Examples of Green Chemistry

Governments and scientific communities throughout the world recognize that the practice of green chemistry and engineering not only leads to a cleaner and more sustainable earth, but also is economically beneficial with many positive social impacts. These benefits encourage businesses and governments to support the development of sustainable products and processes. The United States, desiring to reward and celebrate significant achievements in Green Chemistry, has given out an annual award since 1996, the Presidential Green Chemistry Challenge Award.

Examples of green chemistry accomplishments listed below illustrate how green chemistry impacts a wide array of fields, from pharmaceuticals to housewares, and offer a pathway to a better world.

From Research to Practice

In 2005, the Nobel Prize in chemistry was awarded for the discovery of a catalytic chemical process called *metathesis* – which has broad applicability in the chemical industry. It uses significantly less energy and has the potential to reduce greenhouse gas emissions for many key processes. The process is stable at normal temperatures and pressures, can be used in combination with greener solvents, and is likely to produce less hazardous waste.

In 2012, Elevance Renewable Sciences won the Presidential Green Chemistry Challenge Award by using metathesis to break down natural oils and recombine the fragments into high-performance chemicals. The company makes chemicals for many uses, such as highly concentrated cold-water detergents that provide better cleaning with reduced energy costs.

Computer Chips

To manufacture computer chips, many chemicals, large amounts of water, and energy are required.

- Scientists at the Los Alamos National Laboratory have developed a process that uses supercritical carbon dioxide in one of the steps of chip preparation, and it significantly reduces the quantities of chemicals, energy, and water needed to produce chips.
- Richard Wool from the University of Delaware found a way to use chicken feathers to make computer chips! The protein, keratin, in the feathers was used to make a fibre form that is both light and tough enough to withstand mechanical and thermal stresses. The result is feather-based printed circuit board that actually works at twice the speed of traditional circuit boards.

Although this technology is still in the works for commercial purposes, the research has led to other uses of feathers as source material, including for biofuel.

Medicine

The pharmaceutical industry is continually seeking ways to develop medicines with less harmful side-effects and using processes that produce less toxic waste.

- Merck and Codexis developed a second-generation green synthesis of sitagliptin, the active ingredient in Januvia™, a treatment for type 2 diabetes. This collaboration lead to an enzymatic process that reduces waste, improves yield and safety, and eliminates the need for a metal catalyst. Early research suggests that the new biocatalysts will be useful in manufacturing other drugs as well.
- Originally sold under the brand name Zocor®, the drug, Simvastatin, is a leading prescription for treating high cholesterol. The traditional multistep method to make this medication used large amounts of hazardous reagents and produced a large amount of toxic waste in the process. Professor Yi Tang, of the University of California, created a synthesis using an engineered enzyme and a low-cost feedstock. Codexis, a biocatalysis company, optimized both the enzyme and the chemical process. The result greatly reduces hazard and waste and meets the needs of customers.

Biodegradable Plastics

Several companies have been working to develop plastics that are made from renewable, biodegradable sources.

- NatureWorks of Minnetonka, Minnesota, makes food containers from a polymer called polylactic acid branded as Ingeo. The scientists at NatureWorks discovered a method where microorganisms convert cornstarch into a resin that is just as strong as the rigid petroleum-based plastic currently used for containers such as water bottles and yogurt pots. The company is working toward sourcing the raw material from agricultural waste.
- BASF developed a compostable polyester film that called "Ecoflex®." They are making and marketing fully biodegradable bags, "Ecovio®. Certified by the Biodegradable Products Institute, the bags completely disintegrate into water, CO_2, and biomass in industrial composting systems. The bags are tear-resistant, puncture-resistant, waterproof, printable and elastic. Using these

bags in the place of conventional plastic bags, kitchen and yard waste will quickly degrade in municipal composting systems.

Paint

Oil-based "alkyd" paints give off large amounts of volatile organic compounds (VOCs). These volatile compounds evaporate from the paint as it dries and cures and many have one or more environmental impacts.

- Procter & Gamble and Cook Composites and Polymers created a mixture of soya oil and sugar that replaces fossil-fuel-derived paint resins and solvents, cutting hazardous volatiles by 50 percent. Chempol® MPS paint formulations use these biobased Sefose® oils to replace petroleum-based solvents and create paint that is safer to use and produces less toxic waste.
- Sherwin-Williams developed water-based acrylic alkyd paints with low VOCs that can be made from recycled soda bottle plastic (PET), acrylics, and soybean oil. These paints combine the performance benefits of alkyds and low VOC content of acrylics. In 2010, Sherwin-Williams manufactured enough of these new paints to eliminate over 800,000 pounds, or 362,874 kgs, of VOCs.

Source:

https://www.acs.org/content/acs/en/greenchemistry/what-is-green-chemistry/examples.html