The OPCW Science & Technology Monitor

A sampling of Science & Technology relevant to the Chemical Weapons Convention

26 February 2015 Volume 2, Number 3

Featured Content:

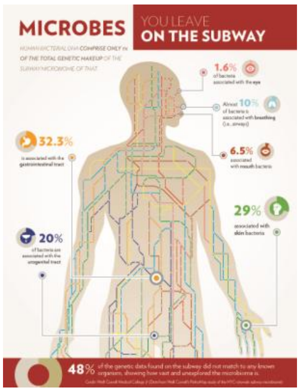

Image from *[Weill Cornell medical college](#)*.

The microbiome of the New York subway system.

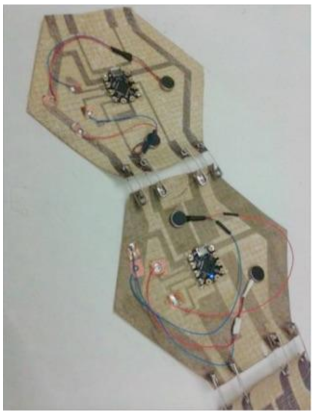

Image from [geek.com](#)

Smart scarf developed by Microsoft.

Welcome

Welcome to the *OPCW Science and Technology Monitor*, an occasional bulletin to provide updates on developments in science and technology across a broad spectrum of topics relevant to the CWC. Past issues are available from the Office of Strategy and Policy (on our portal or by request).

Today's issue of the *S&T Monitor* arrives on the anniversary of the opening of the first pneumatic powered subway line in New York City in 1870. Today, one-hundred and forty-five years later, the New York subway system uses newer technology and is home to hundreds of known and unknown microorganisms as identified by a citywide metagenomics study (details here).

The S&T Puzzle

Congratulations to Alexander Kelle (OSP) for winning the most recent puzzle with his estimate of 155,555,060 CAS numbers (closest to the reported value of >156,920,778). For those of you who were not sure where to look for the correct answer, it had been previously revealed through one of our social media posts. Puzzle statistics now stand at: VER 4, OSP 2, OCS 1.

For our next puzzle, can you guess what analysis is being performed and on what sample (in the image on the left)?

The first person to correctly answer wins the prize: a choice of either choosing our next featured topic, designing the next puzzle, or a gift of a special beverage hand selected by the Science Policy Adviser. Send your answers by email or tweet to #OPCWST. Good luck!

In this issue:

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News and Updates

We are pleased to announce that funding has been received for Project III: Science and Technology from EU Council Decision (CFSP) of 17 February 2015. This was in support of the activities of the Organisation for the Prohibition of Chemical Weapons (OPCW) for the framework of the implementation of the EU Strategy against Proliferation of Weapons of Mass Destruction.

Recently Published Reports:
Report on growing a digital social innovation ecosystem for Europe.

Mobile Technologies and Empowerment: Enhancing human development through participation and innovation from United Nations Development Programme (UNDP).

The Hague Security Delta's Achievements in 2014.

January 2015 edition of *Horizon 2020 Projects Portal*.

Science and Technology Resources:

100 years of chemical weapons from *Chemical and Engineering News*.

Infographics describing G- and V- type nerve agents.

Learn chemistry and perform virtual laboratory experiments with the ChemCrafter App.

Statistics resources for biologists (and useful for chemists too!).

Easy access to Dstl innovation (details here).

A collection of images to teach and promote safe vaccine transport.

Making News in Science and Technology:

In chemistry from the weeks of 1 - 7, 8 - 14 and 15 - 21 February 2015.

A look at what are being called the top breakthrough technologies of 2015 from the *MIT Technology Review*.

Finalists for the UAE Drones for Good Award.

Winners of the 2015 science and engineering visualisation challenge (The Vizzies).

2015 marks the 85th anniversary of the discovery of Pluto.

Analytical Tools

For sampling and analysis related to the CWC, gas chromatography/mass

Science Fun:

The headline read: "science has great news for beer lovers", so how could we possibly not run with this for the latest instalment of science fun?

The great news is of course that the hops used to make beer contain a compound that has neuroprotective properties against oxidative-stress-induced neuronal cell damage (in other words, a chemical that can help fend off Alzheimer's and Parkinson's disease (details here). For those that don't like beer, we offer hop flavoured candy.

Empirical evidence tells us that despite neuro-protective chemicals; too much beer will adversely affect your balance. No need to worry, because it turns out that it is easier to spill coffee than beer. For those that wish to do their own experiments, be aware that magnets can be used to control the foaminess of your beverages (details here).

Even genomics has studied beer (and alcohol consumption in hominids, details here) in its quest to advance our knowledge. All this beer analysis helps us make sense of historical finds too!

Beer inspires inventions; the beer can (which celebrates its 80th birthday in 2015), for example, has enabled the production of sun tracking cameras and barbeques!

Other beverages can be scientifically interesting too, and we offer the following examples:

spectrometry has long been the most suitable method for routine use. As a testament to those who developed protocols and methods, OPCW proficiency tests have been recognised as a model for inter-laboratory testing. Laboratories also have access to a variety of methodology that employs mass spectrometry and other analytical tools. Mass spectrometry coupled with appropriate separation techniques can enable complex sample analysis and characterisation, as demonstrated by a recent collection of papers on global metabolic profiling.

Raman spectroscopy is another tool that has found use in chemical weapon analysis. The methodology also finds applications that include: art and archaeology, analysis of lichens, analysis of hair (details here), identifying cancer cells during brain surgery (details here), and the analysis of biomedical samples (including urine and blood). To improve the reliability of analysis, application specific automatic standardization methods are being developed.

Everyday we read about new analytical tools and methods with a broad range of chemical applications – often identified as potential tools for chemical weapons detection (as in the case of infrared-terahertz double-resonance spectroscopy and tetrahertz gas phase spectroscopy). Tetrahertz waves can also sequence short strands of DNA (details here).

A device that exploits the semiconducting properties of a two dimensional metal-organic framework (MOF) to detect gases has been prepared for the first time (details here). MOF materials can also be used to degrade toxic chemicals. Nanotechnology based sensors with chemical weapons applications and nanosensors for explosives detection have also been demonstrated.

Other inventive approaches to detecting chemical agents use electronic "noses" and "tongues". These devices can be both bio-inspired and based on silicon devices. "Organs on chip" can be used to study the biological response to a chemical agent. The use of biological components that respond to or recognise the presence of selected chemicals is the principle behind a biosensor (these are typically integrated into microfluidic devices). Two examples of biosensor detection methods that have been applied to toxins are quantum dot fluorescence and surface acoustic waves (including Love-waves); the later with integration of the biosensor into a microfluidic device. Did you know that living plants can also be used as chemical weapon detectors (details here)?

There may be many interesting technologies out there, but one should not forget the less exotic approaches. Consider the use of imaging techniques in forensics, image analysis of sea dumped chemical weapons and detecting chemical weapons with colour (details here).

Wearable Technologies

Advancements in technology have allowed devices to become smarter and smaller! Combining cloud computing and data collection, a wealth of wearable devices are now available to consumers, especially fitness

Tequila for growing diamond films, wine for studying brain function, Scotch whiskey to produce art, cider to study fermentation, and the energetics of turning water into wine to teach physics (details here).

There is still the problem of the after effect of alcohol consumption, but science is trying to solve that too (details here)!

Crowdsourcing:

Cancer researchers need help analysing genetic information. You can contribute by playing the game, Genes in Space.

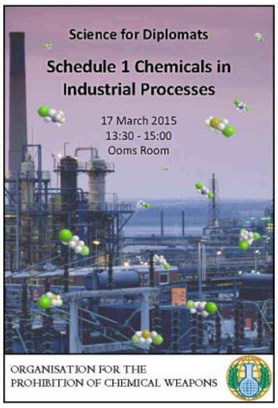
Are you good at visualising complex data? Take a look at the UNDP Human Development Data Visualization Competition.

Have any clever ideas about intravenous sustained release drug delivery technologies?

Upcoming S&T Related Events:

16 - 18 March 2015
CBRN - Research and innovation. Antibes - Juan-les-Pins, France.

17 March 2015
Science for Diplomats side event at EC-78. “Schedule 1 Chemicals in Industrial Processes”. Ooms Room, 13:30-15:00.



21 - 26 March 2015
249th American Chemical Society (ACS) National Meeting & Exposition. Denver, Colorado, USA.

During the open session of the ACS Board of Directors meeting, the 2013 Nobel Peace Prize recipient, the OPCW will be honoured for its work in finding peaceful applications of chemical sciences worldwide.

19 - 24 April 2015
ALLData2015. Barcelona, Spain.

6 - 7 May 2015
6th Meeting of the Scientific Advisory Board’s Temporary Working Group on Verification. The Hague.

10 - 13 May 2015
4th International Conference on Bio-Sensing Technology. Lisbon, Portugal.

trackers. Devices such as smart belts and smart scarves may seem like novelty items, but could actually be helpful for people with disabilities; while telescopic contact lenses and wearable air pollution monitors may have scientific applications. Computers themselves can be produced in button size and still maintain Bluetooth, low-energy radio and motion sensor capabilities.

While in the consumer world, smart glasses (Google Glass for example) have had a rocky reception, these technologies can be used to make colorimetric measurements of chlorophyll levels in plants (details here). For applications, consider that Chlorophyll has been used as a detector for chemical agent exposure.

The power of wearables lies in their combination with other devices (especially Smartphones), allowing for collection and transmission of data with temporal and geospatial information in real time; applications include monitoring crowds and pollution. Accessories to turn Smartphones into personal environmental monitors are commercially available. Health monitors based on Smartphone platforms are being developed. A miniature spectrometer for chemical analysis of food will be developed if they can procure their crowd funding.

Wearables consume energy and it should come as no surprise that wearable energy sources are also being developed. We have seen solar arm bands, energy generating shoes (details here), batteries that can be spun into clothing (details here) and batteries inspired by jewelry makers. Producing power from bodily fluids with bioelectrodes (details here) is another option (for medical implants as well as wearables!).

Despite the push for miniaturization, some wearables, such as mass spectrometer backpacks and robotic devices, may always be large in size. Miniaturization of smart clothing may also create a disadvantage. Consider, for example, nanomaterials that blur faces in photographs, adhesive tape for infrared invisibility, and adaptive optoelectronic camouflage. Smart helmets enabling reduction of stress (involving a Smartphone of course), measurement of brainwaves (for mapping “fun” bicycle routes) or “bat vision” would likewise need to remain large enough to fit your head (although this could be overcome with brain-computer interfaces).

Continuous Flow Chemical Production

When we think of a chemical production facility, we often envision stirrer tanks and large volume reactors in which a “batch” of material would be produced. An accompanying “continuous flow” process might be distillation. As with many things in the world, even this is changing as continuous flow systems for chemical production are finding their way into manufacturing processes, especially for pharmaceutical applications.

Continuous flows devices may be more familiar when called “microreactors”, although larger scale devices are used for industrial scale production (microreactors themselves are best suited to research

7 - 12 June 2015
2015 AAAS-TWAS Course on Science Diplomacy, Trieste, Italy.

8 - 12 June 2015
22nd Session of the OPCW Scientific Advisory Board. The Hague

22 - 26 June 2015
CTBT Science and Technology Conference (SnT2015)
Vienna, Austria

14 - 26 July 2015
19th Annual Green Chemistry and Engineering Conference.
Bethesda, ML, USA.

19 - 22 July 2015
12th World Congress on Industrial Biotechnology.
Montreal, Canada.

6 - 13 August 2015
IUPAC 2015
48th General Assembly
45th World Chemistry Congress. Busan, Republic of Korea

10 - 14 August 2015
Biological Weapons Convention Meeting of Experts.
Geneva, Switzerland.

27 September - 1 October 2015
ECCE10 (10th European Congress of Chemical Engineering)

ECAB3 (3rd European Congress of Applied Biotechnology)

EPIC5 (5th European Process Intensification Conference)

Nice, France.

5 - 8 October 2015
SOLVE.
Cambridge, MA, USA.

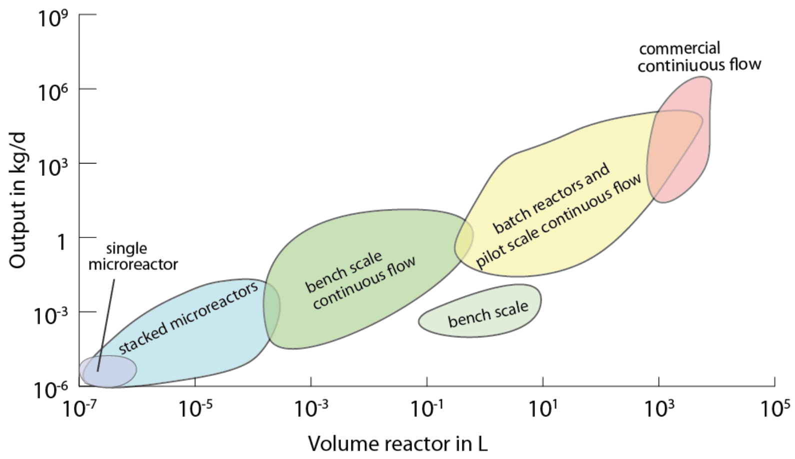
31 October - 2 November 2015
The Port Hackathon.
CERN

applications). Continuous flow chemical synthesis has many applications for pharmaceuticals and fine chemicals. Ibuprofen production has served as a model case (details here), with optimisation of reaction conditions leading to significant reduction of process time (details here). As these synthetic methods become more integrated into research, applications for a variety of organic and inorganic chemicals, and even nanoparticles have been found. Examples of reactivity patterns that change from batch to microscale flow reactors have been reported and polymerisation processes are also possible.

Flow reactors can be customised for temperature control, gas-liquid transformations or combined with sonicators and microwave devices. When combined with analytical devices (including NMR, details here), reaction conditions can optimized in real time. Reactors can be used to flow substrate solution over stationary catalysts (details here) and with their narrow dimensions, they offer advantages for photochemical processes.

Continuous flow reactors will continue to develop and enable more chemistry, however, it is perhaps the benefits they provide to chemical safety that truly make these technologies valuable. This has been demonstrated with scaling up hazardous reactions and handling hazardous reagents.

The chart below compares the scales of chemical production from laboratory (research) to industrial batch processes, to illustrate how continuous flow systems compare with batch reactors for production capability. The size of the bubbles are illustrative not exact.



Chemical Safety and Security

Chemical safety and security (and dual-use chemicals) are topics of much interest to us, and like so many of the themes and issues we think about, they have strong science and technology components.

16 - 19 November 2015
Malta Conference. Rabat, Morocco.

18 - 21 November 2015
16th Asian Chemical Congress. Dhaka, Bangladesh.

22 - 27 November 2015
2nd African Conference on research in Chemical Education (ACRICE). University of Venda, South Africa.

15 - 20 December 2015
Pacifichem 2015. Honolulu, Hawaii, USA.

Contact Us:

Questions, comments, suggestions, want to make a contribution, or be added to the mailing list? Please contact us through the OPCW Office of Strategy and Policy (OSP).

For more frequent updates, Follow us on Twitter at @OPCW_ST.

In regards to safety, we can learn much and continue to improve process safety by examining historical chemical plant disasters. Likewise, surveying safety management, collaboration and work environment in the chemical industry is a valuable way to prevent accidents from occurring. Inherent safety is an important concept that helps to mitigate hazards on a chemical plant; it is valuable to consider amongst the many factors one evaluates in plant design. Hazard identification is another important tool, as illustrated in a recent report on LNG regasification technologies. While safety management may generate bureaucracy, this is not always a bad thing. In regards to the importance of safety awareness, it has been suggested that ignorance is no form of defence!

While chemical safety looks to prevent accidents, chemical security is a more complex issue as it looks to prevent intentional and unexpected harm. Chemical supply chains are of particular interest for security considerations; their complexity lends itself to modelling with game theory. Concerns about security have prompted specialised laws and regulations in some nations and considerable discussions on chemical terrorism, vulnerability of chemical sites and analysis of how chemical weapons might still used in a 21st century world.

Chemical safety and security extends beyond those that work in laboratories or at chemical production facilities. Emergency responders and medical personnel must be trained on how to deal with patients exposed to toxic chemicals in case of an incident. In this regard, the February 2015 issue of *Emergency Medicine Clinics of North America* has an informative collection of articles on the management of hazardous material emergencies. For training, of course we want innovative approaches, perhaps virtual reality platforms are just that!