

**The international conference „Sustainable Chemistry: the way forward“ took place 24 and 25 September 2015 in Berlin. More than 170 participants from 18 countries discussed the role of sustainable chemistry - a key element of the future development of society.**

In his **opening keynote**, Jochen Flasbarth, Secretary of State from the German Federal Environment Ministry, pointed to the central role of chemicals as a basic foundation of our daily life. To ensure safety and welfare on a global scale, it is required that all actors work together for a sustainable use of chemicals. Communication within the value chains has substantially improved over the last years. However, the SAICM 2020 goal to stop the emission of hazardous substances will not be reached. Only 5 short years remain to structure the long term future of sustainable chemistry.

**Sustainability goes beyond the safe use of chemicals. The precautionary principle requires a much more holistic approach.** Right now the Sustainable Development Goals set in New York offer a historical chance to demonstrate the essential role that chemistry plays to support the sustainable development of society.

In the **first session**, a mapping of the landscape of chemistry was given – on a global scale. Trends, drivers and barriers for the marketing of chemicals have been presented by Alexander Keller (Roland Berger Strategy Consultants GmbH) and Alastair MacGregor (TruCost)). At present, the European chemical industry has still a world lead regarding innovation and quality – mainly driven by challenging customers. However, it became clear that Europe as well as Germany are losing importance as suppliers for the worldwide demand of chemicals. This trend will continue in the next decades. At present, the European chemical industry has still a world lead regarding innovation and quality – mainly driven by challenging customers.

**Even if sustainability and environmental protection are basic themes of the chemical industry, at present companies often take an observer role. Sustainability is more than resource efficiency. The total environmental and societal impacts have to be considered.**

As a key element the change from a regulatory scheme to an incentive scheme has been identified. In order to further raise industry's awareness of the importance of sustainable developments such as sustainable chemistry? The importance of sustainable development must be deeper rooted within industry. In order to further raise Industry's awareness can be further raised by making sustainable chemistry a business case. Sustainability should be linked to added value chains – this sets the most attractive incentive for companies. The absence of an appropriate metric for sustainability of chemicals makes it more difficult to count progress and to quantify steps that have been made.

In the **second session**, the policy context of sustainability and chemicals has been discussed. Anne-Sofie Andersson from ChemSec, Barbara Cunningham from the US EPA. Hubert Mandery from CEFIC, Alexander Nies from the BMUB, Kestudis Sadauskas from the EU Commission and Kerstin Stendahl from the UN Secretary for the Basel, Rotterdam and Stockholm convention showed their views on necessary steps to put sustainable chemistry forward. This has more aspects than successful business cases – growth is not a value in itself. The problematic link between an always increasing production of goods and resource consumption as well as export of hazardous waste has been addressed.

**Circular economy requires sustainable chemistry – to ensure recyclability and reuse of materials. Successful business models for sustainable chemicals have to be profiled. A strict and ambitious regulation seems to be the prerequisite for the necessary substitution of substances of very high concern.**

The success of the Montreal Protocol shows that financial mechanisms are required to follow non-compliance.

Apart from this, real challenging issues on a global scale are energy and resource consumption. Excellence in innovation is needed to solve these global problems. And excellence can't be forced by regulation, it grows only on a voluntary base. SAICM as a voluntary approach gives a good international framework to support sustainable chemistry. For specific problems, stricter regulation seems to be required.

**Next steps in implementation:** At present, many countries do not see the importance of sustainable chemistry as a global issue. In order to raise awareness and acceptance, the benefits of sustainable chemistry have to be addressed. When it comes to the decision on the next steps in implementation, the broad differences in dealing with chemicals among the countries play an important role.

**More science, more anticipation of regulation and more interest of public and investors regarding chemicals are important trends which bring sustainable chemistry forward. Downstream users as well as retailers gain importance as actors which demand more sustainable chemicals.**

The sustainable development agenda of the UN and the related sustainable development goals offer the opportunity to show: sustainable chemistry can really make an added value to implementation of sustainability. This requires multi-sectoral actions – including all stakeholders of society, not only industry.

Different from the situation 10 years ago, nowadays a large number of actors are engaged in sustainable chemistry. If they become connected, the present momentum can be used to push sustainable chemistry forward.

The **third session** addresses individual needs and opportunities to grow sustainable chemistry.

- Müfit Bahadır from the University of Braunschweig reported about increasing use of a **lab course in sustainable organic chemistry** – shared with more than a dozen of countries. It includes an easy-to-understand assessment of the hazardous potential of chemicals used in a given synthesis.
- **The concept of sustainable chemistry, key indicators.** Decades after the first definitions, the main objectives and key aspects of sustainable chemistry are becoming more complex. Dirk Bunke from Öko-Institut and Anke Joas from BIPRO addressed the need of a clear understanding what sustainable chemistry means. They invite the participants to comment on the proposed concept. In addition, they show a set of six key indicators addressing the three pillars of sustainable chemistry. And its application in case studies.
- Joel Tickner from the Green Commerce Council brought in broad experience from business cases of sustainable chemistry. **It goes beyond the sound management of chemicals**

**and aims to the innovative design of chemicals and processes.** He proposed 5 steps to enhance sustainable chemistry. They include metrics and ways to measure sustainable chemistry as well as the creation of a more vibrant and active international community.

- **Support of international cooperation and exchange in the field of sustainability is the main goal of the International Sustainable Chemistry Collaboration Centre (ISC<sub>3</sub>).** It is founded by the German Federal Environment Agency on behalf of the German Ministry for the Environment and will start work by 2017. Henning Friege from N3 Nachhaltigkeitsberatung presented the main objectives and key elements of its structure. Participants are invited to participate in this exchange.

**In session 4 panelists discussed challenges and solutions for sustainable chemistry in supply chains. Beyond the chemical industry itself, the customers and suppliers as part of the value chain become more and more important actors for sustainable chemistry.**

The following three speakers not only show successful business examples. They also addressed the challenges in complex supply chains. The examples refer to a large group of products – including textiles, popcorn and waterborne polyurethane – in a broad range of applications.

- Tess Fenelly (from T Fenelly & Associates) set the focus on two questions: Why isn't green chemistry in wider use? What are the means to accelerate availability and adaption? Major barriers to green chemistry adaption are supply chain complexity, incumbency, confusion and switching of risks. She identified four accelerators for green chemistry: collaboration, compromise, technology forcing and enhanced education (for a full report on barriers and accelerators, see the presentation).
- Malene Teller Blume from coop described challenges for growing green chemistry through the supply chain. She gave the view of Denmark's largest retail enterprise which aims to maintain its role as a first mover on the market. Since 1976, coop continuously bans harmful chemicals from their products – on top of legislation. Pro-active work on fluorinated substances in microwave popcorn packaging gave massive positive comments.
- High performance polyurethanes play an important role in different applications of the apparel industry. 99% of all PU synthetics factories use hazardous dimethylformamide (DMF) as the process solvents. Thomas Michaelis from COVESTRO AG reports about the development of waterborne PU chemistry which is based on renewable resources and has an enhanced technical performance.

Sector-specific challenges have been discussed in three break-out groups in the second part of session 4. Selected topics have been per- and polyfluorinated chemicals in the textile sector, the building sector and the electro- and electronic industries. Results of these discussions are documented in the related short notes (see agenda for download). The main findings of the first day (described above) have been summarised by Jutta Emig from the German Environment Agency

## **The second day of the conference**

**Business cases have been in the centre of the second day of the conference.** It started with observations from supply chains of the textile sector.

- Petra Schwager from UNIDO reported about 20 years of experience with chemicals management. She made clear that sustainable chemistry is not a goal in itself. It can make an important contribution to promote inclusive and sustainable industrialization. And it should be a win-win-situation for companies involved in it. Ressource efficiency and cleaner production are the key principles for the work of UNIDO in this field. **The long term objective is decoupling increase in human well being from resource depletion and emissions.**
- The brand perspective of this topic has been given by Bettina Roth from VAUDE. **The company developed its own label for sustainable products – to communicate sustainability in such a way that the consumer understands it.** Often, large environmental impacts are generated at the level of the second tier supplier. For high performance applications it can be a long way to reach the functional requirement with substitutes. **For VAUDE, sustainable chemical is not their main business. However, it is needed to be sustainable. Therefore they expect the chemical experts – from the chemical industry – to take the lead in placing more sustainable solutions.**
- Peter Waeber from bluesign technologies gave insights in recent textile production plants outside Europe. **The key to improve performance and to reduce environmental impacts at lower costs is the analysis of the whole process – not only the assessment of a single substance (at present, more than 250 lists of restricted substances are on the market). The main instrument to achieve progress is to raise awareness regarding the true costs – often not paid directly by the consumers.** The facts are known, ignorance is still a common way to deal with them.
- **Chemical leasing: saving costs, reducing impacts.** MAS is one of the largest Asian producers of intimate apparel. Nadeera Wijesinghe reported about win-win-experience of MAS due to chemical leasing. Within 15 months, a reduction of around 30% of chemicals in a specific production process has been realised. Savings in costs have been shared between the supplier of the service and the customers. For MAS, this is the only the first step – no limitations are seen for further use of this principle.

The further set of successful business cases have been presented in the second half of session 5.

- **High technology applications – increase in efficiency.** The shift of the chemical industry from finite fossil fuels to renewable feedstocks has been the topic of the presentation of Sonja Jost from DexLeChem. She gave the perspective from start-up companies. They use high technology applications – e.g. quantum chemical analysis and dynamic simulations. By this they aim to achieve substantial increase in efficiency. Main barriers for high-tech start-ups are infrastructure, financing requirements, industrial partnership agreements and risk aversions. To find the first customer – that's the biggest challenge. The open data policy of ESA for satellite data has been cited as an example for a trigger supporting start-ups.
- **Better performance – the dooropener for sustainable chemistry.** Babette Pettersen shared the experience of Bio-Amber with the audience. The company produces succinic acid on the base of sugars from plants. Compared with the production based on fossil fuels, emissions of greenhouse gases as well as energy costs are remarkably reduced. This increase of sustainability has not been of interest for the main customers. Success came when the biobased chemical products proved better performance – the door-opener for the

more sustainable product. Better options for funding by government have been the reason for Bio-Amber to place the 3.000 mtons plant in Canada.

- Asphalt for paving of roads is used in Germany in more than 20.000 different recipes. To ensure the required technical specification, analytical assessment of its composition is required. Up to know, trichloroethylene (TRI) has been essential for the analytical work. Knut Johannsen (from the German Asphalt Paving Association) and Steffen Säcker (from SAFECEM) describe a successful supply chain cooperation with an replacement of TRI by another, less hazardous acid at its end. This process will take approximately 10 years since it is connected with change of regulations and re-assessment of analytical tolerances. In the meantime a chemical leasing concept for the safe use of TRI has been established and recently accepted by the European Chemical Agency as the way to go within the authorisation process.
- Andy Shafer from ELEVANCE gave examples for the use of organic chemicals based on biomaterials for a broad range of applications. The key for success in the value chains has been improvement in the performance of the products – and a smaller environmental footprint at the same time, compared to petrol based products.

**How to push sustainable chemistry? To further push sustainable chemistry, three key elements has been in the discussion round concluding this session: communication of the added value of SC in the value chain, education and connecting the actors.**

**Make the transition: Chemiewende.** During the second day, a pitching session of Start-ups has been performed. 10 entrepreneur companies presented their business models – addressing the transition (“Chemiewende”) of chemical industry to renewable feedstocks. Groundbreaking scientific research has been combined with specific technological progress for disruptive innovations. Objectives have been reduction of expensive and harmful chemicals, biobased materials, recycling and reuse of materials. Lowering of manufacturing costs for chemicals and pharmaceuticals is one benefit if these objectives are reached. The start-ups are high-tech spin-offs from German research institutes. For more details see the presentations of the individual companies.

**Pharmaceuticals in the environment:** Several hundred pharmaceuticals are found as micro pollutants in surface waters. Session 6 of the conference has been the place to discuss options for a more sustainable way of producing and using these chemicals.

- Better avoid than solve problems: Klaus Kümmerer from Leuphana University in Lüneburg set the focus on the design of better degradable substances. Some decades ago, solvent reduction (and related cost reductions) has been the door opener for sustainable pharmaceuticals. Beyond this, tailor-made design can lead to drugs which are effective enough in the body – and better degradable in the environment. Targeted structure variation and Re-Design are two approaches to get chemicals which are “benign by design”. New business cases, a prolonged patent time and a fast track authorisation could be incentives to support the development of better degradable pharmaceuticals. The concept can be applied also for “normal” chemicals (non-pharmaceuticals).
- New and more sustainable strategies against microbes: Wailang Chang from Lisando presents ART-175. This antimicrobial agent consists of a proteolytic enzyme with a membrane-penetrating peptide. It rapidly destroys gram negative microbes. At present, no alerts for the development of resistance have been found. ART-175 could help to solve the problem

of increasing resistance of bacteria against antibiotics. Compared to conventional antibiotics, the peptide used in case of ART-175 seems to be well biodegradable.

- Adolf Eisenträger from the German Federal Environment Agency presented the view of a national authority on pharmaceuticals in the environment. By intention they enter the environment after use; often they are persistent, toxic and bio-accumulative; some are in addition very mobile. Different from the registration of industrial chemicals under REACH, the authorisation of a legacy human drug does not require an environmental risk assessment. A huge number of human drugs have been placed on the market before REACH. Only limited data are available regarding their impacts on the environment. A more powerful authorisation process including legacy drugs and a strengthening of sustainable life style are steps which could reduce adverse effects of drugs on the environment.

**The concluding discussion in this session clearly shows that more sustainable pharmaceuticals are an important issue, not only in SAICM.**

**How can we reach the SAICM 2020 goal? What steps in sustainable chemistry are required? In the final session, three break-out groups discussed potential contents of a roadmap towards more sustainability in chemistry. Important building blocks for this road map will come from the following sources:**

- **Investment**
- **Policy and**
- **Education.**

Details of the discussion can be found in the documentation in the short notes of these groups (see presentations).

Jutta Klasen from the German Environment Agency and Achim Halpaap from the United Environmental Program concluded the conference with key messages.

- **The process of making chemistry more sustainable speeded up in the last decade.**
- **This affects not only industry- but nearly all branches. Downstream users, retailers and consumer become more important. Transparency and availability of information in supply chains play a crucial role.**
- **More sustainability needs more education, more training, more awareness raising.**
- **The concept of sustainable chemistry has to include the basics – safe management of chemicals, today not achieved globally.**
- **Looking at SAICM, the setting of an international centre for sustainable chemistry takes place at the proper point in time.**
- **An exchange as today should be continued – with an increased participation of developing countries.**
- **Sustainable chemistry has gained enough momentum to be placed on the global level.**

**Note:** For details of the results, see the respective presentations (all of them are available at the conference homepage). A summary of the most important points of this documentation is given in the short paper “Messages from Berlin”.