless and odorless, are in contrast to the V agents, highly volatile and they vaporize rapidly to form a highly toxic cloud. Their viscosity is somewhat same as that of petrol and their volatility makes them generally unsuitable for dissemination in liquid or aerosol form. They are therefore diffused as vapours, which attack through the eyes and respiratory tract, but may also penetrate normal clothing to attack through the skin. Although vapour is the most likely hazard, liquid G Agents coming directly in contact with the skin are also lethal. The standard non-persistent agent is GB.

(c) **Symptoms of Nerve Agent Poisoning;** The order of the onset of the symptoms of nerve agent poisoning varies with the type of attack. With vapours, dimness of vision with pinpointed pupil occurs early; when absorbed through the skin, nausea and vomiting occur in the early stages. Later, irrespective of type of attack and unless preventive measures are taken, convulsions and paralysis set in, followed by eventual death. Following large doses, death may occur within minutes.

II. **Blister Agents:** Mustard (HD) is used as the principal blister agent.It gives off an invisible vapour having a slight but characteristic odour of garlic. Mustard (HD) can be used in liquid or vapour form. It can seriously damage the eyes, respiratory passage and skin if these are unprotected. Liquid mustard will penetrate normal clothing in a few minutes; vapour takes considerably longer time. Liquid mustard on the skin causes large blisters after about eight hours, whereas the vapour causes small blisters in the form of a rash, which takes much longer, sometimes even days to develop. Internal injuries will also result due to the consumption of contaminated food and drink. Mustard in field concentrations is normally lethal and a high casualty producer. It is normally disseminated as a liquid or aerosol and attacks through both the skin and the respiratory tract.

Symptoms of Blister Agents :

These vary with time and are described below: -

(a) In the 20-60 minutes after exposure, nausea, vomiting and burning and watering of the eye have occasionally been observed.

(b) In the next two to six hours, nausea, vomiting, headache, inflammation of

Note

the eyes, excessive watering from the eyes, reddening of face and neck, soreness of throat, increase in pulse and respiration are observed.

(c) After 24 hours of exposure, there is a general increase in severity of above effects. Inflammation of inner thighs, axilla, genitalia, tocks, followed by onset of blister formation - blisters are large, filled with yellow fluid and may be pendulous.

(d) After 48 hours, the blistering becomes more marked. Swelling of genitalia, bronchitis, expectoration of mucous and dead cells with increased temperature is observed.

III. Blood Agents: Blood agents are mostly used as vapours and the usual entry route is through the respiratory system. They produce their effects by interfering with some of the vital body functions. In the liquid form the skin can absorb them. Hydrocyanic Acid (AC) and Cyanogen Chloride (CK) are the important agents in this group. Blood agents affect the respiratory system causing inflammatory changes leading to pulmonary edema and stop of breath besides local effects such as irritation of the eyes.

Symptoms of Blood Agents :Inhalation of AC or CK in sufficient quantity may produce symptoms within seconds and death within minutes. Acute poisoning is characterized by: -

(a) Dizziness.

(b) Headache.

(c) Palpitation.

(d) Anxiety.

(e) Ataxia, paralysis and coma.

(f) Cardiovascular collapse, respiratory arrest, convulsions and metabolic acidosis are seen in severe cases.

IV. Choking Agents: These are chemical agents, which attack the lung tissues causing pulmonary edema. The most common choking agent is Phosgene, which is a non-persistent chemical agent. It is a colourless gas with a suffocating odour reminiscent of moldy hay. Phosgene is rapidly hydrolysed in water leading to the formation of hydrochloric acid, which is corrosive, affects lung tissues and damages the capillaries. This is followed by seepage of fluid into the air sacs, leading to pulmonary edema.

Symptoms of Choking Agents:

The symptoms are delayed and initially no symptoms are observed for two to

Note

three hours. The effects of agent start showing as follows: -

(a) A mild irritation of eyes (lachrymation)

(b) Soreness in the throat.

(c) Coughing, tightness of chest.

(d) Nausea, vomiting and headache.

(e) There is a symptomless period before pulmonary odema sets, which is indicated by: -

(i) Uneasiness, cough with white and yellow sputum.

(ii) Nausea, vomiting, gastric pain.

(iii) Rapid breathing and cardiac failure.

(f) The victim collapses and suffers spasmodic convulsions. Severe cases show unconsciousness followed by death.

14.6 Protective Measures against Nerve Agents, Blister Agents, Blood Agents and Choking Agents

The respirator gives complete protection to the eyes, nose, throat and lungs against the vapour. Holding the breath till the mask is donned is also effective. The IPE/PPE made up of non-permeable material provides some amount of protection against entry through the skin. If contaminated by the liquid, one can avoid becoming a casualty by carrying out personal decontamination drill. Decontamination of affected equipment or ground by weathering is a slow process and so chemical decontaminants should be used.

I. **Incapacitating Agent:** The non-lethal, incapacitating psycho-chemicals produce physical or mental effects of sufficient severity, to prevent men from carrying out their normal tasks. The duration of effect could be as brief as several minutes, although it could last for several days in certain cases. Recovery is complete and there are normally no after effects. The respirator affords full protection against the incapacitating agents.

II. **Riot Control Agents:** CS Agent is mostly used as the riot control agent. It is a white crystalline solid, which is disseminated as an aerosol.This causes intense irritation of the eyes, accompanied by copious tears, a stinging of the skin and a burning sensation in the throat and lungs, with pain and difficulty in breathing in more severe cases. The effects are immediate and although they disappear rapidly in fresh air. CS agent attacks through the eyes and respiratory tract, but is a truly non-lethal agent. The respirator or gas mask provides complete protection against such agents.

14.6.1 Mode of Delivery of Chemical Agents

The CW agents may be disseminated in one or more of the following forms: -

(a) Liquid droplets or spray, like rain.

(b) Liquid aerosols, like a fine mist, small enough to be inhaled.

(c) Very small particles of solids, like smoke.

(d) Vapour or true gas.

14.7 Requirements of a Good Chemical Warfare Agent

A CW Agent must possess following requirements to be effective:-

(a) **High Toxicity:** The extent to which a chemical agent affects a person depends upon the toxicity of the agent and the time to which he is exposed. Hence a suitable chemical agent must have high toxicity. It must also, preferably, affect more than one organ of the human body simultaneously.

(b) **Quick toAct:** Since the degree of injury also depends upon the time of exposure, the agent must not only be highly toxic but should also be fast acting.

(c) **Non-perceptible to Human Senses:** The target population must not realise that they have been subjected to a chemical attack.

(d) **Non-availability of Antidote:** The enemy should not have an effective antidote.

(e) **Controllable Dissemination:** The agent should be capable of being delivered by more than one delivery system and disseminated at the target in more ways than one, on target or off target, in vapour or aerosol form.

(f) **Volatility and Persistency:** Highly volatile agents are generally non- persistent. If persistent agents are required, the chemical must not be volatile.

(g) **Capacity to Penetrate:** It should enter the human body through inhalation or skin ingestion.

(h) **Non-detectable:** It must be difficult to detect.

(j) Availability of raw materials and economy and ease of manufacture.

(l) Stability in storage.

(m) **Purity:** The final product must be a pure substance since impurities would degrade its effectiveness.

(n) **Detonation Stability:** The agent must not be destroyed by the heat and blast of detonation.

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(o) **Suitable Vapour Pressure:** The chemical must be capable of being released at high pressure.

(p) **Ability to be Aerosolized:** Aerosols are very fine droplets in the air, small enough to be inhaled or to penetrate through clothing and skin.

(q) **Miscibility and Solubility:** Miscibility is the ability of an agent to be mixed with other compounds whereas solubility denotes its ability to be dissolved for the preparation of a solution.

Intext Questions 14.2

1. What are the protective measures against the CW agents? Suggest any three measures.
2. Mention any five basic requirements of a good chemical warfare agent?
3. Write two symptoms each of blood agents and choking agents.

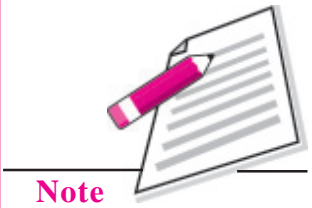
ACTIVITY 14.1

Watch the "Chemical Warfare: Nerve Agents 1964 US Army Training Film" at https://www.youtube.com/watch?v=vsfUEgoFA6o.

What You Have Learnt

In this lesson you have learnt about the term Chemical Warfare. Important points of the lesson are as follows:-

- The science behind chemical agents wherein, types of Chemical Agents, Characteristics and Effects were analysed;
- The military use of the chemical agents in which, the military classification, duration of eeffectiveness and their classification based on Effectiveness;
- Effects on the body when agents such as Blister agent, Nerve agents come in contact with the human body and protective measures to be taken;
- The military requirements of a chemical warfare agent and the mode of delivery.



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Terminal Exercises

1. Write short notes on
   (a) Persistent and Non Persistent Agents
   (b) Incapacitating Agent
   (c) Nerve Agent
   (d) Riot control Agents
2. Explain the factors that affect the duration of effectiveness of a chemical agent?
3. What are the modes of delivery of chemical agents?
4. What are the symptoms if Blister agents are used?
5. Classify the killer agents on the basis of their action and effect. Also give examples of each.

Answers to Intext Questions

14.1

1. (a) Military use, Duration of effectiveness and Effects on the body.
   (b) Riot control Agents
   (c) Non-Persistent Agents and Persistent Agent.
   (d) Nerve agents.
   (e) Blister agents
2. Persistent agents continue to remain in the area for a long time. They are hazardous when touched. Non persistent agents disperse quickly and are effective only for a short duration of time.

14.2

1. Gas Mask or Respirator, Protective clothing and personal Decontamination.
2. (a) High toxity
   (b) Quick to act
   (c) Capacity to penetrate
   (d) Detonation stability

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(e) Miscibility and solubility

3. (a) Blood Agents: Dizziness, headache, palpitation, anxiety

(b) Choking Agents: A mild irritation of eyes, coughing tightness of chest, soarness in the throat, vomiting & headache