CHEMISTRY

44 Gases Used in World War; New Ones Promised for Next

Chlorine, Bromine, Arsenic and Ethyl Radicle Figure Prominently in Numerous Lethal Compounds

HERE are the most important known poison gases which have been found effective in warfare. Many of them were developed and used during the World War. Others, in addition, will be used if war now comes to Europe.

1. *Mustard Gas.* Chemically is dichloroethyl sulfide. In pure state almost odorless. In World War smelled like mustard or garlic. Heavy, oily liquid of dark straw color. Evaporates slowly at ordinary temperatures. Thus a persistent type of gas. Frequently diluted with another poison, chloropicrin, to keep it liquid in colder weather. Has delayed action on body. First symptoms itching and blistering. Especially damaging to eye's cornea. In eye, tissue degeneration begins two minutes after exposure to dilute concentrations. If gas is swallowed symptoms of nausea, vomiting and diarrhea develop. Gas very penetrating. Goes through ordinary clothing, rubber and even leather. Is 50 times as toxic as chlorine.

2. *Chlorine Gas.* First gas used in World War. Two and a half times as heavy as air. Clings to ground. Fills shell holes, depressions and dugouts. Greatest action occurs in presence of moisture. Major action is on respiratory tract with symptoms of choking, coughing and suffocation.

3. *Phosgene Gas.* A combination of carbon monoxide and chlorine. Resembles chlorine in action but has a more delayed effect. Is ten times as toxic as chlorine. First symptoms very minor. Its effectiveness mainly due to initial innocuous character. Its menace is revealed only after considerable gassing has occurred.

4. *Lewisite.* Known chemically as chloro-vinyl-dichloro-arsine. Developed secretly during World War by Capt. W. Lee Lewis of U. S. Chemical Warfare Service. War ended just before gas entered combat use. Has all blistering properties of mustard gas but more effective because it has ability to penetrate the skin. Three drops, placed on rat's abdomen, causes death in two to three hours. Is powerful respiratory irritant. Produces violent sneezing. Another variety called beta-beta-prime-chloro-vinyl-dichloro-arsine has less blistering effect but its irritation on respiratory system is much more severe.

5. *Toxic smokes.* Chemically are diphenyl-chloro-arsine and diphenyl-cyano-arsine. Popularly called sneezing gas. Are really finely divided dusts. Can pass through ordinary gas masks unless special filter attachments are provided. Effective in concentrations of one part in 10,000,000, of air. In higher concentrations cause vomiting. Considered as poisonous as phosgene in equal concentrations.

6. *Crying Gas.* Twenty-three different varieties used in World War. All intended to produce temporary disability and confusion. Favorite German lachrymatory gas was xylyl bromide. Among Allies chloropicrin was widely used.

In all some 44 individual gases and mixtures of gases were employed by the combatant nations from 1915 to 1918. Their names follow:

Acrolein; arsenic chloride; benzyl iodide; benzyl chloride; bromoacetone; bromobenzylcyanide; bromomethylethylketone; benzyl bromide; chlorine; chlorosulfonic acid; chloroacetone; chlorobenzene; chloropicrin; cyanogen bromide; dichloromethylether; diphenylchloroarsine; dichloroethylsulfide; ethyldichloroarsine; ethyliodoacetate; hydrocyanic acid; methylchlorosulfonate; monochloromethylchloroformate; phosgene; phenylcarbylamine chloride; trichlormethylchloroformate; stannic chloride; sulfuric anhydride; xylyl bromide.

And mixtures of: bromoacetone and chloroacetone; chlorine and phosgene; chlorine and chloropicrin; chloropicrin and hydrogen sulfide; chloropicrin and stannic chloride; chloropicrin and phosgene; dichloroethyl sulfide and chlorobenzene; ethyl carbazol and diphenylcyanoarsine; ethyldichloroarsine and dichloromethylether; ethyliodoacetate and alcohol; hydrocyanic acid, chloroform and arsenious chloride; hydrocyanic acid, arsenious chloride, stannic chloride and chloroform; phosgene and arsenious chloride; dichloroethyl sulfide and carbon tetrachloride; phosgene and stannic chloride; methyl sulfate and chloromethyl sulfate.

Science News Letter, January 28, 1939

ENGINEERING

Industrial Research Cuts Costs to Consumer

INDUSTRIAL research does many things but where it comes nearest to most folks is in the improved quality of many products and in lowered costs to the ultimate purchaser.

Back in 1918 we bought what we thought was a pretty good rubber tire for our automobiles whose rate of wear was such that for every mile the car traveled it took 2.15 cents out of our pocket. Today, twenty years later, automobile tire cost per mile of travel is less than a third of a cent.

Intensive research on the ways to produce a longer wearing, more rugged rubber and on ways to fabricate more easily and with greater control over the quality of the output, is the answer.

In comparable fashion is the automobile itself. In 1925 a good car, by the standards of that day, cost $1,000. Twelve years later, in 1937, a better car sold for only $700.

Before the forum of the American Engineering Council, T. A. Boyd of the research division of the General Motors Company cited these examples of what research can do for the consumer.

Reviewing research progress over various lengths of time, Mr. Boyd noted the following lowering of costs:

Research over a period of between 10 and 14 years:

Electric refrigerators dropped in cost from $334 to $169, telephone message for 970 miles decreased from $7.50 to $2.75, rayon yarn from $2 a pound to 50 cents a pound, ammonia from 7.5