

How chlorine became a chemical weapon

September 8 2016, by Simon Cotton



Chlorine gas. Credit: W Oelen/Wikimedia, CC BY-SA

New claims that the Syrian government have dropped barrel bombs full of chlorine [on a suburb of Aleppo](#) are the latest in a series of allegations of chemical weapon use. Although the Syrian government denies using chemical weapons, a recent UN-led enquiry found it had used chlorine on [at least two occasions](#).

Here's what you need to know about [chlorine](#) and its use as a chemical weapon.

Greenish-yellow gas

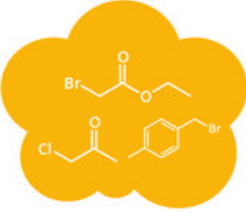

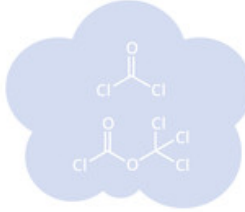
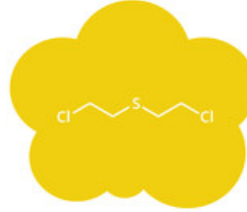
The chemical element chlorine is too reactive to exist on its own in nature, but some of the compounds that contain it are essential to life. We use hydrochloric acid (HCl) in our stomachs to break down food and destroy bacteria, while sodium chloride (NaCl) – the common salt we add to food – is so important that it was once used as a currency.

Pure chlorine was first isolated from [hydrochloric acid](#) by Carl Wilhelm Scheele in 1774. Within a few years, its bleaching properties were discovered and in 1810 Humphry Davy announced that it was a chemical element. At room temperature, it is a greenish-yellow gas with a choking smell, which is denser than air.

Dry chlorine gas won't bleach, but in water it forms hypochlorite, responsible for the bleaching action, and also responsible for its disinfectant action. It was first used to [disinfect tap water](#) at the time of a typhoid outbreak in Maidstone in 1897. Since then the process has been generally adopted.

CHEMICAL WARFARE WORLD WAR I

WORLD WAR I IS SEEN AS THE DAWN OF MODERN CHEMICAL WARFARE, WITH A VARIETY OF DIFFERENT CHEMICAL AGENTS BEING EMPLOYED ON A LARGE SCALE, RESULTING IN APPROXIMATELY 1,240,000 NON-FATAL CASUALTIES, AND 91,000 FATALITIES. A VARIETY OF POISONOUS GASES WERE USED THROUGHOUT THE CONFLICT, WITH EACH HAVING DIFFERING EFFECTS UPON VICTIMS.

 <p>TEAR GASES (ethyl bromoacetate, chloroacetone & xylol bromide)</p> <p>SMELL & APPEARANCE Both ethyl bromoacetate and chloroacetone are colourless to light yellow liquids with fruity, pungent odours. Xylol bromide is a colourless liquid with a pleasant, aromatic odour.</p> <p>EFFECTS Tear gases are what is known as 'lachrymatory agents' - they irritate mucous membranes in the eyes, mouth, throat & lungs, leading to crying, coughing, breathing difficulties, and temporary blindness.</p> <p>FIRST USED 1914 In August 1914, the French forces used tear gas grenades against the German army, to little effect.</p> <p>ESTIMATED CASUALTIES 0 fatal These gases were used to incapacitate enemies rather than to kill; symptoms commonly resolved within 30 minutes of leaving the affected area.</p>	 <p>CHLORINE</p> <p>SMELL & APPEARANCE Chlorine is a yellow-green gas with a strong, bleach-like odour. Soldiers described its smell as 'a distinct mix of pepper and pineapple'.</p> <p>EFFECTS Chlorine reacts with water in the lungs, forming hydrochloric acid. It can cause coughing, vomiting, and irritation to the eyes at low concentrations, and rapid death at concentrations of 1000 parts per million.</p> <p>FIRST USED 1915 Used by German forces at Ypres in April 1915. British forces used it for the first time at Loos in September.</p> <p>ESTIMATED CASUALTIES >1,100 Chlorine was devastating as troops were initially unequipped to deal with it. Later, gas masks limited its effectiveness.</p>	 <p>PHOSGENE & DIPHOSGENE (carbonyl dichloride & trichloromethane chloroformate)</p> <p>SMELL & APPEARANCE Phosgene is a colourless gas with a musty odour comparable to that of newly mown hay or grass. Diphosgene is a colourless, oily liquid.</p> <p>EFFECTS React with proteins in lung alveoli, causing suffocation. Cause coughing, difficulty breathing and irritation to the throat & eyes. Can cause delayed effects, not evident for 48hrs, including fluid in the lungs & death.</p> <p>FIRST USED 1915 In December 1915, the German forces used phosgene against the British at Ypres.</p> <p>ESTIMATED CASUALTIES 85% It's estimated 85% of all gas-related fatalities in World War I resulted from phosgene and diphosgene, which were both used to fill artillery shells.</p>	 <p>MUSTARD GAS (bis(2-chloroethyl) sulfide)</p> <p>SMELL & APPEARANCE When pure, mustard gas is a colourless and odourless liquid, but it's used as a chemical agent in impure form. These are yellow-brown in colour and have an odour resembling garlic or horseradish.</p> <p>EFFECTS Powerful irritant and vesicant (blistering agent) that can damage the eyes, skin, & respiratory tract. Causes chemical burns on contact with skin, forms intermediates that react with DNA leading to cell death.</p> <p>FIRST USED 1917 On 12th July 1917, German forces used mustard gas against the British at Ypres.</p> <p>ESTIMATED CASUALTIES 2-3% The mortality rate of mustard gas casualties was low, but its effects were debilitating, and patients required elaborate care.</p>
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Forty million tons of chlorine is manufactured a year, among other things for use in making many pharmaceuticals. Thousands of organic chlorine compounds occur naturally including vancomycin, which for many years was the antibiotic of last resort and is [made in nature](#) by a bacterium in the soil.

Health dangers

But chlorine itself is [very reactive with the human body and very toxic](#). It irritates the eyes and skin and, even at quite low levels, can causes

permanent lung damage even if it does not kill you. Breathing high levels of chlorine causes pulmonary oedema – fluid buildup in the lungs.

[Accidents with chlorine](#) do happen. In Graniteville, South Carolina, on January 6 2005, a railroad tanker full of liquefied chlorine gas was punctured [killing eight people](#) that day, with another fatality three months later attributed to inhaling the gas. More than 5,000 people were evacuated from its immediate vicinity and some have health problems more than ten years later.

Use as a weapon

[Fritz Haber](#) (1868-1934) knew about the toxicity of chlorine when he chose it as his agent of warfare in 1915. He had already come up with the [Haber-Bosch process](#), patented in 1910, for the fixation of nitrogen as ammonia, which won him the 1918 Nobel Prize in chemistry. This made the manufacture of artificial fertilisers possible and the survival of millions of people today depends on it.



British chlorine gas casualties April 1915. Credit: Thomas Keith Aitken/Imperial War Museum

But it also enabled the mass production of nitric acid, source of the explosives that Germany used in World War I. Haber was an intensely patriotic German Jew. He was head of the chemistry section in the Ministry of War, coordinating the production of ammonia needed to fight the war. He was also in charge of chemical warfare, choosing [chlorine gas](#) as the agent.

Haber supervised the installation of the [first chlorine gas cylinders](#) in the trenches on the Western front, near Ypres. He and the specialist troops waited for the wind to blow from the east towards the Allied trenches and launched the first gas attack on April 22 1915. As clouds of chlorine drifted towards the Allies, [panic set in](#). It was no good diving into a

trench, as the dense chlorine was heavier than air and poured in. Of the 15,000 or more casualties, [5,000 soldiers were killed](#).

Haber's story ended tragically in several ways. He returned home to a celebration of the success of the attack on May 1 but that night his wife Clara committed suicide after an argument – possibly over the morality of what he was doing. A few years later he developed a system for getting rid of insect pests, using hydrogen cyanide. It became known as the Zyklon system. A derivative pesticide, Zyklon B, was used to exterminate millions in Nazi concentration camps, where many of Haber's close relatives died.

Gas masks were developed to protect against chlorine attacks and other chemical warfare agents were developed. But chlorine remains the simplest [chemical weapon](#) and reappeared on the battlefield [during the Iraq War](#) and allegedly now in Syria. In World War II, both sides of the conflict knew that the other side had weaponised chlorine and refrained from using it. Today in Syria, it sadly appears this may not have been the case.

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