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GREEN CHEMISTRY

N. MD. Akram

Asst. Prof of Chemistry, Santhiram Engineering College, Nandyal, Kurnool Dt, Andhra Pradesh.(India)

ABSTRACT

Green chemistry is the most utilization of a set of principles that will help to decrease the use and generation of hazardous during the preparation and application of different chemical products. The main aim of Green chemistry is to protect the environment not only cleaning up, but also by the inventing new chemical methods that do not pollute the environment. It is a rapidly developing and the most important area in the environmental sciences. It is the design of chemical products and methods that to decrease or remove the use or generation of toxic substances. It applies across the whole life cycle of chemical products, including its design, preparation, applications, and ultimate disposal. It is also called as sustainable chemistry. It prevents the different types of pollutions at the molecular level. It prevents the generation of different types of pollutions and reduces the negative impacts of chemical products and processes on human health and the environment.[1]

Key Words*: *Green Chemistry Goals And Aims, Examples, Principles, Differ From Cleaning Up Pollution And Pollution Prevention Act.

I. GREEN CHEMISTRY GOALS AND AIMS

Green chemistry aims to design and produce cost-competitive chemical products and processes that attain the highest level of the pollution-prevention hierarchy by reducing pollution at its source. *[2]*

1. Designing syntheses and other processes with reduced or even no chemical waste.
2. Designing syntheses and other processes that use less energy or less water.
3. Making chemical products from feed stocks, reagents, and solvents that are less hazardous to human health and the environment.
4. Disposing of untreated chemicals safely and only if other options are not feasible.
5. Using feed stocks derived from annually renewable resources or from abundant waste.
6. Designing chemical products to be less hazardous to human health and the environment.
7. Designing chemical products for reuse or recycling.
8. Source Reduction and Prevention of Chemical Hazards.
9. Reusing or recycling chemicals.
10. Provide encouragement for green chemistry research, development, demonstration, education, and technology transfer.
11. Examine methods by which state government can create incentives for consideration and use of green chemistry processes and products.
12. Facilitate the adoption of green chemistry innovations in Michigan.

13. Expand education and training of undergraduate and graduate students, and professional chemists and chemical engineers in Michigan, including through partnerships with industry, in green chemistry science and engineering.
14. Collect and disseminate information on green chemistry research, development, and technology transfer.
15. Promote voluntary, cooperative efforts with industrial sectors to develop green chemistry plans.
16. Maintain a website to provide information about the Green Chemistry Program.
17. Provide venues for outreach and dissemination of green chemistry advances such as symposia, forums, conferences, and written materials in collaboration with, as appropriate, industry, academia, scientific and professional societies, and other relevant groups.
18. Make recommendations to the Governor on an annual basis for a Governor's Green Chemistry Award, promoting excellence, innovation, economic development and public health risk reduction by businesses and institutions.
19. Provide for public input and outreach to be integrated into the Green Chemistry Program by the convening of public discussions, through mechanisms such as citizen panels, consensus conferences, and educational events.
20. Support economic, legal, and other appropriate social science research to identify barriers to commercialization and methods to advance commercialization of green chemistry.

II. EXAMPLES OF GREEN CHEMISTRY

2.1 In the Manufacture of Computer Chips: To manufacture computer chips, many chemicals, large amounts of water, and energy are required.

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

2.3 In Biodegradable Plastics: Several companies have been working to develop plastics that are made from renewable, biodegradable sources.

2.4 In Paints: 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. *[3]*

III. GREEN CHEMISTRY'S PRINCIPLES

3.1 Prevention

It is better to prevent waste than to treat or clean up waste after it has been created.

3.2 Atom Economy: Synthetic methods should be designed to maximize the incorporation of all materials used in the process into the final product.

3.3 Less Hazardous Chemical Syntheses: Wherever practicable, synthetic methods should be designed to use and generate substances that possess little or no toxicity to human health and the environment.

3.4 Design Safer Chemicals and Products: New products can be prepared and designed that are fully effective and safer. Some of the Drugs often consist of chiral molecules.

3.5 Use Safer Solvents and Auxiliaries: Avoid using solvents, separation agents, or other auxiliary chemicals. If you must use these chemicals, use safer ones. Solvents are extensively used in most of the syntheses. Widely used solvents in syntheses are toxic and volatile – Methyl alcohol, benzene, CCl_4, $CHCl_3$, perchloroethylene, CH_2Cl_2.

3.6 Increase Energy Efficiency: Use different types of chemical reactions at room temperature and pressure whenever possible.

3.7 Use Renewable Feed Stocks: Use starting materials that are renewable. The source of renewable feed stocks is often agricultural products or the wastes of other processes; the source of depletable feed stocks is often fossil fuels or mining operations.

3.8 Reduce Derivatives: Avoid using blocking or protecting groups or any temporary modifications if possible. Derivatives use additional reagents and generate waste.

3.9 Catalysis: Catalytic reagents (as selective as possible) are superior to stoichiometric reagents.

3.10 Design Chemicals and Products to Degrade After Use: Design chemical products to break down to innocuous substances after use so that they do not accumulate in the environment.

3.11 Real-time Analysis for Pollution Prevention: Analytical methodologies need to be further developed to allow for real-time, in-process monitoring and control prior to the formation of hazardous substances.

3.12 Minimize the Potential for Accidents: Design chemicals and their physical forms (solid, liquid, or gas) to minimize the potential for chemical accidents including explosions, fires, and releases to the environment. *[4]*

IV. GREEN CHEMISTRY DIFFERS FROM CLEANING UP POLLUTION

Green chemistry reduces the different types of pollutions at its source by reducing or removing the different types of toxic substances and hazards of chemical feedstock, reagents, solvents, and products. This is unlike cleaning up pollution, which involves treating waste streams or cleanup of environmental spills and other releases. Remediation may include separating hazardous and toxic chemicals from other materials then treating them so they are no longer hazardous or concentrating them for safe disposal. Most remediation activities do not involve green chemistry. Remediation removes toxic and hazardous materials from the environment; on the other hand, it keeps the hazardous materials out of the environment. It reduces or eliminates the toxic and hazardous chemicals used to clean up environmental contaminants. *[5]*

4.1 Solvent Substitution: When CO_2 is heated to 88°F and compressed to 1,100 psi, it acts like a solvent and can be used for thinning viscous coatings to the desired level for application. Because of its solvent-like properties, CO_2 can replace hazardous hydro-carbon solvents. Solvent use can be reduced by 50 to 85 percent; and use of hazardous air pollutants.

4.2 Catalyst: Utilizing CO_2 to replace traditional reaction catalysts can eliminate hazardous by-products and create closed-loop processes.

4.3 Bio Based Materials: Bio based products are inherently less toxic and promote the principles of green chemistry by expanding opportunities to develop possible closed-loop processes utilizing renewable resources. Ultimately, renewable resources may produce a significant amount of manufacturing, pharmaceutical and consumer materials which are currently produced with nonrenewable and sometimes hazardous materials. Many biological synthesis processes are replacing conventional refining or hazardous polymerization processes.

4.4 Bio Based Feedstock for Propylene Glycol: This alternative process produces propylene glycol from waste glycerol more economically and efficiently than from petroleum. This boosts the biodiesel market by giving value to the glycerin co-product and provides a cheaper, less toxic antifreeze option to ethylene glycol.

4.5 Enzymatic Reactions: Important breakthroughs have occurred in using natural processes such as enzymatic action to create substances that previously required hazardous materials. For instance, Archer Daniels Midland Company (ADM) changed from a chemical intensive process to a natural enzymatic process to produce triglycerides that are free of any trans fatty acids. The ADM/ Novozymes process has the potential to save 400 million pounds of soy bean oil and eliminate 20 million pounds of sodium methoxide, 116 million pounds of soaps, 50 million pounds of bleaching clay and 60 million gallons of water each year.

4.6 Bio Based Feedstock for Resins: Dow has a new process to produce liquid epoxy resins (LER) which are used in marine protective, automotive, can coatings and many other applications. This process involves making a key raw material for LER resins, epichlorohydrin, from glycerin, a renewable-based feedstock.

4.7 Alternative Synthesis Pathways: Another important aspect of green chemistry is the discovery of alternative synthesis pathways. A classic example of this is the traditional synthesis of ibuprofen which previously produced large quantities of hazardous waste and had a relatively low product yield.

4.8 Production of Propylene Oxide via Hydrogen Peroxide: Propylene oxide (PO) is one of the biggest volume industrial chemicals in the world. It is a chemical building block for a vast array of products including detergents, polyurethanes, de-ice, food additives and personal care items. Its manu-facture creates by- products,

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including a significant amount of waste. Dow and BASF have jointly developed a new route to make PO with hydrogen peroxide that eliminates most of the waste and greatly reduces water and energy use.

4.9 Supramolecular Chemistry: Concepts such as supramolecular chemistry achieve reactions in a solid state without the use of any solvents and achieve up to 100 percent yields. Supramolecular chemistry and self- assembly processes in particular have been applied to the development of new materials. *[6]*

V. GREEN CHEMISTRY'S ROOTS IN THE POLLUTION PREVENTION ACT

The Act defines some points as any practice that:

1. Reduces the amount of any toxic substance, hazardous substance, pollutant, or contaminant entering any waste stream or otherwise released into the environment prior to recycling, treatment, or disposal.
2. Reduces the hazards to public health and the environment associated with the release of such substances, pollutants, or contaminants.
3. The term "source reduction" includes: *[7]*
4. Modifications to equipment or technology
5. Modifications to process or procedures
6. Modifications, reformulation or redesign of products
7. Substitution of raw materials
8. Improvements in housekeeping, maintenance, training, or inventory control
9. Section 2 of the Pollution Prevention Act establishes a pollution prevention hierarchy, saying
10. The Congress hereby declares it to be the national policy of the United States that pollution should be prevented or reduced at the source whenever feasible;
11. Pollution that cannot be prevented should be recycled in an environmentally safe manner, whenever feasible;
12. Pollution that cannot be prevented or recycled should be treated in an environmentally safe manner whenever feasible; an
13. Disposal or other release into the environment should be employed only as a last resort and should be conducted in an environmentally safe manner. *[8]*

VI. CONCLUSION

The challenges in environmental sustainability require more accurate and develop scientific technologies for chemical methods and manufacture of products. It provides such challenges by opening a wide and multifaceted research scope thus allowing the invention of novel reactions that can maximize the desired products and minimize the waste and byproducts, as well as the design of new synthetic schemes that are inherently, environmentally, and ecologically benign. Hence, combining the principles of the sustainability concept as promoted by the green chemistry principles with established cost and performance standards will be the continual endeavor for economies for the chemical industry. It is, therefore, essential to direct research and development efforts towards a goal that will constitute a powerful tool for fostering sustainable innovation. It is alone cannot solve the pressing environmental concerns and impacts to our modern era, 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. *[9]*

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