PRESS RELEASE

EuCheMS European Chemical Sciences

CHEMISTS AGAINST CHEMICAL WEAPONS

EUCHEMS ON THE 100 YEARS OF CHEMICAL WEAPONS - MEMORY AND RESPONSIBLE SCIENCE

On the 22nd of April 1915 in Ypres, Belgium, the first large-scale use of a chemical weapon took place. Even though chemical weapons had been around for many centuries, namely in the form of poisoned arrows, arsenic smoke or boiling tar, never had their use caused such suffering and devastation as during World War I, where weapons such as chlorine gas or mustard gas would result in 90,000 deaths and over one million casualties.

EuCheMS President, David Cole-Hamilton, who will attend the OPCW commemoration in Ypres on 21st April, 2015, says: "Chemists have the ability to make, control or deactivate chemical weapons, so EuCheMS as the representative of 160,000 chemists in Europe and beyond, stands by all thinking people in deploring chemical weapons and calls for their complete elimination in all countries."

On this occasion, EuCheMS, the Association for Chemical and Molecular Sciences, praises the prohibition and control of chemical weapons as exemplified in the work of the Organisation for the Prohibition of Chemical Weapons (OPCW), but not less important, EuCheMS calls for the ethical mobilisation of all chemists, either in academia or industry, to nurture critical thought, to act ethically, and to properly inform non-chemists about both the potential virtues and dangers of chemistry. In short, EuCheMS calls for a responsible science.

100 years have passed since the fatal date when chemical weapons were first used on a large scale and fortunately much has changed. In the domain of international law, many treaties and protocols have followed, culminating with the Chemical Weapons Convention entering into force in 1997. This convention is administrated by the Organisation for the Prohibition of Chemical Weapons (OPCW) and relies on the work of many chemists to analyse and control potential threats of chemical weapons. OPCW has recently won the Nobel Prize for Peace.

History has constantly shown that as for every science, chemistry is an open ended activity that can be used with either positive or negative intentions. This is indeed a common place, but one that we should not forget, as the very same molecule can either save or destroy depending on its utilisation. Many of the dangerous compounds used in chemical weapons have been investigated further to understand their impact on diseases such as cancer or Alzheimer's disease.

As chemists and as citizens, let us not forget all the suffering still being caused by non-chemical weapons, let us learn from the example of chemistry that uses of science must be limited by ethical considerations and be used for our common good. Collective memory is a crucial part of our identity, and the 22nd of April 1915 is a date that every chemist should know, as the symbol of a conduct that should never be repeated, as the opposite of what science should always be - *responsible science*.

Attached: Ferruccio Trifirò: The duality of chemistry and the First World War

For more information please contact Dr. Nineta H. Majcen, EuCheMS Secretary General on her desk phone +32 2 289 2690 or through her email address nineta@euchems.eu - www.euchems.eu

About EuCheMS: EuCheMS, the European Association for Chemical and Molecular Sciences, aims to nurture a platform for scientific discussion and to provide a single, unbiased European voice on key policy issues in chemistry and related fields. Representing more than 160,000 chemists from more than 40 Member Societies and other chemistry related organisations, EuCheMS relies on a unique network of active researchers involved in all the fields of chemistry.

The duality of chemistry and the First World War

Ferruccio Trifirò
Scientific member of SAB (OPCW); Emeritus Professor of University of Bologna

Reported in this note is the role of chemical culture during the First World War, particularly in the production of explosives and chemical weapons using substances and processes that were shown afterwards to have a big utility for humanity. The First World War, that it has also been named "the chemical war" for the large use of chemical weapons, also received a big contribution from chemical science in the production of explosives. Besides the contribution of chemistry in disruptive activity it was also an emblematic example of the duality of chemistry.

The production of explosives

For the Germany empire, it was possible to start a war only after the discovery of ammonia synthesis used for the production of explosives, that all other countries produced starting from nitro of Chile (sodium nitrate), which was unavailable to Germany during an European war. The synthesis of ammonia was discovered by the German chemist, Fritz Haber (1), patented in 1909, who then constructed the industrial plant in 1913 with Carl Bosch, a chemist from BASF. For the discovery of ammonia Haber received the Nobel prize in chemistry in 1918, and Bosch together with Friedrich Bergius received the Nobel prize in 1931 for the discovery of chemical syntheses under pressure (he started with ammonia synthesis). The discovery of ammonia synthesis from nitrogen and hydrogen is considered one of the most important reactions for humanity, because it allowed the production of nitrogen fertilizers at low prize and in higher amount; in fact after its discovery the population in the world strongly increased. For the production of explosives and also of fertilizers another important discovery had been realized just a few years before: it was the oxidation of ammonia to nitric acid, realized by the German chemist Wilhelm Ostwald (Nobel prize for chemistry in 1909) with a catalytic process at high temperature using platinum wire as a catalyst.
Another chemical product which was important for the war's activities was sulphuric acid, that just before and during the First World War strongly increased in production especially with the "contact process", using a heterogeneous catalysts (2). Before the First World War most sulphuric acid was produced using the "lead chamber" process, which was optimal for the production of fertilizers. But for the production of explosives it was necessary to use concentrated sulphuric acid (oleum), which could be obtained more easily and at lower price with the contact process. This is the reason why the use of the contact process increased strongly during the war. Emblematic example of these developments is the fact that in Italy the first contact process was realized by Dynamit Nobel AG (a German company founded by Alfred Nobel) in 1902, and after 1908 a lot of contact processes were started. The realization of plants with a contact process for the production of sulphuric acid let, in many countries, to the start of the modern chemical industry and developed the culture of the use of heterogeneous catalysts in chemical processes.
Another innovation that just started at the beginning of the war in 1914 in England was the synthesis of acetone realized by the British chemist Chaim Weizmann, who developed the process ABE (acetone, butanol, ethanol) (3) under the request of British Government. The ABE process consists in the synthesis of acetone, butanol and ethanol by fermentation of carbohydrates using the bacterium *Chlostridium acetobutylicum*. It thus became the second industrial fermentation process in the world after production of ethanol. The process was useful for the production of acetone, necessary for the preparation of cordite, a substance used as explosive powder for guns. It seems that Weizmann (from a Jewish family) was reimbursed from the British ad American Government for his invention with their support for the creation of the Israel State, of which Weizmann was the first President.
The ABE process was used in all around the world till 1960. It has recently been modified to produce essentially butanol, which might be a fuel of the future.

Chlorine and phosgene

French troops were the first to use "tear gas" in 1914, to whom the German troops replied with a more lethal gas. Haber was not only involved indirectly on the production of explosives, but he was personally involved in the use of chemical weapons, for the first time employed in Ypres (Belgium) in April 1915. Haber not only suggested the use of chlorine and phosgene, but he was also present during their distribution in the war's field, supervising all the operations (4, 5). For the personal role of Haber in the use of chemical weapons, his wife, who was also a chemist, committed suicide in 1915. Phosgene, however, was not only used by the German troops but also by the French ones. Another noble father of chemistry, Victor Grignard (Nobel prize for chemistry in 1912) helped the government in its production. Chlorine and phosgene were raw materials largely used in the chemical industry. Just at the beginning of 20th century the electrochemical process for the production of NaOH from NaCl was developed, and a large amount of chlorine was obtained as coproduct. With chlorine as an available feedstock it was very easy to produce phosgene, that later was used for the production of polycarbonates and for the synthesis of isocyanides, starting monomers for polyurethanes.

Yperite

Bis(2-chloroethyl)sulphide, known as yperite or mustard gas, was used by the German troops for the first time as a chemical weapon at Ypres on 12th July 1917, but it had been synthesized the first time in France in 1820. Over the years much information appeared on its different synthesis and also on its toxicity. The most interesting information is from 1913 when a British chemist, Hans Tacher Clarke, went to Berlin to work together with Emil Fischer (Nobel prize for chemistry in 1902) where he synthesized mustard gas in a very simple way starting from potassium sulphide, 2-chloroethanol and HCl. The product obtained was very pure, but a flask containing it was broken and he was poisoned and spent two months in hospital. Fischer, for precaution, advised the German Chemical Society of the danger of using this type of sulphide, but this information arrived also to the German Government, and they at once started its industrial production to use it as a chemical weapon. Later British chemists studied the nitrogen mustard gases to use them as chemical weapons, but they found applications also as anticancer agents.

Lewisite

2-Chlorethenylarseneous dichloride, known as Lewisite (6, 7), was synthesized for the first time by Julius Arthur Nieuwland during his doctoral thesis work at the University of Notre Dame in the United States, by the reaction between acetylene and arsenic trichloride. During the thesis Nieuwland was poisoned by the substance he was studying and was hospitalized for some days. After this accident Nieuwland decided to stop to work on this product and he concentrated only on the chemistry of acetylene, but the object if his thesis remained always the synthesis of the toxic arsenic compound. Nieuwland was a Catholic priest and, after becoming professor of organic chemistry at the University of Notre Dame, he worked on acetylene and discovered the synthesis of divinylacetylene and its polymerization to a rubber. Later scientists of Dupont modified the preparation of Nieuwland and synthesized neoprene, the first synthetic rubber which revealed to be better than the natural one. In 1917 in the Unites States a centre for the study of chemical weapons was created, and a chemist at this centre, Lee Lewis, was informed by professor Griffin, supervisor of Nieuwland, of his thesis and content and was given a copy. Lewis at once reproduced the synthesis in his laboratory and constructed the industrial plant in 1918, giving his name to the product. Lewisite was not used in the World First War because it was obtained only at the beginning of the armistice.

Bibliography

1) http://www.nobelprize.org/nobel_prizes/chemistry/laureates/1918/haber-bio.html
2) http://www.treccani.it/enciclopedia/acido-solforico_(Enciclopedia-Italiana)/
3) http://opensourceecology.org/wiki/Acetone-butanol-ethanol_fermentation
4) http://www.historylearningsite.co.uk/poison_gas_and_world_war_one.htm
5) http://www.firstworldwar.com/features/chemical_warfare.htm
6) http://www.historynet.com/weaponry-lewisite-americas-world-war-i-chemical-weapon.htm
7) http://www.britannica.com/EBchecked/topic/414713/Julius-Arthur-Nieuwland