Biodegradability assessments of organic substances and polymers

Gerald Thouand, Graham Whale

Thursday May 26, 8:15 AM - 10:15 AM, Salle 200

The biodegradation of organic substances is a natural yet poorly understood process. Given that biodegradation assessments form an integral part of chemical regulations to assess the persistent of substances this lack of knowledge needs to be addressed. Official references define the biodegradation process as "The biologically mediated degradation or transformation of chemicals usually carried out by microorganisms" (ECHA, 2012). The International Union of Pure and Applied Chemistry (IUPAC) expand this definition to include the breakdown of a substance in vitro or in vivo as catalysed by enzymes (IUPAC, 1993).

Biodegradability tests/assays are usually selected depending on chemical properties and the study objective. Most are designed to batch test a chemical substance (or polymer) as the sole carbon source in a mixed inoculum from different origins (river water, sea water, activated sludge and soil). Monitoring the biodegradation process remains a difficult task, ranging from the use of basic sensors to measure non-specific biodegradation parameters (oxygen or carbon dioxide) to sophisticated analysis to measure fate of the substance (Raman spectroscopy, Nuclear Magnetic Resonance, etc.). The data used from such assays is used in two ways. The first is to claim that the substance is degraded by a biological process (biodegradable), and the second is to predict the persistence of the substance in the environment. This classification assumes that the test would mimic one part of a complex environmental process.

The European REACH Regulation (Registration, Evaluation, and Authorisation of CHemicals) envisions a tiered approach to evaluate persistence. The first tier includes the use of cheap and simple test(s) of ready biodegradability corresponding to OECD (Organisation for Economic Co-operation and Development) 301 A to F guidelines. These stringent screening level tests were developed to identify chemicals that are readily biodegradable and are not considered to be persistent. A non-readily biodegradable substance is considered persistent unless it is shown to be inherently biodegradable (i.e. using OECD 302) or 'degradable' in more expensive and complex simulation tests (e.g. OECD 303, 307, 308 and 309 tests). The simulation test(s) used will depend on the potential receptor environments of (wastewater treatment plants, surface water, sediment, or soil).

Although there are several methods to assess biodegradation there are a number of critical issues which still need to be addressed (e.g. inocula, challenge of the mixture of substances, device for the testing, non-extractable residues, interpretation and use of the data for persistence assessment). This session will aim to address some of these issues and assess the validity/robustness of current biodegradation assays and approaches to provide relevant data in the context of the REACH regulation and environmental risk assessment.

Chemical Transport via the Global Food System

Carla A. Ng, Natalie Von Goetz

Wednesday May 25, 8:10 AM - 6:30 PM, Exhibition Hall (Poster only session)

Global chemical fate models are used to determine how a chemical moves from its point of emission and distributes among different media on a global scale. Research into bioaccumulation has shown that some of the highest concentrations can be found in biota, due to accumulation from the surrounding environment and magnification from prey to predator within food webs. Owing to such accumulation mechanisms, food is recognized as a major pathway for human exposure to chemicals. Yet the system by which the majority of human populations now obtain their food is far different from the local subsistence food webs typically used in coupled chemical fate and bioaccumulation models. Over the past thirty years, our food system has become increasingly globalized. At the same time, food trade and production have shifted from fresh foods and agricultural raw materials to more complex, processed food products. These changes have important implications for the global fate of chemicals that accumulate in foods.

Foods contain a wide variety of chemicals that can enter at any point along the value chain: during production, processing, packaging and storage. Our ability to understand how food trade impacts the global distribution of chemicals is constrained by how much we know about the entire food system, from field to fork. In this session, we will bring together expertise from all branches of SETAC to explore how chemicals are transported between countries through food trade, and which chemicals enter the system at which point along the value chain. We invite contributions from life cycle assessment, fate and exposure modeling, representatives of the food industry, food and environmental scientists and regulators.

Exploring links between the biodegradation of chemical contaminants, the metabolic capability of microbial communities and environmental variables

Kathrin Fenner, Gary Bending

Thursday May 26, 10:50 AM - 12:50 PM, Salle 200

For most organic pollutants, biodegradation is the primary process determining fate and persistence in the environment and within bioremediation systems. The capability to predict biotransformation rates and potentially recalcitrant products is therefore essential. However, it requires an understanding of how rates and pathways depend on interactions between the molecular structure of contaminants, their bioavailability, the diversity and composition of microbial consortia and the prevailing environmental conditions. Recently, there have been enormous advances in analytical chemistry and molecular biology methods that provide the potential to shed light on the linkages between trace organic chemical attenuation and the metabolic capability of the microbiome in complex environments.

The goal of this session is to bring together environmental chemists, microbiologists and engineers to share recent findings which have unraveled interactions between biotransformation rates and pathways and environmental conditions and/or microbial community characteristics, integrating understanding from terrestrial and aquatic systems, including engineered treatment systems such as activated sludge, river bank infiltration or constructed wetlands.

Topics would include:

Techniques:

- Is -omics information useful in predicting biodegradation rates and pathways?
- In situ identification and characterization of degraders
- Pollutant bioavailability to degrading organisms

(Novel) results on dependencies:

- Role of microbial diversity in determining biodegradation rates and pathways
- Dependence of biodegradation rates and pathways on chemical structure and redox conditions

Specific environmental/experimental settings:

- Biodegradation under oligotrophic conditions
- Adaptation of communities to degrade pollutants

Innovative techniques for monitoring chemicals in the environment

Lorraine Helen Youds, Chris D. Metcalfe, Yelena Sapozhnikova

Tuesday May 24, 8:15 AM - 10:15 AM, Salle R0-B

Innovative technologies and new analytical techniques for pollution monitoring are fast increasing in usage by researchers, regulators and policy-makers in the field of ecotoxicology. Technological innovations in pollution monitoring include devices such as: mobile phones; passive samplers; miniaturised sensors; and robotics. New technologies provide a number of advantages over current monitoring methods in that they allow us to: quantify levels of pollution at greater frequencies and spatial resolutions than is currently possible; monitor locations that in the past have been difficult to sample (e.g. hostile environments or systems with accessibility issues); and characterise human and ecological exposure to the plethora of chemicals that have never been monitored before.

A particular application for new technologies includes (but is not limited to) the monitoring of contaminants of emerging concern (CECs) in the environment. New sensing technologies may also reduce barriers to CECs' sample collection and analysis through the application of real-time sensing and data provision. Furthermore, use of newly-developed and reliable analytical techniques (such as time of flight mass spectrometry and developments in biological assays) allow us to determine the occurrence, behaviour and fate of CECs. Newer CECs that have not previously been recognised require novel analytical methods for their characterisation, identification and detection.

Effective application of the myriad pervasive technologies provides a better understanding of the degree of exposure of humans and wildlife to pollutants and hence the risks of these pollutants to ecosystem and human health. Use of state-of-the-art analytical methods is required to detect and quantify newer CECs, which have proven difficult to analyse due to their susceptibility to degradation and transformation.

Innovative technologies and new analytical methods can also be used to inform mitigation measures both in the short term and over longer timescales. However, significant barriers to use of the data and information provided by new methods of assessment exist. For example, users of pollution data (general public and decision-makers) are often hindered by a lack of understanding of the information provided and/or a knowhow related to integration of new data into current regulatory and policy frameworks. This session will promote an open discussion inclusive of representatives from the academic, industrial, governmental and regulatory sectors, who are interested in the development of new technologies and methodologies for pollution monitoring.

Implications for human health and wellbeing, ecosystem health, big data management and stakeholder involvement and the use of new pollution data will be explored.

Interactions between traditional, novel and green carbonaceous materials and contaminants

Melanie Kah, Thomas Bucheli, Thilo Hofmann

Wednesday May 25, 8:10 AM - 6:30 PM, Exhibition Hall (Poster only session)

Understanding interactions between carbonaceous materials and contaminants has long been a topic of interest for environmental scientists working on a broad range of problematics.

Soot particles are ubiquitous in urban and industrial area, while sorption to activated carbon is the most widely applied and accepted technologies to remediate contaminated air, water, and more recently, also soil or sediment. Over the last decade, a wide range of novel carbonaceous materials have been considered. A lot of work focussed on new generations of carbon-based materials emerging from progresses in nanotechnologies (e.g., carbon nanotubes, C60 fullerenes, graphene and graphene oxides). Meanwhile, lower-cost and possibly more sustainable materials such as biochars, with or without modification, have also received great interest in the context of remediation.

The session aims at wrapping up recent knowledge on the interactions between carbonaceous materials and contaminants, and how this may impact environmental fate and effects. We invite contributions from the laboratory up to the field scale, which will support the development of promising applications (e.g., mitigation and remediation strategies, analytical method development) as well as a more robust assessment of the impact of contaminants on human and environment health.

Mercury Biogeochemistry and Policy

Nelson J O'Driscoll, Sara Klapstein, Davide A.L. Vignati, Michael S Bank

Thursday May 26, 8:15 AM - 10:15 AM, Salle R0-A

The global and regional distribution of mercury is of primary importance to both ecosystem and human health. The Global treaty on mercury is a topic of international importance and many governments are currently developing policy at both a national and international level to reduce mercury emissions.

Mercury in the form of methyl mercury (MeHg) is an acute neurotoxin and endocrine-disrupting chemical that biomagnifies in food webs, with the result that higher trophic-level organisms can suffer severe neurological and reproductive effects. Temperature, moisture and solar radiation are key climate variables affecting the fate of mercury in temperate and northern ecosystems through processes that alter mercury speciation. These processes are particularly significant given the current release of mercury into the atmosphere and the prospect of future increases in emissions. According to the most recent Arctic Monitoring and Assessment Program (AMAP) report on mercury, mercury emissions may increase by as much as 20% by the year 2020. This increase in mercury will be particularly damaging in ecosystems that retain atmospherically deposited mercury and efficiently convert it to bioavailable MeHg. These mercury-sensitive ecosystems may be located in remote areas with no direct industrial mercury emissions. While a higher average global temperature is expected to increase the global mercury burden through the release of natural stores, the rate of release and the mechanisms controlling the distribution, retention and bioavailability of deposited mercury in sensitive ecosystems still require much research. The session proposed here will discuss a wide range of topics including the processes that define a mercury-sensitive ecosystem. Facilitating collaborations and tools for ecological risk assessments around the world.

With the predicted rise in global atmospheric mercury emissions, mercury will continue to be a problem contaminant for the foreseeable future, causing particular damage to mercury-sensitive ecosystems around the world. This highlights the national and international importance of the proposed session and international collaboration. Key to the continued understanding and mitigation of the mercury problem is the fundamental science controlling its movement and bioaccumulation in ecosystems. This session will cover a wide range of mercury science including new analytical techniques, speciation in ecosystems, bioaccumulation in the food web, and multimedia modeling. We welcome both field and laboratory studies on selected sites to provide important site-specific information on mercury mobility, bioavailability, toxicity and ecological effects.

A similar session has been successfully held at every SETAC North America over the past 12 years with excellent attendance and at 2 previous SETAC Europe confernces. This topic is of great interest to a wide range of researchers, government agencies, and industries. This topic was proposed in combination with a general trace metals session in 2010 and was successful, however the abstracts presented were dominated by mercury specific research. At SETAC Basel in 2015 the session was run as mercury specific with excellent attendance. We feel that a mercury specific session would allow for better discussion and capacity building.

Passive sampling of organic micropollutants and toxicity assessment: opportunities, challenges and innovations

Rainer Lohmann, Eddy Y. Zeng, Timo Hamers, Ron van der Oost

Wednesday May 25, 10:50 AM - 4:00 PM, Salle 200

The advance of passive sampling has made it posible to monitor for a wide range of dissolved organic contaminants in local, regional and remote locations. Initially, major progress was made for the sampling of legacy, mostly hydrophobic, organic compounds using a range of apolar sampling membranes. Polar organic chemical integrative samplers have also been widely applied for passive sampling of polar organics. Ideally, passive sampling would be able to yield representative measurements of both hydrophobic and hydrophilic compounds.This session aims to discuss the latest development and applications of field monitoring, new passive sampling developments and theoretical approaches to access the occurrence, temporal trends, transport/transformation processes and impact of the organic contaminants in aquatic systems (e.g. rivers and their watersheds, lakes, seas, and oceans). In particular, we are interested in presentations that convey cost-effective environmental monitoring techniques and that address challenges such as deployments in large water bodies over extended periods of time.

Persistent and mobile contaminants in the aquatic environment: how to identify, analyse and regulate a potential threat for drinking water resources

Michael Neumann, Pim de Voogt, Thorsten Reemtsma

Tuesday May 24, 2:00 PM - 4:00 PM / Wednesday May 25, 8:15 AM - 10:15 AM, Salle 200

Chemical substances as well as their uses that fall within the scope of the REACH Regulation (EC No. 1907/2006) have to be registered by the European Chemicals Agency (ECHA) in Helsinki. Registrants are requested to ensure that their chemicals and uses provide a high level of protection to human health and the environment. The aquatic environment and more critically, drinking water resources are particularly vulnerable and require a high level of protection. In Europe, drinking water is obtained mainly from groundwater, surface water reservoirs or river bank filtration. If these environmental compartments are exposed to hazardous chemicals, drinking water can become contaminated.

In the last decade the fate and behaviour of polar and ionic organic substances has been investigated both scientifically and from a regulatory perspective. Findings point to the fact that their intrinsic hazard potential is maximised if they are persistent in the environment and simultaneously mobile in the water cycle. Once emitted, these substances can move and remain in the aquatic environment for long periods of time and the contamination is therefore irreparable. For persistent and mobile organic contaminants that reach the aquatic environment, the likelihood of them further migrating to drinking water resources is high. Their physico-chemical properties might hinder their degradation by ozone and UV or their retention via filtration using activated charcoal during water treatment processes. If the chemicals are also toxic, emissions during the production and downstream uses should be avoided.

However, for many of these substances little is known about their occurrence in the aquatic environment because analytical determination is often difficult. Their hydrophilic character hampers efficient extraction and no generally applicable analytical methods are available.

There is a need for closing these significant analytic and knowledge gaps.

The aim of this session is to stimulate the exchange between water monitoring and analytical specialists on the one hand and hazard assessment, risk mitigation and regulation on the other. We encourage contributions that propose substance properties and criteria for the identification and prioritisation of persistent and mobile organic chemicals. The session is a platform for monitoring approaches and target or non-target screenings in the aquatic environment and drinking water resources. We aim to clarifying the question regarding whether there is a need to improve the protection of drinking water resources through the improvement and enforcement of chemical regulations (e.g. REACH).