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Green Chemistry & Sustainable Development

Abstract

Green chemistry is also known as Environmentally Benign Chemistry, Clean Chemistry, Atom Economy and Benign by Design Chemistry. Green Chemistry is the use of chemistry techniques and methodologies that reduce or eliminate the use or generation of feedstock, products, by-products, solvents, reagents, etc. in the design, manufacturing and application of chemical products that are hazardous to human health or the environment. Green Chemistry is an approach to the synthesis, processing and use of chemicals that reduces toxicity, minimizes waste, saves energy, and cuts down on the depletion of natural resources. Green chemistry approach includes new synthesis and processes as well as new tools for instructing aspiring chemists how to do chemistry in a more environmentally benign manner.

Keywords: Green Chemistry, Environment, Sustainable, Development.

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Introduction

Green chemistry discusses the engineering concept of pollution prevention and zero waste both at laboratory and industrial scales. It encourages the use of economical and eco-compatible techniques that not only improve the yield but also bring down the cost of disposal of wastes at the end of a chemical process. Green chemistry is based on the principles that reduce consumption of non renewable resources and promotes technological approaches for preventing pollution. Green chemistry is just a different way of thinking about how chemistry and chemical engineering can be done for the protection of human health and environment. The principles of green chemistry enable scientists and engineers to protect and benefit the economy, people and the planet by finding creative and innovative ways to reduce waste, conserve energy, and discover replacements for hazardous substances.

Principles of Green Chemistry

1. Prevent waste
2. Maximize use of materials – atom economy
3. Less hazardous synthesis.
4. Design safer products: design in efficacy design out hazards
5. Design benign chemicals
6. Design for energy efficiency.
7. Use of renewable feedstock.
8. Reduce derivatives
9. Catalysis (vs. Stoichiometric)
10. Design for degradation
11. Real-time Analysis for pollution prevention.
12. Inherently benign chemistry for accident prevention.

Aim of Green Chemistry

Green chemistry aims to minimise the environmental impact of the chemical industry. The aim of green chemistry is safer design of molecules, materials, products, and processes. Green Chemistry provides a design for chemical evolution and a guide for scientists to accomplish sustainable practices during chemical research, development, and manufacturing. Focus of Green chemistry is on safety, improving energy efficiency and, most importantly, minimising toxic waste from the very beginning.

Green Chemistry & Sustainable Development

The UN defines sustainable development as “meeting the needs of present without compromising the ability of future generation”. Green chemistry focuses on how to achieve sustainability through science and technology. To better understand and solve the issue of environmental pollution, many approaches and models have been developed for environmental impact assessments. Some of these approaches and models have been successful in predicting impacts for selected chemicals

in selected environmental settings. These models have joined air and water quality aspects to point and nonpoint sources and have been very useful for the development of emission control and compliance strategies. However, some of the approaches and models were aimed primarily at evaluating the quantity of pollutants that could be discharged into the environment with acceptable impact, but failed to focus on pollution prevention. The concept of end-of-pipe approaches to waste management decreased, and strategies such as environmentally conscious manufacturing, eco efficient production or pollution prevention gained recognition.

The term green chemistry, coined in 1991, is defined as "the design of chemical products and processes that reduce or eliminate the use and generation of hazardous substances." This approach to the protection of human health and the environment represents a significant departure from the traditional methods previously used. Although historically societies have tried to minimize exposure to chemicals, green chemistry emphasizes the design and creation of chemicals that are not hazardous to people or the environment. It has been applied to a wide range of industrial and consumer goods, including paints, dyes, fertilizers, pesticides, plastics, medicines, electronics, dry cleaning, energy generation, and water purification.This area of chemistry had been developed by the need to avoid chemical hazards that organic and inorganic compounds had on the body of humans and animals.

Aim of the Study

The aim of present study is to explain the role and importance of green chemistry for sustainable development.

Importance of Green Chemistry

Green chemistry gives emphasis to reducing the impact of chemicals on human health and the environment. Green chemistry focusses on higher efficiency, less waste, better product quality, and reduced liability. Green chemistry allows companies to comply with the law in much simpler and cheaper ways. Green chemistry is a fundamental science-based approach addressing the problem of hazard at the molecular level, it can be applied to all kinds of environmental issues. Research and development in the field of green chemistry are occurring in several different areas.

Green Chemistry in Day-To-Day Life

Green Dry Cleaning of Clothes

The commonly used solvent for dry cleaning is Perchloroethylene (PERC), $Cl_2C{=}CCl_2$. It is known that PERC is a suspected carcinogen. Micell technology developed by Joseph De Simons, Timothy Romark, and James McClain uses liquid CO_2 and a surfactant for dry cleaning clothes, thereby replacing PERC.

Green Bleaching Agents

The use of chlorine in wood manufacturing removes all the lignin (to give good quality white paper) but causes environmental problems. Chlorine also reacts with aromatic rings of the lignin to produce dioxins, such as 2,3,4-tetrachloropdioxin and chlorinated furans. These compounds are potential carcinogens and cause other health problems. Terrence Collins of Camegie Mellon University developed a versatile agent. They used H_2O_2 as a bleaching agent in the presence of some activators known as TAML activators .The TAML activators allow H_2O_2 to break down more lignin in a shorter time and at much lower temperature. These bleaching agents find use in laundry and result in lesser use of water.

Green Solution to Turn Turbid Water Clear

Conventionally, municipality and industrial waste water is made clear by the use of Alum. Alum is found to increase toxic ions in treated water which causes Alzheimer's disease.

Tamarind seed kernel powder, discarded as agriculture waste, is an effective agent to make municipal and industrial waste water clear. Kernel powder is non- toxic and is biodegradable and cost effective.

Computer Chips

Many chemicals, large amounts of water, and energy are required to manufacture computer chips. Richard Wool, former director of the Affordable Composites from Renewable Sources (ACRES) program at the University of Delaware, used chicken feathers to make computer chips. The protein, keratin, in the feathers was used to make a fiber form that is both light and tough enough to withstand mechanical and thermal stresses. The feather-based printed circuit board works at twice the speed of traditional circuit boards.

Medicine

Medicines with less harmful side-effects and using processes that produce less toxic waste are being developed by pharmaceutical industries. Merck and Codexis in collaboration lead to an enzymatic process for the green synthesis of sitagliptin that reduces waste, improves yield and safety, and eliminates the need for a metal catalyst. Professor Yi Tang, of the University of California, created a synthesis for the drug, Simvastatin, a leading prescription for treating high cholesterol using an engineered enzyme and a low-cost feedstock.

Biodegradable Plastics

Several companies have been working to develop plastics that are made from renewable, biodegradable sources. A method has been discovered by the scientists at Nature Works in which microorganisms convert cornstarch into a resin just as strong as the petroleum-based plastic presently used for making containers, water bottles etc. The company is working toward sourcing the raw material from agricultural waste.

Nature Works of Minnetonka, Minnesota, is making food containers from polylactic acid branded as Ingeo. BASF developed a biodegradable polyester film called as Eco flex.[20] This film is used along with cassava starch and calcium carbonate to make fully biodegradable bags called as Ecovio. The bags are certified by the Biodegradable Products Institute as completely biodegradable into water, CO_2, and biomass in industrial composting systems. bags are also found to be tear-resistant, puncture-resistant, waterproof, printable and elastic so can be used in the

place of conventional plastic bags. They will quickly degrade in municipal composting systems along with kitchen and yard waste.

Eco friendly Paints

Procter & Gamble and Cork composites & polymers established a mixture of soya oil and sugar to be used in place of petroleum petrochemicals derived paints resins and solvents which reduced the hazardous volatiles by 50%.Chermpol MPS, paint formulation use these bio basedsepose oils to replace petroleum based solvents and create paint which is safer to use.

Sherwin William established water based acrylic alkyd paints from recycled soda bottle plastic (PET), acrylics and soya bean oil. These paints give performance benefits of alkyds and low VOC content of acrylics.

Putting Out Fires in the Green Way

The conventionally used chemical firefighting foams used worldwide discharge toxic substances into environment contaminating water and deleting ozone layer. A new foam called pyro cool has now been invented to put out fires effectively without producing toxic substances as in other firefighting materials.

Solar Cell

The solar cell directly converts the light energy into electrical energy by the process of photovoltaics. Solar photovoltaic technology has been found to be one of the few renewable, low-carbon producers with both the scalability and the technological development to congregate the ever-growing global demand for electricity. Generation of electricity from solar energy results in less consumption of fossil fuels, reduction of pollution and greenhouse gas emissions.

Building with Green Technology

Green buildings make use of a variety of environmentally friendly techniques in order to reduce their impact on the environment. Use of domesticated materials, reflexive solar design, natural ventilation and green roofing technology may allow builders to construct a building with a significantly smaller carbon footprint than normal construction. These techniques are beneficial for the environment as well as they can produce cost-effective buildings which are healthier for the occupants too. Green ventilation techniques reduce the need for traditional air conditioning by allowing natural airflow

Conclusion

Green chemistry encourages chemical and biochemical technologies that are being studied, optimized, and eventually developed to promote environmental sustainability. Green Chemistry is a way of dealing with risk reduction and pollution prevention by addressing the intrinsic hazards of the substances rather than those circumstances and conditions of their use that might increase their risk. Green chemistry alone cannot solve the problem of environmental pollution but applying the twelve principles of green chemistry into practice will eventually help to pave the way to a world where the grass is greener.

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