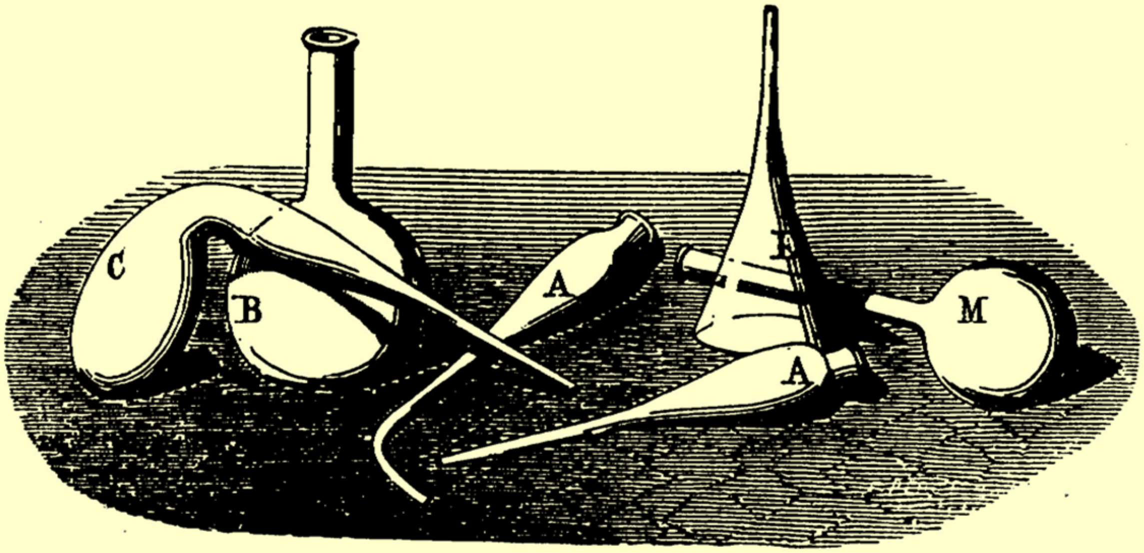
American Chemical Society

DIVISION OF THE HISTORY OF CHEMISTRY



PROGRAM & ABSTRACTS

249th ACS National Meeting
Denver, CO
March 22-26, 2015

S. C. Rasmussen, Program Chair

Final Program
HIST

DIVISION OF THE HISTORY OF CHEMISTRY

S. C. Rasmussen, *Program Chair*

SUNDAY AFTERNOON

Section A

Sheraton Denver Downtown - Tower Court D

HIST Tutorial and General Papers

S. C. Rasmussen, *Organizer, Presiding*

1:00 1. HIST Tutorial: Elemental sulfur – a natural (and unnatural) resource. **Margaret E. Schott**

1:40 2. James Hyatt, chemist, scientist, and communicator: A man of his times. **William P. Palmer**

2:10 3. Inaccuracy of dates in accounts of the history of chemistry: A case of deliberate falsification? **Joseph Gal**

2:40 Intermission.

2:55 4. Rules, formulas, names: The lexical legacy of the 1892 Geneva Nomenclature Congress. **Evan Hepler-Smith**

3:25 5. NMR characterization of resin blocks from 13th century Java Sea Wreck. **Joseph B. Lambert**, Allison Levy

3:55 6. Investigation into the first isolation of carbonic acid. **Reggie L. Hudson**

4:25 7. Foundation and influence of the Sydney School of Coordination Chemistry. **Anthony T. Baker**

SUNDAY EVENING

Sheraton Denver Downtown - Director's Row F

5:00 - 8:00 **HIST Executive Committee Meeting**

MONDAY MORNING

Section A

Sheraton Denver Downtown - Tower Court D

Chemical Technology in Antiquity

Cosponsored by MPPG, ANYL, CHED, INOR, ORGN

S. C. Rasmussen, *Organizer*
C. L. Heth, *Presiding*

8:25 Introductory Remarks.

8:30 8. Pigments in antiquity: Colorful forerunners of every aspect of modern chemistry. **Mary Virginia Orna**

9:15 9. First artificial material: Ceramics from prehistory to the fall of Rome. **Nicholas Zumbulyadis**

10:00 Intermission.

10:15 10. From honey wine to cultivation of the grape: An early history of fermented beverages. **Seth C. Rasmussen**

11:00 11. Metals of antiquity and their alloys. **Vera V. Mainz**

MONDAY AFTERNOON

Section A

Sheraton Denver Downtown - Tower Court D

Chemical Technology in Antiquity

Cosponsored by MPPG, ANYL, CHED, INOR, ORGN

S. C. Rasmussen, *Organizer*, *Presiding*

1:30 12. The skin they were in: Leather and tanning in antiquity. **Christopher L. Heth**

2:00 13. Modern chemistry of the ancient chemical processing of organic dyes and pigments. **Zvi C. Koren**

2:45 14. Scented oils and perfumes in antiquity. **Narayanaganesh Balasubramanian**

3:15 Intermission.

3:30 15. Soap production and use in antiquity. **Kristine L. Konkol**, Seth C. Rasmussen

4:00 16. Modern materials in antiquity: An early history of the art and technology of glass. **Seth C. Rasmussen**

MONDAY EVENING

Section A

Colorado Convention Center - Halls C/D

Sci-Mix

S. C. Rasmussen, *Organizer*

8:00 - 10:00

11, 12, 14. See previous listings.

TUESDAY MORNING

Section A

Sheraton Denver Downtown - Tower Court D

Modern Chemical Warfare: History, Chemistry, Toxicology, Morality

J. Gal, *Organizer*
J. A. Asper, *Presiding*

8:00 Introductory Remarks.

8:05 17. Modern chemical warfare: A historical overview. **Joseph Gal**

8:35 18. German chemists and chemical weapons: Fritz Haber and his legacy. **Sarah Everts**

9:05 19. Chemical warfare and French chemists. **Pierre Laszlo**

9:35 Intermission.

9:50 20. American chemists and chemical warfare. **Thomas T. Tidwell**

10:20 "Haber: The Father of Chemical Warfare", a film by Daniel Ragussis

11:00 Q&A with Daniel Ragussis

Sheraton Denver Downtown - Tower Court D

Modern Chemical Warfare: History, Chemistry, Toxicology, Morality

J. Gal, *Organizer*, *Presiding*

1:00 21. Chemical weapons: Clinical description and discussion of basic injuries. **David Gilmore**

1:30 22. Aiming chemical weapons at student engagement: Chemistry and war as a first year seminar. **Janet A. Asper**

2:00 23. Modern chemical warfare: A philatelic chronology. **Daniel Rabinovich**

2:30 24. Chemical warfare: The American WWII aftermath. **Douglas C. Neckers**

3:00 Intermission.

3:15 25. Nerve agents: From inception to current concepts. **Sage W. Wiener**

3:45 26. Ethics of chemical weapons research. **Jeffrey D. Kovac**

4:15 27. OPCW: Working for a world free of chemical weapons. Daniel Feakes, **Alexander Kelle**

ABSTRACTS

HIST 1 - HIST Tutorial: Elemental sulfur – a natural (and unnatural) resource

***Margaret Schott**, Chemistry, Northwestern University, Evanston, Illinois, United States*

The story of elemental sulfur (S_8), which has also been called brimstone since biblical times, is a fascinating one. And yet how many of us know the natural origins of this solid yellow substance that is capable of adopting such a wide array of crystalline forms? The purpose of this tutorial is to provide an overview of (i) the known processes, namely volcanogenic and biogenic, for the formation of S_8 in Earth’s geologic history, (ii) traditional methods for the extraction of sulfur from Earth's crust, (iii) contemporary methods for the synthesis of “unnatural” S_8 from sulfur-containing components in unrefined fossil fuels, (iv) some properties of the linear and cyclic allotropes of sulfur, ranging from gaseous S_2 up to polycatena S_n (where n >1000), (v) the long-distance transport of molten sulfur, and (vi) the major industrial uses of S8 in sulfuric acid production, rubber vulcanization, and the formulation of medicinal agents, black gunpowder, fireworks, and more. The talk will be illustrated throughout with chemical structures and equations as well as historical images and original artwork.

HIST 2 - James Hyatt, chemist, scientist, and communicator: A man of his times

***William Palmer**, SMEC, Curtin University, Brighton, Victoria, Australia*

James Hyatt was born in 1817 in New York. Little has been discovered about his education but he obtained a doctorate. He wrote a number of text books including First lessons in chemistry, (1839), Lime and marl: their agricultural uses (1848), The elements of chemistry, (1856) and Periodicity in vegetation (1875).

He was an early member of the American Association for the Advancement of Science and a popular lecturer. An interesting feature of his 1856 textbook was his social concern, as he believied that if the children of ‘the labouring classes’ were taught chemistry, they would be paid more for their work. He also emphasised the uses of chemistry in providing ‘human necessity, comfort, health, and life’. His chemistry text published in 1856 (four years prior to the Karlsruhe Conference) makes the assumption that the chemical formula for water was (HO) and he did not consider the common gases to be diatomic. These features were common in textbooks of the time, but his clarity in expressing these concepts may have been the reason why there was no second edition of his book.

Another aspect of James Hyatt’s life was his habit of breathing in the chlorine gas in the belief that it assisted his good health; again this was a common view. He also habitually breathed in ‘nitrous oxide ... ‘whence it is known as exhilarating or laughing gas’. He lived to the ripe old age of eighty-seven, promoting science to the end.

HIST 3 - Inaccuracy of dates in accounts of the history of chemistry: A case of deliberate falsification?

***Joseph Gal**, Departments of Medicine and Pathology, University of Colorado School of Medicine, Aurora, Colorado, United States; Clinical Laboratories A-022, University of Colorado Hospital, Aurora, Colorado, United States*

In historiography, accuracy in dates is essential, yet inaccurate dates are common in the literature, for several reasons. A particularly troubling case of an apparently deliberate falsification of an important date in chemistry concerns the historic announcement by Louis Pasteur (1822-1895) of his discovery of molecular chirality to the *Académie des sciences* in Paris on Monday, May 22nd, 1848. The literature nearly completely ignores this date, favouring instead Monday, May 15th, 1848 (i.e., a week earlier), which first surfaced in 1922 in Pasteur’s collected works edited by his grandson Louis Pasteur Vallery-Radot. On Sunday, May 21st, 1848, i.e., one day before Pasteur's presentation in Paris, his mother died suddenly of a stroke in Arbois, eastern France. Pasteur probably did not learn of her demise in time, but in any case he left for Arbois only after his presentation. Biographies of Pasteur by his son-in-law René Vallery-Radot or the grandson and Pasteur's collected correspondence edited by the grandson are puzzlingly silent about Pasteur's historic presentation. An examination of a variety of relevant information strongly suggests that the biographer relatives deliberately suppressed the correct date, presumably for fear of adverse public judgment of Pasteur for a real or perceived insensitivity to a grave family medical emergency, inasmuch as Pasteur remained in Paris and lectured there on the day after his mother's death. Such fear would have been expected from the two relatives, who throughout their works on Pasteur built a hagiographic image of Pasteur as a 'lay saint'. Since the correct date is clear from the publication of Pasteur's lecture in the proceedings of the *Académie*, its near-complete replacement in the literature with an incorrect date requires an explanation, which is most likely that Pasteur's collected works edited by the grandson are much more widely available than the proceedings of the *Académie*.

HIST 4 - Rules, formulas, names: The lexical legacy of the 1892 Geneva Nomenclature Congress

***Evan Hepler-Smith**, Program in History of Science, Princeton University, Princeton, New Jersey, United States*

There are three characteristic features of systematic nomenclature in modern organic chemistry. First, the prefixes, suffixes, and root of the systematic name correspond precisely to sections of the structural formula of the molecule to which it refers. Second, this mode of identification and ordering is the foundation of how organic compounds are represented and indexed in chemical information systems. Third, most chemists - even organic chemists - want as little to do with these names as possible. These three features of systematic nomenclature - its correspondence to structural formulas, its importance for the structure of chemical information, and its perceived disconnection from the concerns of the daily practice of chemistry - are all rooted in the events of the Geneva Nomenclature Congress of 1892. This meeting brought together a small group of Europe's foremost organic chemists to work out a set of rules for naming organic chemical substances. One faction, led by French chemist Charles Friedel, favored creating a flexible nomenclature that express the various functional properties of compounds in their names. Another faction, led by German chemist Adolf von Baeyer, wished to codify a set of rules that would directly map structural formulas into systematic names, so that a list of tens of thousands of compounds could be ordered by name in a manner that grouped compounds by structure. In this paper, I will discuss the arguments that each group presented, and draw out some of the consequences of the victory of Baeyer's plan for the shape of the Geneva Nomenclature, for subsequent systems of organic nomenclature, and even for the enduring practice of representing molecules by means of two-dimensional structural formulas.

HIST 5 - NMR characterization of resin blocks from 13th century Java Sea Wreck

***Joseph Lambert** and Allison Levy, Deparment of Chemistry, Trinity University, San Antonio, Texas, United States, United States*

Resin blocks from the 13th century Java Sea Wreck (a total of 16 samples, provided by the Field Museum, Chicago, IL) have been analyzed by solid state carbon-13 nuclear magnetic resonance (NMR) spectroscopy in order to develop our understanding of exchange and commerce in East and Southeast Asia and the Indian Ocean region in the early to mid-second millennium A.D. All samples but one had common NMR fingerprints by all spectral tests, characteristic of NMR Group B ambers. The exception, sample 1560, had a carbon-13 NMR fingerprint that suggests a compound with a carbon framework composed entirely of carbonyl groups; this sample is believed to be an inorganic carbonate. The effect of a saline environment on amber was also analyzed for the fifteen remaining samples, and NMR analysis revealed that saline environments affect the perceived maturity of the sample. Investigation into the provenance of the samples was completed by visual inspection of spectra of known samples from East and Southeast Asia and the Indian Ocean region. Chinese and Middle Eastern origins were eliminated because these ambers are characteristically Group A. Australia and Papua New Guinea were eliminated because spectra of known Australian and Papua New Guinean samples are visually inconsistent with those of the Java Sea Wreck samples. Indonesian origin was also eliminated because previous study revealed that Indonesian samples have two distinct peaks at $\delta 5.5$; these two peaks are not seen in the spectra of the resin blocks. However, the spectra of the resin blocks have a clear resemblance to the spectrum of sample 139 from the Indian state of Gujarat. The spectra of the Java Sea Wreck samples are consistent with having originated from Gujarat, India. Additionally, 13th century Chinese export patterns are also consistent with the samples having originated from Gujarat, India.

HIST 6 - Investigation into the first isolation of carbonic acid

***Reggie Hudson**, Astrochemistry Laboratory, Code 691, NASA Goddard Space Flight Center, Greenbelt, Maryland, United States*

Carbonic acid (H_2CO_3) has a claim to be the most-widely synthesized compound of all budding chemists as it is produced by mixing vinegar and baking soda. More-experienced chemists recognize H_2CO_3 as an unstable material that is present in terrestrial systems, including the human body, only in submicromolar concentrations. However, the initial isolation of H_2CO_3 was carried out not by chemists but by two physicists with chemical interests and under distinctly non-biological, non-terrestrial experimental conditions. The history of this first synthesis and the acid's isolation will be reviewed in this ACS presentation, the discovery spectrum will be shown, and the subsequent events and chemistry will be described, including the author's minor contribution to the story.

HIST 7 - Foundation and influence of the Sydney School of Coordination Chemistry

***Anthony Baker**, School of Chemistry and Forensic Science, University of Technology, Sydney, Broadway, New South Wales, Australia*

In the 1950s, Australia was a powerhouse of coordination chemistry. The standard monographs of the 1950s and 1960s include a disproportionate number of references to papers from the relatively small Australian academic chemistry community of the time.

The source of this activity was the so-called Sydney School of Coordination Chemistry. Usually the foundation of the Sydney School is credited to the Australian George Joseph Burrows and, in recognition, the senior inorganic chemistry award of the Royal Australian Chemical Institute is the Burrows Award. It appears that the critical event in sparking Burrows' interest in coordination chemistry was the short-term appointment (1919-1921) of Eustace Ebenezer Turner (later FRS) to the University of Sydney. Turner certainly came with some experience in coordination chemistry and had been involved in a debate through the literature with J.A.N. Friend on the bonding within coordination compounds. Coordination chemistry was a hot topic at that time, following on from Alfred Werner's work (Werner was awarded the 1913 Nobel Prize for Chemistry). Burrows was a physical chemist and Turner's work was principally in organic chemistry so perhaps the backgrounds were suitable for a contribution to inorganic chemistry. Burrows published until 1940 and almost all his publications after Turner's visit are in coordination whereas no papers before 1919 were in that field. Burrows' influence on Australian inorganic chemistry was very strong.

The foundation of the Sydney School of Coordination Chemistry will be discussed in detail and the influence of Australian coordination chemists in the 1950s and 1960s will also be considered.

HIST 8 - Pigments in antiquity: Colorful forerunners of every aspect of modern chemistry

***Mary Virginia Orna**, Chemistry, The College of New Rochelle, New Rochelle, New York, United States*

Our ancient forebears certainly made use of colors to color virtually everything they used or had: bodies, caves, pottery, sculpture, stone structures, clothing and other textiles. This paper will document their usage with an emphasis on mineral pigments and how a gradually increasing understanding of the nature of these colorants eventually led to other surprising advances in civilization.

HIST 9 - First artificial material: Ceramics from prehistory to the fall of Rome

***Nicholas Zumbulyadis**, Independent Scholar, Rochester, New York, United States*

The dehydration and irreversible thermal dehydroxylation of clay are among the first chemical reactions humans intentionally used to create a new material. The earliest ceramic objects, ceremonial cult figurines from Dolni Vestonice (Czech Republic) have been dated to 28,000 B.P. The earliest utilitarian pottery are vessels from the Xianrendong cave (China), determined to be 20,000-19,000 old. The earliest ceramics known from the Americas have been found in the lower Amazon Basin in the Caverna de Pedra Pintada and Taperinha near Santarem (Brazil), and were dated to 7,500-7,000 years ago. The archaeological record suggests that pottery was independently invented at multiple locations by hunter-gatherers that predated the emergence of sedentary human populations (i.e. prior to the so-called “Neolithic Revolution”). The compositions of the objects reflect the chemistry of the local natural resources. We will examine the numerous innovations in materials processing across cultures, some with roots in the Upper Paleolithic that led to ever more refined objects. These innovations include remarkably modern concepts such as improving mechanical properties through the use of fillers, control of reaction kinetics by particle size, carefully timed protocols for redox processes and melting point depression by the addition of fluxes. We will show how utilitarian concerns and aesthetic impulses have driven in tandem the development of glazes, polychromy, and sophisticated kilns capable of higher temperatures and controlled kiln atmospheres leading to advanced ceramics. We will also examine accounts of ceramic technology in the earliest chemical texts and the relationship of ceramics to glassmaking and metallurgy.

HIST 10 - From honey wine to cultivation of the grape: An early history of fermented beverages

***Seth Rasmussen**, Department of Chemistry and Biochemistry, North Dakota State University, Fargo, North Dakota, United States*

It is generally believed that the origin of alcoholic fermented beverages is shrouded in the mists of human prehistory. While its specific origins are uncertain, it is clear that the production of alcohol via fermentation is one of the oldest forms of chemical technology, with the production of fermented beverages such as mead, beer, and wine predating the smelting of metals. As a result of the intoxicating effects of these drinks, as well as their perceived pharmacological and nutritional benefits, fermented beverages have also played key roles in the development of human culture, contributing to the advancement of agriculture, horticulture, and food-processing techniques. A general overview of the early history and chemistry of fermented beverages and their uses will be presented.

HIST 11 - Metals of antiquity and their alloys

***Vera Mainz**, School of Chemical Sciences, University of Illinois at Urbana-Champaign, Urbana, Illinois, United States*

The first metals discovered by man were likely gold and copper, as these can be found in forms pure enough for immediate working. The other “metals of antiquity” were silver, tin, lead, iron and mercury, bringing the total metals known to ancient man to seven. The most important alloys of these metals were bronze (copper and tin) and electrum (gold and silver). Most of these metals had to be found, usually as an ore, and reacted under a controlled temperature and atmosphere to give the metal. The metal then had to be collected and then worked to give the final desirable properties and shape. I will give an historic account of how such a relatively complicated process was evolved by primitive man and the chemistry involved.

HIST 12 - The skin they were in: Leather and tanning in antiquity

***Christopher Heth**, School of Physical Sciences, Lake Superior State University, Sault Ste. Marie, Michigan, United States*

As the prehistoric human creature expanded geographically toward more extreme climates, early man began to use the pelts of other animals for clothing and shelter for protection from the elements and other physical dangers. With further technological development, skins and hides found additional uses as shoes, armor, or other equipment such as livestock harnesses. In order for this to be practical, means of retarding or preventing the rapid decomposition of the hide material was necessary. A variety of treatment processes were developed, with many of them also altering the physical properties of the hides, rendering the leather material harder, stiffer, or more durable than the original hides. The treatment methods available to early tanners will be discussed, including archeological evidence of these methods and discussion of the chemical changes that occur during these tanning processes.

HIST 13 - Modern chemistry of the ancient chemical processing of organic dyes and pigments

***Zvi Koren**, The Edelstein Center for the Analysis of Ancient Artifacts, Israel; Department of Chemical Engineering, Shenkar College of Engineering, Design and Art, Ramat-Gan, Israel*

The ancient dyer was an advanced chemist! He (or she) utilized vast empirical know-how to produce colorful long-lasting dyeings that have withstood the ravages of time. When the dyer used the full spectrum of the natural dyestuff sources available he also applied his practical knowledge of botany, entomology, and malacology.

A discussion of the colorants used in ancient – and modern – times requires understanding the difference between a “pigment” and a “dye”, which unfortunately have sometimes been erroneously used interchangeably.

A pigment is a water-insoluble colorant used on a surface to paint a wall (as in frescoes), canvas (paintings), vessel, to print or paint on a textile, or even on a body part; in ancient times, most paint pigments were of an inorganic, mineral, nature. Conversely, a dye is a water-soluble organic colorant and that word is specifically used when the purpose of this colorant is to dye a textile and producing a true dyeing. In antiquity, some dyes were chemically transformed into pigments by complexing with a metallic ion, and, likewise, a pigment was transformed into a dye by, for example, reducing the pigment to its water-soluble counterpart.

While inorganic pigments produce magnificent colors, the most elaborate chemical processing of colorants in antiquity – from the source to the final product – involved organic dyes from flora and fauna sources and the subsequent dyeing steps. Thus, by controlling the pH and the temperature of the dye bath, the ancient dyer mastered advanced chemical topics, such as, ionic, covalent, and intermolecular chemical bonding, organometallic complexation, enzymatic hydrolysis, photochemical chromogenic precursor oxidation, anaerobic bacterial fermentative reduction and air-oxidation.

The talk will highlight numerous examples of archaeological dyeings and pigments analyzed by the speaker from the Near East from the Late Chalcolithic, Pharaonic, Phoenician, Persian, and Roman Periods and their modern ancient chemistries.

HIST 14 - Scented oils and perfumes in antiquity

***Narayanaganesh Balasubramanian**, Chemistry and Biochemistry, North Dakota State University, Fargo, North Dakota, United States*

Scented oils and perfumes have fascinated mankind with their very existence. The first knowledge and use of these materials is buried within the layers of time, with evidence of their usage thought to date back to the beginning of civilization. Over this time period, both men and women have used oils in their one form or the other, be it as a cure to an ailment or simply as a fragrance-enhancing component. Although various materials and archeological evidence has been collected over the years on the use of oils and perfumes, the lack of written documentation makes it difficult to paint a picture of their status in early humans life and its history tends to exist via numerous interesting anecdotes. This talk will summarize what is known of the history of the development and use of oils and perfumes in antiquity with a closer look at the scientific validity of some common anecdotes. Such anecdotes include how the young king Tutankhamen was buried with so many fragrances for the afterlife, Queen Cleopatra who wooed Julius Caeser with lavish fragrances, and an Egyptian queen who used her perfumes as a mystic power.

HIST 15 - Soap production and use in antiquity

***Kristine Konkol** and Seth Rasmussen, Department of Chemistry and Biochemistry, North Dakota State University, Fargo, North Dakota, United States*

The production of soap is one of the later forms of chemical technology in the ancient world, where the earliest written record of soap production dates to ~2500 BCE from Sumerian clay tablets. As soap can be produced through the simple combination of potash and animal fat, it is quite possible that it was formed prior to that time period, although no empirical evidence for its earlier existence has been found. It is to be noted that much of the soap manufactured at that time was either soft or liquid in consistency, with hard soap believed to be a more recent development. An overview of the historical production and usage of soap will be presented, pertaining to its origins in antiquity through the Roman era.

HIST 16 - Modern materials in antiquity: An early history of the art and technology of glass

***Seth Rasmussen**, Department of Chemistry and Biochemistry, North Dakota State University, Fargo, North Dakota, United States*

Glass and its uses predate recorded history. Even before the ability to manufacture glass, early tribes discovered and shaped nature glass such as obsidian. The technology of synthetic glass production, however, is thought to date back to no later than 3000 BCE. This glass technology was not discovered fully formed, but grew slowly through continued development of both chemical composition and techniques for its production, manipulation, and material applications. This development had become fairly advanced by the Roman period, and the 1st to 4th century CE is often described as the First Golden Age of Glass. During this time, glass was widely used and glass objects started to become as widespread as pottery. By the 4th century, glass use had developed to the point that certain kinds of glass were actually considered a household necessity, although many still remained luxury items. A general overview of the early history and chemistry of glass and its use will be presented.

HIST 17 - Modern chemical warfare: A historical overview

***Joseph Gal**, University of Colorado School of Medicine, UCH Mail Stop A-022, Aurora 80045, Colorado, United States*

Chemical warfare (CW) is millennia-old, but modern CW began in World War I (WWI) when in April 1915 the German army released chlorine gas on the Belgian front, killing or injuring thousands of Allied soldiers. The Allies responded in kind, and Great Britain and France engaged extensively in CW. The US entered WWI late (1917) and also engaged in CW. The Hague treaties (1899, 1907) unequivocally banned chemical weapons (CHEWEs) but were ignored by the belligerents. Ca. 50 substances were used as CHEWEs in WWI, some lethal poisons while others 'incapacitating agents', e.g., lachrymators and nasopharyngeal irritants. Mustard 'gas' [*bis*(2-chloroethyl) sulfide] was particularly devastating. Ca. 91,000 were killed by CHEWEs in WWI and 1.2 million injured; many were left with long-term severe physical or psychological wounds. CW provided no strategic advantage in WWI. On both sides, many scientists, including eminent chemists, participated in CW work, e.g., F. Haber (Nobel laureate, 1918), O. Hahn (Nobel 1944), H.O. Wieland (Nobel 1927), G.N. Lewis, J.B. Conant, W.J. Pope, V. Grignard (Nobel 1912), etc. But some scientists refused to participate, on moral grounds, e.g., E. Rutherford (Nobel 1908), H. Staudinger (Nobel 1953), M. Born (Nobel 1954). Indeed, WWI CW raises difficult questions concerning the ethics of scientist participation in war-related work. Since WWI, other treaties have prohibited CHEWEs (e.g., Geneva Protocol, 1925; Chemical Weapons Convention, 1997, administered in The Hague by the Organization for the Prohibition of Chemical Weapons, OPCW) but CW has nevertheless continued to the present, often targeting civilian populations. The 'chemical weapons' of WWII were the incendiary agents (napalm, magnesium, etc.), used extensively to firebomb Japanese and German cities. New, extremely toxic CHEWEs ('nerve agents', e.g., sarin, VX) have been developed and used (e.g., Syria, 2013). For their efforts to eliminate CHEWEs, OPCW was awarded the Nobel Peace Prize in 2013.

HIST 18 - German chemists and chemical weapons: Fritz Haber and his legacy

***Sarah Everts**, Chemical & Engineering News, Berlin, Germany*

Rarely in science is a single name tied to a discovery, let alone an entire field of research. Yet Fritz Haber is widely touted as the father of chemical weapons, even though many others have conceived of and deployed these sorts of arms. Like a father, Haber shepherded the development of chlorine gas, phosgene gas and mustard gas for use as World War I weapons; he travelled to war torn areas to see his scientific progeny deployed; and he remained a loyal proponent of gas weaponry until his death, arguing that this form of armament was more humane than traditional bullets. Haber's devotion to chemical weapons was so deep that he also participated in secret research after World War I, in contravention of the Treaty of Versailles.

His devotion to chemical weaponry can be hard for many to fathom given that Haber had also used his exceptional intelligence to develop a cheap and efficient way to make fertilizer, and in doing so helped feed humanity's growing population. This presentation will follow the trajectory of Haber's life, examining his science, his relationships with friends and family, and his tragic end as a displaced Jew in pre-World War II Europe. If time permits, the talk will also address other significant German contributions to the development of chemical weapons.

HIST 19 - Chemical warfare and French chemists

***Pierre Laszlo**, Ecole polytechnique, Palaiseau, France and University of Liège, Belgium. «Cloud's Rest», Prades, F-12320 Sénergues, France*

First use of gases by the German military did not catch the French totally unprepared. Prior to the start of the Great War, there had been some experimentation, under great secrecy. As soon as it became evident that France had to engage in chemical warfare as well, a task force was assembled. The elite of French chemistry and pharmacy took part in that war effort. After the end of the war, Charles Moureu published in 1920 a rather comprehensive memoir, La Chimie et la Guerre — Science et Avenir. One of its purposes was to show Moureu as the leader of the war effort, which was not entirely accurate. We are fortunate to have a letter [1] from Lucien Herr to Albert Thomas, who organized production of armament from his governmental position — at first Under-Secretary of State, later Minister —, with candid sketches of the French chemists involved, Moureu included. Thomas was brilliantly seconded by General Paul Ozil, an alumnus of the Ecole polytechnique who had entered the French Corps of Military Engineers. Ozil had been posted to Madagascar, where he oversaw building of the railroads, overlapping there with General Joseph Joffre, who also belonged to the Corps of Military Engineers. A second section of my paper will address the hospitalization and treatment of gas victims, together with the public horror in France at this new form of warfare, as documented from contemporary accounts in the press and in books. Regarding the latter, André Malraux, in Les Noyers de l'Altenburg (1943, 1948) wrote a stylistically admirable account of the first "real-size" use of gases, supervised by Fritz Haber on the Eastern Front, that led to a most unusual scene of fraternization between the soldiers on both sides.

[1] Pierre Laszlo, "Quality information from the grapevine," Ambix, 2010, 57(2), 202-215.

HIST 20 - American chemists and chemical warfare

***Thomas Tidwell**, University of Toronto, Mountain View, California, United States*

The United States had avoided the first years of WWI, but in 1918 began producing Lewisite, C2H2AsCl3, a potent poison first prepared in the US, for use as a poison gas, and named for the chemist Winford Lee Lewis, but the war ended before it was actually used. Among other American chemists James Bryant Conant (1893-1978) was engaged in development of poison gases during WWI and then became Professor of Organic Chemistry at Harvard. He became President of the University, and in 1941 was President of the National Defense Research Committee. His former student Paul D. Bartlett together with Gardner Swain studied the chemistry of mustard gas, while Louis Fieser invented napalm, extensively utilized in fire bombing of Japan.

HIST 21 - Chemical weapons: Clinical description and discussion of basic injuries

***David Gilmore**, Emergency Department, Exempla St Joseph Hospital, Colorado Permanente Medical Group, Denver, Colorado, United States*

This presentation will provide a clinical description of the basic injuries due to chemical warfare. It will include the original substances brought forth during the Great War of 1914 to 1918. The chemicals utilized may present with characteristic syndromes and medical injuries. It may be helpful, in studying and cataloguing these substances, to understand the various biological and medical effects associated with the use of this type of warfare.

Injuries due to exposure to these substances, whether in manufacturing or use as weapons of mass destruction, may range from mild to life-threatening. Immediate illness followed by varying degrees of chronic injury are common. The onset of death may range from minutes to even months or years. Multiple organ systems may be, and usually are, affected in any one individual. Blindness, suffocation, organ failure, cardiac collapse and severe burns are common. These substances are capable of producing temporary organic and biological damage as well as perhaps even altering the DNA of the victim. Some of these substances are carcinogenic. These chemicals may persist for varying degrees of time in the environment into which they are released. The delivery systems of various compounds demonstrate widely varying degrees of lethality.

HIST 22 - Aiming chemical weapons at student engagement: Chemistry and war as a first year seminar

Janet Asper, *Chemistry, University of Mary Washington, Fredericksburg, Virginia, United States*

As part of the University of Mary Washington’s First Year Seminar program, I have taught Chemistry and War to first year college students for 3 years. The students are from all possible majors, and have a wide variety of backgrounds in chemistry and history. This seminar will describe the sources and activities I have used in my course, student reactions to the chemical warfare unit, and my plans for further course development.

HIST 23 - Modern chemical warfare: A philatelic chronology

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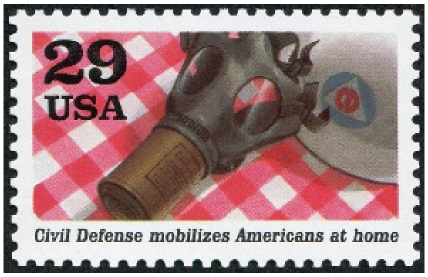
Chemicals, from poisoned arrows and boiling tar to smoke and malodorous substances, have been used as artifacts of warfare for millennia. However, the first large-scale use of a traditional weapon of mass destruction (chemical, biological or nuclear) occurred during World War I, when the German Army released massive amounts of chlorine during the Second Battle of Ypres on 22 April 1915. This presentation will summarize the history of modern chemical weapons as illustrated on postage stamps, including the use of Zyklon B by the Nazis as an effective instrument of death in gas chambers and the use of chemical weapons during the Iran-Iraq War in the 1980's. Postage stamps and other philatelic materials, which are often used as a simple yet effective means of communication to inform the general public about more benign subjects (history, literature, geography, science, etc.), are used here to remind us about the inherent dangers of chemical weapons and the decades-old effort to curtail their use.



HIST 24 - Chemical warfare: The American WWII aftermath

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German forces were mostly defeated when the British found Gerhard Schrader in labs in Elberfeld. There, British Col. Paul Tilley managed a first report of the German nerve gasses, sarin and tabun. Soman, the most toxic, originated in Nobel laureate Richard Kuhn’s labs in Heidelberg. What followed, attributed to the recently deceased John Dolibois, is that the American stock of nerve gasses came from initiatives of Brigadier General, Charles Loucks, and the assistance of numerous Nazi chemists. In an era of fear, a single general could accomplish so much potential devastation. Our knowledge of how the structural information about the phosphonofluoridates penetrated the American academic community isn't known. Organic chemists then hid these carefully from their students. And American army chemists, during WWII, spent time dropping known halogenated lachrymators on terrain increasingly similar to that expected in the islands leading up to Japan, and developing instruments to measure the residues. Noyes, Jr. (1948) Ed. Chemistry for his part says nothing about nerve gasses. Schrader testified in the Nuremberg Farben trial, and the structures of tabun and sarin came up, as did his research philosophy. But these were military trials; chemists were not central to the questioning of their German counterparts, nor were these reports known until much later. Near that time, Morris Kharasch (Chicago) penetrated the Army Chemical Corps after the War, and convinced the Army that it needed to know more about the organic chemistry of phosphorus. So under this guidance, numerous young scientists were funded to study that. Basic chemistry resulted that remains of interest. This talk will be tinged with WWII history and trace the trail of organic phosphorus chemistry from Elberfeld to Muscle Shoals; from Braunswieg to Lawrence, Kansas and parts beyond.

HIST 25 - Nerve agents: From inception to current concepts

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Organophosphorus compounds were first synthesized in 1854. After World War I, German scientist Gerhard Schrader discovered Tabun (GA), the first nerve agent. Although he had been trying to develop pesticides for the chemical manufacturer IG Farbenindustrie, he recognized the potential of these agents as chemical weapons. By the end of World War II, Germany had developed several for this purpose, known as the G series (for German) of organophosphates, including Sarin (GB) and Soman (GD). During the Cold War, both American and Soviet scientists developed organophosphates as weapons, including what is now known as the V series (for vesicant), including VX. Physical properties of individual nerve agents make some more of a threat when inhaled as an aerosol, while others are most dangerous when absorbed through the skin. These properties also determine the persistency of an agent. Clinical experience with patients poisoned by nerve agents is limited, although there is extensive experience with patients poisoned by organophosphate pesticides. However, data are available from the Sarin attack on the Tokyo subway in 1995, and to lesser extent from use in Iraq in 1988 and more recently in Syria. All organophosphates act by inhibiting cholinesterases in both muscarinic and nicotinic synapses, leading to excess parasympathetic action and paralysis, as well as effects in the brain that are not as well understood. Compared to organophosphate pesticides, nerve agents appear to have greater effect on the cholinesterases in the neuromuscular junction. Elements of treatment include decontamination, atropine, a muscarinic antagonist, and cholinesterase reactivators called oximes, although the utility of oximes is controversial.

HIST 26 - Ethics of chemical weapons research

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Throughout history, the use of chemical weapons in warfare has been controversial. The morality of chemical weapons research is similarly controversial because several potentially conflicting obligations and codes of ethics impact the decision of the individual chemist as to whether to participate in such research. In this presentation I will discuss the complex ethical questions surrounding chemical weapons research. All chemists are members of a national community with the obligations of citizenship, but they are also professionals subject to a code of ethics. Of course, they are also members of the human community and consequently subject to the more or less universal common morality. Membership in a religious community might also add moral restraints. A key question for chemists is whether the current code of ethics can provide adequate guidance in trying to deal with this complex issue.

HIST 27 - OPCW: Working for a world free of chemical weapons

Daniel Feakes and __Alexander Kelle__, OPCW, The Hague, Netherlands

This presentation will describe the history and background to the negotiation and entry into force of the only multilateral treaty to verifiably ban an entire class of weapons of mass destruction - the Chemical Weapons Convention. One hundred years after their first large-scale use on the battlefields of the First World War, chemical weapons are now comprehensively prohibited by a treaty to which 190 states are party. This presentation will describe the programmes and activities of the international organisation created to oversee the implementation of this treaty - the Organisation for the Prohibition of Chemical Weapons (OPCW). The OPCW's achievements were recognised by the award of the Nobel Peace Prize in 2013. The presentation will conclude with an overview of recent OPCW activities in collaboration with the United Nations to eliminate Syria's chemical weapons and with an overview of the future priorities of the OPCW as, one hundred years after their first use, we are finally moving towards a world free of chemical weapons.