International Journal of Science and Research Archive

eISSN: 2582-8185

Cross Ref DOI: 10.30574/ijsra

Journal homepage: https://ijsra.net/

(Review Article)

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Green chemistry and technology for sustainable development

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International Journal of Science and Research Archive, 2023, 08(02), 161–165

Publication history: Received on 03 February 2023; revised on 14 March 2023; accepted on 17 March 2023

Article DOI: https://doi.org/10.30574/ijsra.2023.8.2.0225

Abstract

Green chemistry is one of the most explored topics these days. Major research on green chemistry aims to reduce or eradicate the production of harmful bi-products and maximizing the desired product in an eco friendly way. The green chemistry is required to minimize the harm of the nature by anthropogenic materials and the processes applied to generate them. Green chemistry indicates research emerges from scientific discoveries about effluence responsiveness. Green chemistry involves 12 principals which minimize or eliminates the use or production of unsafe substances. Scientists and Chemists can significantly minimize the risk to environment and health of human by the help of all the valuable ideology of green chemistry. The principles of green chemistry can be achieved by the use environmental friendly, harmless, reproducible and solvents and catalysts during production of medicine, and in researches. Green chemistry could include anything from reducing waste to even disposing of waste in the correct manner. All chemical wastes should be disposed of in the best possible manner without causing any damage to the environment and living beings. This article presents selected examples of implementation of green chemistry principles in everyday life.

Keywords: Green chemistry; Environment; Sustainability; New technology; Development

1. Introduction

Environmental issues in the past were considered as part of the economic system and the rapid exploitation of natural resources. It took many years to consider the established ways that materials were used (feedstocks), the initial design of chemical processes, the hazardous properties of products, the energy consumption and other parameters involved in the manufacture of products (life cycle, recycling, etc)..Green Chemistry was for many years a relatively abstract idea with no basic principles and definitions of practical applications. Now, the term Green Chemistry has been defined as “the invention, design and application of chemical products and processes to reduce or to eliminate the use and generation of hazardous substances for workers and consumers”. The definition of Green Chemistry starts with the concept of invention and design. Another aspect of the definition of Green Chemistry is in the phrase “use and generation of hazardous substances”. Green Chemistry aims not only for safer products, less hazardous consequences to the environment, saving energy and water, but includes broader issues which can promote in the end Sustainable Development. In recent years Green chemistry has gained a strong foothold in the areas of research and development in both industry and academia, especially in the developed industrial countries. The U.S environmental law “The Pollution Prevention ACT of 1990” stated that the first choice for preventing pollution is to design industrial processes that do not lead to waste production . This made the approach for green chemistry.[1]

2. Basic Principles of Green Chemistry

- Prevention
- It is better to prevent the production of waste than to treat or clean up waste after it has been created.

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- Atom Economy; Synthetic methods should be designed to maximize the incorporation of all materials used in the process into the final product i.e. Reduce waste at the molecular level.
- Less Hazardous chemical synthesis; Wherever practicable, synthetic methods should be designed to use and generate substance that possesses little or no toxicity to human health and environment.
- Designing Safer Chemicals; Chemical products should be designed to affect their desired function while minimizing their toxicity and environmental destiny throughout the design of the process.
- Solvents and auxiliaries; Chose the safest solvents available for any given step and avoid whenever possible.
- Design for energy efficiency; Choose the least energy demanding chemical route. Ambient temperature and pressure are optimal.
- Use of renewable feed stocks; Use chemicals which are made from renewable (i.e. Plant based) resources rather than chemicals originating from depleting resources.
- Reduce derivatives; Minimize the use of temporary derivation such as blocking group, protecting groups.
- Catalysis; Use catalytic reagents (as selective as possible) rather than stoichiometric reagents in reactions
- Design for degradation; Design chemicals that degrade and break down into harmless products which do not persist in environment at the end of their function.
- Real time pollution prevention; Monitor chemical reaction in real time, in process and control prior to the formation of hazardous substance
- Safer chemistry for accident protection; Choose and develop chemical procedures and substances that are safer and minimize the potential for chemical accidents, explosions and fires. Here are some of the fields involved in everyday life where green chemistry has been applied to some extent.

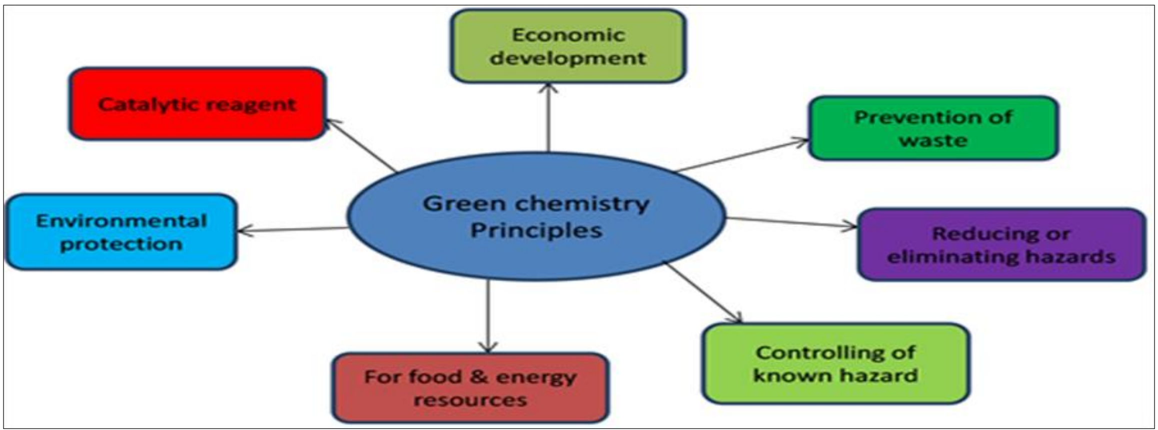

Figure 1 Principles of Green Chemistry

3. Applications of green chemistry in daily life

3.1. Green Dry Cleaning of Clothes

Percholoroethylene (perc) is the solvent most commonly used in dry cleaning clothes. Perc ($Cl_2C = CCl_2$) is suspected to be carcinogenic and it contaminates ground water on its disposal. A new technology known as miCell technology is developed by Joseph De Simons, Timothy Remark and James Mcclain in which liquid carbon dioxide can be used as a safer solvent along with a surfactant to dry clean clothes.[2] This method is now being used commercially by some dry cleaners. Dry cleaning machines have been modified for using this technology so carcinogen PERC is replaced by green solvent.[3]

3.2. Green Bleaching Agents

Conventionally during manufacturing of good quality white paper, lignin from wood used for it, is removed by placing small pieces of wood into a bath of sodium hydroxide and sodium sulphide followed by its reaction with chlorine. Chlorine during the process also reacts with aromatic rings of the lignin to form chlorinated dioxins and chlorinated furans. These compounds being carcinogens, cause health problems. Terrence Collins of carnegie Mellon university developed a green bleaching agent which involves use of H_2O_2 as a bleaching agent in the presence of some activators such as TAML which catalysis the fast conversion of H_2O_2 into hydroxyl radicals that cause bleaching.[4] This bleaching agent breaks down lignin in a shorter time and at much lowertemperature .It can be used in laundry and results in lesser use of water.[5]

3.3. Solution to Turn Turbid Water Clear

Tamarind seed kernel powder, discarded as agriculture waste, is a good agent to create municipal and industrial waste water clear. the current follow is to use Al-salt to treat such water. it's been found that alum will increase poisonous ions in treated water and will cause diseases like Alzheimer's. On the opposite hand kernel powder is not- poisonous and is perishable and price effective. For the study, four flocculants specifically tamarind seed kernel powder, mixture of the powder and starch, starch ad alum were used. Flocculants with slurries were ready by combining measured quantity of clay and water. The result showed aggregation of the powder and suspended particles were a lot of porous and allowed water to exudates and become compact a lot of simply and shaped larger volume of clear water. Starch flocks on the opposite hand were found to be light-weight weight and fewer porous and thus didn't enable water to taste it simply. The study establishes the powder's potential as associate degree economic flocculants with performance shut more matured flocculants like $K_2SO_4Al_2(SO_4)_3.24H_2O$ (potash alum).

3.4. Wind Generator

The costs of a home wind generator vary greatly. Some have built their own wind generators with off-the-shelf parts from their local hardware stores. Others have purchased kits or paid for professional installation to supplement the power purchased from their local electrical grid. The power production capability of a home wind generator varies about as much as the initial expense. Many kit based generators will produce only enough power to offset 10-15% of your Home energy costs

3.5. Rainwater Harvesting System

Rain collector systems are extremely simple mechanical systems that connect to a gutter system or other rooftop water collection network and store rain water in a barrel or cistern for later nonpotable use (like watering plants, flushing toilets, and irrigation). These systems are extremely inexpensive.

3.6. Insulation of House

Based on EPA estimates, 10% of household energy usage a year is due to energy loss from poor insulation. We will get an excellent return on investment from sealing our home to prevent energy escape.

3.7. Computer Chips

Many chemicals, huge amounts of water, and energy are required to manufacture computer chips. At the Los Alamos National Laboratory scientists have developed a method where supercritical carbon dioxide is used in one of the steps of chip preparation which appreciably decreases the amounts of chemicals, energy and water required to manufacture chips. At the University of Delaware, Richard Wool, former director of the Affordable Composites from Renewable Sources (ACRES) program established a method to make use of chicken feathers to manufacture computer chips.[6] The protein, keratin of the feathers was worn to make a fiber form that is light but tough enough to withstand mechanical and thermal stresses.[7]

3.8. Medicine

The pharmaceutical industry is working to develop medicines with less harmful side-effects, by methods which produce less deadly waste.[8]Merck and Codexis developed a second-generation green synthesis of sitagliptin that is an active ingredient in Januvia, a treatment used for type 2 diabetes.[9] This resulted in an enzymatic process that eliminates the need for a metal catalyst, reduces waste, enhances yield and safety.[10] The drug, Simvastatin, sold under the brand name Zocor, is used on large scale for treating high cholesterol. The traditional method to make this medication employed a large number of steps, used large quantity of harmfulreagents and formed a large amount of toxic waste in the process. Professor Yi Tang, of the University of California used an engineered enzyme and a low-cost feedstock to synthesize it. A biocatalysis company, Codexis, optimized both the enzyme and the chemical process which reduces hazard and waste to a great extent, is lucrative, and meets the requirements of the consumers.[11],[12]

4. Potential of green chemistry

4.1. Oxidation chemical agent and contact action

Several of the oxidization reagents and catalysts are comprised of nephrotoxic substances like Significant metals. Since these substances were typically employed in very massive volumes Needed to convert numerous pounds of petrochemicals, there was a major inheritance of those Metals being discharged to the setting and having substantial negative impact on human health and setting. It may be modified by the utilization of benign substances.

4.2. Biometric multifunctional reagents

Whereas artificial contact action and reagents for the foremost half have targeted on concluding one distinct transformation. The manipulations could embrace activation, conformational changes, and one or many actual transformations and derivitizations.

4.3. Combinatorial inexperienced chemistry

The chemistry of having the ability to create massive numbers of chemical compounds chop-chop on a little scale exploitation reaction matrices. The instance is lead that incorporates a massive no of derivatives. This chemistry has enabled massive no of gear to be created and their properties assessed while not the magnitude of the consequences of waste disposal.

4.4. Energy focus

The environmental impact of energy usage square measure profound however haven't been as visible and as direct as a number of the hazards that haven't been expose by materials employed in manufacture, use and disposal of chemicals. The advantage of contact action is dramatic in chemical science. there's a requirement to style substances and materials that square measure effective, economical and cheap at the capture, storage and transportation.

5. Fields of Green Chemistry with New Technological Developments

In the last decade Green Chemistry and Green Engineering have advanced for a great variety of research and technology fields providing cutting-edge research and practical applications for a wide spectrum of chemical products and technological innovations. The most important research and technological fields of GC (green chemistry) and GE(green engineering) include solutions. Among other things, reduction of global warming and use of CO_2 as a raw material for chemical synthesis, microwave, electrochemical and ultrasound synthetic methods, solvent free reactions (or water as a solvent), phytoremediation, waste management and wastewater, eco-friendly dyes and pigments, innovative food products, catalysis and biocatalysis, biopolymer technology, renewable materials, renewable energy sources, etc. Although there are many fields of innovation for GC and GE products are

- Biocatalysis and biotransformations processes for practical synthetic reactions
- Directed evolution. New enzymes for organic synthesis
- Green chemistry and synthetic processes in the pharmaceutical industry
- Hydrogen production via catalytic splitting of water
- Green and renewable energy sources
- Green chemistry and agricultural technologies benign to environment
- Green chemistry. Multi component reactions
- Green flow chemistry and continuous processes in chemical industry

Except for the above, there are also numerous other technological; fields of Green Chemistry and Green Engineering that have been advanced in the last years. Already, some these innovative inventions have been applied and improved sustainability, reduced environmental pollution and released less hazardous chemical products.

'Directed Evolution', Green Chemistry and Biocatalysis In 2016 the biochemical engineer Frances Arnold (CALTECH) received the Millennium Technology Prize (1 million Euros, awarded by Technology Academy Finland, Helsinki) inrecognition of her discoveries and research on the field of ‗directed evolution', which mimics natural evolution to create new and better proteins (enzymes for biocatalysis) in the laboratory. This technology have solved many important synthetic industrial problems, often replacing less efficient synthetic methods and sometimes harmful technologies. Thanks to directed evolution, sustainable development and clean technology (biocatalysis) become available in many fields of chemical industry.

6. Conclusion

Green chemistry isn't a brand new branch of science. it's a brand new approach that through application and extension of the principles of inexperienced chemistry will contribute to property development. Green Chemistry is new philosophical approach that through application and extension of the principles of green chemistry can contribute to sustainable development. It is clear that the challenge for the future chemical industry is based on safer products and processes designed by utilizing new ideas in fundamental research. Furthermore, the success of green chemistry depends on the training and education of a new generation of chemists. Students at all levels have to be introduced to the philosophy and practice of green chemistry.

Compliance with ethical standards

Acknowledgments

We thank the almighty first for the enlightenment showed on us to cross each and every step successfully . We Would like to express our thanks to Mr. Manoj Kumar, Manager Of Krishna College Bijnor for providing us a healthy environment in college, necessary facilities and encouragement during the paper work. We express our thanks to Dr. Seema Sharma, Principal, Krishna College Of Science, Bijnor for her advice and proper support.

Disclosure of conflict of interest

We have no conflicts of interest to disclose.

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