Press release
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Five steps for the implementation of a full CO_2 economy: How the next revolution in the chemistry sector is unfolding, and first successes.

The chemical industry and the solar industry are partners in developing artificial photosynthesis to produce sustainable carbon without using biomass. Solar fuels and solar materials cover the demands of society and industry. This will change the face of the world dramatically and sets out a realistic pathway towards a truly sustainable society with infinite resources from CO_2 recycling.

Regarding that sustainable innovation sector the nova-Institut (Germany) organizes the world's largest conference: From 10th to 11th October 2012 the topic of carbon dioxide as feedstock for fuels, chemicals and polymers is the main focus in the Haus der Technik (Essen, Germany). The world's leading experts on the use of carbon dioxide will be presenting their latest developments and will put it up for discussion: http://www.co2-chemistry.eu

The revolution is already underway and it is taking place step by step – all comprehensively covered by the coming conference:

Step 1: Power-to-gas

Status: First demonstration plants are already under construction

There is an increasing demand for means of storing surplus production of solar and wind energy. Alongside other options, surplus renewable electricity can be used to split water into hydrogen (H_2) and oxygen (O_2). CO_2 and H_2 can easily be used to form the chemical compounds methane and methanol, which can be stored and later used for electricity production.

Presently, CO_2 is coming from power plant combustion; in future, it will be possible absorbing CO_2 from atmosphere (see Step 5).

The challenge for Step 1 is to optimize the system, increase the total efficiency and decrease the costs. Today, the production of methane and methanol via the pathway described above is only price-competitive using very cheap electricity (circa 0,03 € cents/kWh) like renewable surplus. In any case, methanol is the more promising option, because less hydrogen is needed in production.

Step 2: Polymers and chemicals from CO_2

Status: Polypropylene carbonate (PPC) and CO_2 polyols are already produced on small scale and available on the market; other chemicals and plastics are on the track

A very interesting CO_2-based polymer is PPC: it is 43% CO_2 by mass and biodegradable, and has high temperature stability, high elasticity and transparency, and a memory effect. These characteristics open up a wide range of applications for PPC, including countless uses as packing film and foams, dispersions and softeners for brittle plastics.

PPC is also a good softener for bio-based plastics. Many bio-based plastics, e.g. PLA and PHA, are originally too brittle and can therefore only be used in conjunction with additives for many uses. Now a new option is available. They cover an extended range of material characteristics through combinations of PPC with PLA or PHA. This keeps the material biodegradable and translucent, and it can be processed without any trouble using normal machinery. The vacuum cleaner casings that Bosch Siemens Household Appliances (BSH) displayed at ACHEMA are predominantly made of BASF's PPC and PHA and are intended as a substitute for the bulk plastic ABS.

Another CO_2-based polymer is polyethylene carbonate (PEC). PEC is 50% CO_2 by mass and can be used in a number of applications to replace and improve traditional petroleum-based plastics currently on the market. PEC plastics exhibit excellent oxygen-barrier properties that make it useful as a barrier layer for food-packaging applications.

At ACHEMA Bayer Material Science exhibited polyurethane blocks made from CO_2 polyols. CO_2 replaces some of the mineral oil use. Industrial manufacturing of foams for mattresses and insulating materials for fridges and buildings is due to start in 2015.

With the right political and research framework, CO_2-based polymers will not only have a bright future but also realize quick market penetration.

Step 3: CO_2 as carbon source for industrial biotechnology

Status: CO_2 is already used in pilots as feedstock for algae and bacteria

Modern biotechnology opens up new pathways for the direct utilization of CO_2 as a carbon source in fermentation processes according to two main, and very different, strategies.

In one strategy, CO_2 is directly fed to microalgae, either genetically modified or not, in specially designed photo-bioreactors or open ponds. The CO_2 is directly used by the microalgae to grow, and the product is the final biomass. This strategy allows the production of different kind of chemicals and has attracted a lot of interest for the production of "diesel-like" fuels, especially aviation fuel.

The other strategy involves the use of genetically modified bacteria that are able to use the CO_2 as a carbon source for their metabolism and as the backbone for producing a specially designed molecule. Although this field is still in its infancy with no commercial exploitation as yet, it is one of the most promising biotechnological routes towards creating tomorrow chemicals. Modern biotechnology offers the possibility to "reprogram" bacteria and turn them into a chemical plan that is able to synthetize virtually any target molecule.

Step 4: Artificial photosynthesis as an efficient chemical process to split water directly with photons (via catalyst) and reform hydrocarbons into fuel, chemicals and plastics

Status: Panasonic showed summer 2012 the first running prototype of an artificial photosynthesis to produce formic acid

Artificial leaves and trees use artificial photosynthesis in a fully integrated system by direct use of photons via photochemical water splitting in order to generate hydrocarbons. Hydrogen and CO_2-based processes can convert them via artificial photosynthesis into a wide spectrum of fuels (incl. aviation fuels), chemicals and polymers – and even produce fermentable sugars as feed for downstream biotechnological processes to access complex molecules.

Early technological breakthroughs in this field show us a technology that is compatible with large industrial as well as decentralized local use and robust enough for long-term operations.

Different research projects have set clear targets such as being fully cost-competitive in terms of productivity, having a low environmental impact (construction, use and end of life) and not using costly or rare elements as a catalyst.

The efficiency of the first artificial (chemical) photosynthesis is already at the same level as natural (biological) photosynthesis; the aim is to multiply efficiency by a factor of ten.

Step 5: CO_2 recovery from the atmosphere

Status: Research into more efficient and cost-competitive absorption of CO_2 from the atmosphere

With fast developing absorption and cleaning technology it will be possible to take CO_2 directly from the atmosphere – all over the globe. That would represent a huge step towards ensuring a sustainable and infinite raw material supply for industry and society.

The vision is of a world powered by solar material and fuel, splitting fresh and sea water using sunlight and CO_2 to produce food, materials, fuels, oxygen and also fresh water from sea water. A world powered by artificial photosynthesis, in which a growing proportion of human-engineered structures operate like artificial trees to feed the demands of industry and society, will lead to a truly sustainable world.

Because these technologies can be used almost everywhere, they arguable involve a moral imperative to address internationally agreed targets to reduce poverty and the lack of necessary food, energy and material as expressed in the United Nations Millennium Development Goals (2012).

Conference on Carbon Dioxide as Feedstock for Chemistry and Polymers
October 10th-11th 2012
Haus der Technik, Essen, Germany

Please find the final programme at: www.co2-chemistry.eu

Nova expects at least 400 international participants from the industry and academia. The conference language will be English.

Don't miss the world's largest event on CO_2 as feedstock for chemistry and polymers in 2012! Use the unique opportunity to gain early and comprehensive information on this innovative future-oriented sector!

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