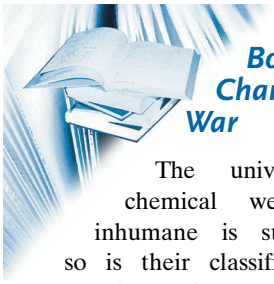


Gas! Gas! Quick, Boys! How Chemistry Changed the First World War

The universal abhorrence of chemical weapons as manifestly inhumane is surprisingly recent and so is their classification as weapons of mass destruction. While the latter is a concept of the nuclear age, the former is not … At the time of their use in the First World War, the perverse-sounding notion that chemical weapons were in fact humane had been a part of the vocabulary of munitions and war experts of the Central Powers and the Entente alike, including, e.g., that of the U.S. Assistant Secretary of War and Director of Munitions, Benedict Crowley: "The methods of manufacturing toxic gases, the use of such gases, and the tactics connected with their use were new developments of this war; yet during the year 1918 from 20 to 30 per cent of all American battle casualties were due to gas, showing that toxic gas is one of the most powerful implements of war. The records show, however, that when armies were supplied with masks and other defensive appliances, only about 3 or 4 per cent of the gas casualties were fatal. This indicates that gas can be made not only one of the most effective implements of war, but one of the most humane."

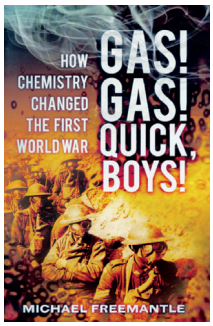
Fritz Haber, whose efforts in the Great War earned him the epithet "father of chemical warfare," regarded chemical weapons as a means to break the stalemate of trench warfare, shorten the war, and thereby preclude the slaughter of millions by artillery and machine gun fire. Haber: "All modern weapons, although seemingly aimed at causing the death of the adversary, in reality owe their success to the vigor with which they temporarily shatter the adversary's psychological strength"—and force them to surrender. Emil Fischer was among the few who forewarned Haber and the German military leadership that the German use of chemical weapons will lead to a quick retaliation by the Entente powers and a widespread use of chemical weapons. And indeed, the Entente introduced its own potent chemical arsenal within a few months of the German chlorine attack at Ypres, Belgium, on April 22, 1915. At the end of WWI, about 25% of all artillery shells fired were filled with chemical agents, mainly phosgene, introduced by the French under the tutelage of Victor Grignard. Providing little advantage to either of the equally equipped warring parties, chemical weapons only increased the already unspeakable suffering of the troops on both sides of both the Western and Eastern fronts. According to Quincy Wright's count, a total of 92000 soldiers were killed and 1.3 million injured by chemical weapons in WWI. What put finally an end to the war was the economic collapse of Germany. The image of a circus elephant hauling an empty hay-cart through the 1917 snow-covered Berlin captures the level of Germany's exhaustion.

Albert Einstein's pacifist view contrasted sharply with that of his friend Haber. As he would later put it: "Warfare cannot be humanized. It can only be abolished." Strangely enough, there is no record of Einstein's criticism of Haber's WWI efforts, although Einstein occupied an office at Haber's institute at the time and must have been aware of what was going on. Gruesome as they were, chemical weapons have been banned only since 1997, when the 65th country deposited its instrument of ratification to the Chemical Weapons Convention. As of 2013, 189 countries are party to the Convention.

Much of the military death toll in WWI (estimated to be at least 10 million troops) was, however, due to high explosives produced by the chemical industries of the warring nations. Hence the characterization of WWI as the "chemists' war". The Spanish flu pandemic (involving the H1N1 virus), which started already in January 1918 and claimed at least 50 million lives worldwide before it abated nearly three years later, provides an inkling of what biological warfare would look like. This as well as the numbers of those who perished in the trenches of WWI as "cannon fodder" thus puts the notion of WWI chemical agents as weapons of mass destruction into perspective.

The role of chemical industry in feeding the shells and grenades used in WWI with propellants and explosives is fraught with ironies. Perhaps the greatest is that the Haber–Bosch process, developed as a cheap and unlimited supply of ammonia from the elements, was diverted from the production of fertilizers ("bread from air") to the production of explosives ("gunpowder from air") as soon as the war had begun. That Germany developed and acquired the Haber–Bosch technology just in time for the Great War was key to sustaining her war effort: without it, the embargoed supplies of Chilean saltpeter would have run out within months and WWI would have indeed been as brief as anticipated by the German military planners, except that it would have ended not in Germany's speedy victory but rather her abrupt defeat.

Scholarly accounts of chemical warfare in WWI abound, but one stands out as definitive—and authentic. It is *The Poisonous Cloud* by Fritz Haber's son Ludwig (Lutz) Haber. An economic historian, Lutz Haber was well predisposed to probe the connection between industry and the



Gas! Gas! Quick, Boys! How Chemistry Changed the First World War
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military. His personal interest in the topic was fueled not just by his family lineage but also by his acquaintance and friendship with Harold Hartley, whose confidant—and in a sense heir of his extensive collection of materials connected with chemical warfare in WWI – Lutz Haber had become. Sir Harold Hartley was Fritz Haber's counterpart at the British War Office during WWI who, after the war, was in charge of inspecting German research and production facilities related to chemical warfare, and banned by the Versailles Treaty. He had also met the "great Haber", as he put it, during his visit to Haber's Kaiser Wilhelm Institute for Physical Chemistry and Electrochemistry in Berlin Dahlem—the center of German chemical warfare research. Apparently their conversation slipped quickly into a joking mode when Haber pointed out to Hartley one of the differences between them: While Hartley had been promoted to the rank of general, Haber had made only a captain. A similarly amiable relationship would evolve between Fritz Haber and Sir William Pope, who was Haber's British counterpart as head of a team that developed mustard gas. William Pope hosted Fritz Haber at Cambridge after Haber's forced emigration from Nazi Germany in 1933 and Haber eulogized William Pope's chivalry in return.

A noteworthy but largely neglected account of chemical warfare in WWI comes from Fritz Haber himself. In a series of lectures presented to the German parliament in 1920–1923, Haber puts squarely the blame for any legal issues with chemical warfare on the German Chief of General Staff, Erich von Falkenhayn. Haber does not shy away, however, from playing a legalistic shell game when he argues that German gas attacks were carried out either without the use of shells (like the chlorine attack at Ypres) or with shells loaded, in addition to poison gas, with explosives (whereas the Hague conventions prohibited the use of shells or grenades filled solely with poisonous substances). Haber also claims that chemical weapons were first used in WWI by the French—in August 1914—when they fired rifle grenades filled with the highly toxic ethyl bromoacetate. Although ineffective for technical reasons, the intended purpose was, according to Fritz Haber, the same as that of the German chlorine cloud: to force the enemy out of his trench positions by exposing him to an asphyxiating agent.

Michael Freemantle's book *Gas! Gas! Quick, Boys! How Chemistry Changed the First World War* takes its title from a pacifist poem by English poet Wilfred Owen, who had experienced WWI from the trenches and died just one week before Armistice. Apart from a review of chemical warfare and some of the controversies connected with it, Freemantle's book describes many of the novel uses of chemistry in WWI. So one can find a chapter about shell chemistry, Mills bombs and grenades, high and low explosives, metals used in the war, khaki dyes, caring for the wounded, fighting infection, and pain killers. The book is written in an accessible, encyclopedic style and may well serve the interested reader to quickly find various facts about how chemistry shaped the First World War.

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