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Review Article

Review on Green Chemistry

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Abstract

The use of toxic, poisonous, hazardous, and bio-accumulative chemical substances is reduced or eliminated in green chemistry, which involves the design of chemical processes and products. It is a fresh take on scientifically based environmental protection and is essential to preventing climate change, acid rain, and global warming. Its basic tenet increases efficacy, selectivity, and minimises waste creation, making it a crucial instrument in the fight against pollution.

Keywords: Introduction, Definition, History, Principle, Industrial Interest, In Education, Advantages, Disadvantages, Conclusion.

INTRODUCTION

Green Chemistry is a non-scientific method of creating chemical processes and goods that minimises or completely does away with the usage and manufacturing of potentially harmful, toxic, and bioaccumulative chemicals by humans. It comprises developing chemicals' raw materials that will be utilised later and are healthier for the environment and people's health. It helps researchers and scientists build a useful world where people use everything via the bio-geo-chemical cycle, resulting in better lives for all people and sustainable development.. Green chemistry tries to solve these environmental issues by developing safe, alternative technology, in contrast to environmental chemistry, which identifies sources, clarifies mechanisms, and quantifies problems in the earth's environment.

DEFINITION

Green chemistry, also called sustainable chemistry, is an area of chemistry and chemical engineering focused on the design of products and processes that minimize or eliminate the use and generation of hazardous substances.[1]

HISTORY

As part of a unique initiative operated by the US Environmental Protection Agency (EPA) to encourage sustainable growth in chemical technology by business, academia, and government, Poul.T. Anastas invented the term "green chemistry" in 1991. In 1995, the US presidential green chemistry challenge was launched. The working party on green chemistry was created by the International Union of Pure and Applied Chemistry in 1996. The first book and two magazines on the subject of green chemistry were published in 1990 by the Royal Society of Chemistry. In 1990, the royal society of chemistry published the first book and two periodicals on the topic of green chemistry. Green chemistry is a novel method for creating, processing, and applying chemicals in order to lessen hazards to human health and the environment, such as:

Clean chemistry

Atom economy

Environmentally benign chemistry. [2-8]

Twelve principles of Green chemistry have been developed by Poul Anastas, speaks about the reduction of dangerous or harmful substances from the synthesis, production and application of chemical products. When designing a green chemistry process it is impossible to meet the requirements of all twelve principles of the process at the same time, but it attempts to apply as many principles during certain stages of synthesis.[9-10]

PRINCIPLE

1) PREVENTION / PREVENT WASTE

Cleaning or treating is preferable to controlling or avoiding the synthesis of hazardous, poisonous, explosive, bio-accumulative, and waste chemical compounds.[12]

Ex :

1.Prevent the manufacturing of nuclear and non-nuclear weapons, explosives, and dangerous biochemicals in a variety of industrialised and developing nations since they contribute to a variety of environmental pollutions.[13]

2.Check for and/or stop the overuse of natural resources like coal and petroleum, as these fuels produce toxic gases during combustion that lead to acid rain and global warming.[14]

2) ATOM ECONOMY:

Plan or follow the chemical procedure in such a way that the last resultant conteins large portion of the reactant or loss of raw material is less.[15]

Ex: Calculation of atom economy

One mole of anhydride, two moles of carbon dioxide, and two moles of water are formed when one mole of benzene reacts with 4 1/2 moles of oxygen.[16]

Atom Economy=

Mass of atom in desired product/mas of atomic reactant*100

=98/222*100 =44.1%

3) LESS HAZORDOUS CHEMICAL SYNTHESIS

Develop and implement the chemical process or product so that its usage and production will not degrade the environment.

Ex: 1) Avoid the preparation like organ mercurial compound, it causes minamata disaster.[17]

2) Methyl isocynate (MIC) preparation should be prevented because it contributed to the Bhopal gas disaster.[15]

4) DESIGN BENIGN CHEMICALS:

Chemical processes and products should be created in a way that minimises bio-accumulation and bio-transformation while being extremely selective in nature and affecting their target function.

Eg. 2, 4-D: It is a selective pesticide which selectively kills only broad leaf weeds.[18]

5) BENIGN SOLVENTS AND AUXILIARIES:

The use of aids or auxiliaries such as solvents or separating compounds must be non-toxic, harmless, and not able to producing mutation.

Ex: super critical carbondioxide is a better solvent because it is a non-toxic and non-explosive fluid. [19]

6) DESIGN FOR ENERGY EFFICIENCY:

It is essential or required to develop the method of chemical production so that it uses less energy to create the desired result. Chemical reaction carried out at ambient pressure and temperature with a suitable catalyst.

Ex: formation of ammonia from Haber' process. [20]

$N_2 + 3H_3 \rightarrow 2NH_3$

Temp =673 – 723kelvin, Pressure = 200 atm, catalyst =Iron

7) USE OF RENEWABLE FEEDSTOCK'S:

For continuous development, it is better to keep away from the utilization of non-renewable natural resourses likr oil, neuclear energy and natural gas.

But utilizing renewal resource per its continuous development does not pose much of a problem as it is replenished through natural processes and bio-chemical cycles.

Ex: Furfural production from bagasse and leftover biomass from the wheat and rice plants.[21]

7) REDUCE CHEMICAL DERIVATIVES:

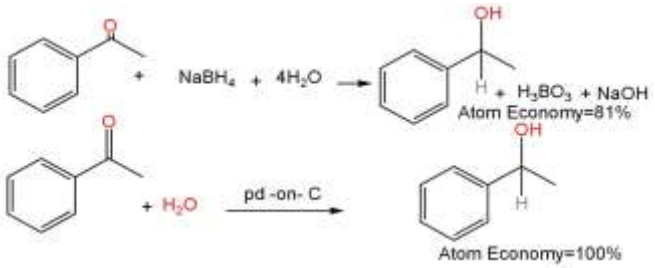
In chemical process with addition of chemical reagnts used to block orprotest the group. Hence do not use the chemical reagents which protest the group.

Ex: The commercial production of semi-synthetic antibiotics like ampicillin and amoxycillin uses enzymes to circumvent protecting groups and the cleaning procedure.[22]

8) CATALYST:

It is a chemical compound that, by lowering the activation energy, quickens the pace of reaction and then regenerates after the process. [23]Stereochemistry reagents are utilised in various chemical processes, albeit they just serve as a catalyst and do not complete the reaction. [24]

Ex



9) DESIGN FOR DEGRADATION:

The desired product and waste products from the chemical process should be arranged such that they are ecological in the surrounding environment.

By physical, chemical, and biological processes, the intended product is broken down into soft, tiny particles and does not survive in the environment.

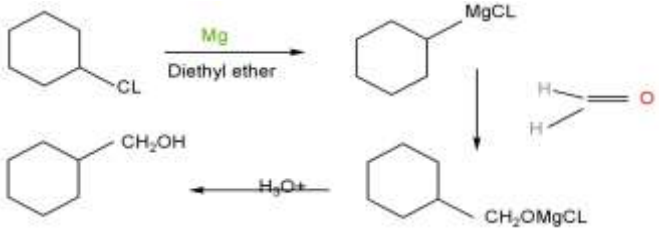
The item shouldn't be biomagnified. and do not exhibit bioamplification.

Ex: Biodegradable and bioactive thermoplastic aliphatic polyester polylactic acid (PLA).[25]

10) REAL TIME ANALYSIS FOR POLLUTION PREVENTION:

To regulate the creation of desired products and prevent the production of an unstable substance or waste material as a result, it is important to identify the occurrence of products formation through a chemical process at various temperatures, pressures, and times.

Ex.[26]



12) INNERENTLY BENING CHEMISTRY FOR ACCIDENT PREVENTION:

Develop the chemical process and changes in the product physical state (slide, liquid, gas)

To reduce or remove the potential accidents like explosion at a factory, fire accures due to chemicals liberate into the anvironment.

Hazardous substances are

Poisonous (toxic)

Flammable

Radioactive

Explosive

Corrosive (decompose or rust)

- To read labels and safety data sheet.

- To learn about dangerous and required safety provision.

- Inspect the sufficient air flow.

-Remove anything from the workspace that could burn or react with a chemical or product that is harmful.[27]

INDUSTRIAL INTEREST IN GREEN CHEMISRTY

Many forward-thinking businesses are embracing green chemistry since it frequently boosts their bottom lines as well as the environment and fosters positive public relations. According to estimates, US firms spend between $100 and $150 billion annually on compliance with environmental standards. Additionally, it will cost hundreds of billions of dollars to clean up hazardous waste sites. The cost of complying with environmental standards often outweighs the money spent on research in many businesses. Larger businesses set aside about $1 billion annually for environmental compliance. If a business can considerably cut this expense, the money saved can be used in more profitable ways, which will boost the bottom line.Thus, Green Chemistry (pollution avoidance) benefits industry as well as the environment. [28]

GREEN CHEMISTRY IN EDUCATION

Education is the first step in getting chemists to think more sustainably. In 1994, the concept of teaching green chemistry in chemistry classes was first proposed. There aren't many Green chemistry textbooks available.[29] These books will be extremely useful to graduates, postgraduates, teachers, and researchers. The necessity of introducing Green Chemistry into the classroom and the lab has been acknowledged by both the Environmental Protection Agency (EPA) and American Chemical Agency. Together, they have started a substantial initiative to create teaching resources for Green Chemistry and promote the "greening" of the chemistry curriculum.[30]

The integration of environmentally friendly technology in academia and industry depends on student engagement with Green Chemistry principles and practises. By participating in at least three Green Chemistry activities throughout the academic year, ACS Student Affiliate Chapters can be designated as "green" chapters. The following are some ideas for these activities: hosting a speaker on green chemistry

• Setting up a campus workshop on multidisciplinary green chemistry.

• Participating in a Green Chemistry initiative with a nearby business.

• Creating a Green Chemistry activity in cooperation with a nearby school.

• Making an existing scientific experiment more environmentally friendly.

• Planning a campus poster session on green chemistry sending out a Green Chemistry Newsletter to the neighbourhood.

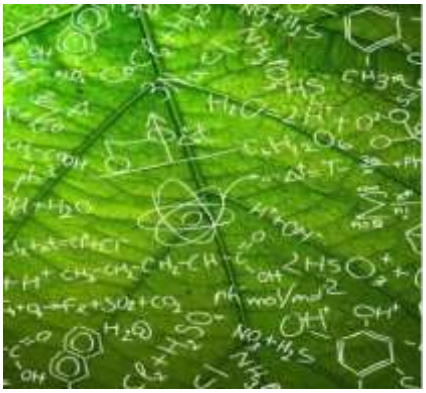
• Creating an eco-friendly Chemistry website.

ADVANTAGES

Green Chemistry reduces waste production. In actuality, green chemistry is a fresh strategy for protecting both the environment and human health. Conservation of energy and that consumption has a significant impact on the environment has long been acknowledged. Solid-state microwave irradiation [31] is a technique that, in contrast to how they have historically been carried out in liquid solutions, is being employed to speed up chemical reactions. Microwave-assisted processes without solvent [32-34] allow for the use of open containers, which lowers the danger of high pressure and increases the possibility that such reactions may be scaled up. The feasibility of microwave aided solvent free synthesis has been demonstrated by a number of real-world transformations and the synthesis of heterocyclic systems.[31-34]

DISADVANTAGES

-Creating chemical products and procedures that lessen or do away with dangerous chemicals is the fundamental task of green chemistry. This objective is also the most challenging for green chemistry, and it is particularly reflected in the amount of time, money, and information required to complete it. For example, switching from an outdated, conventional product to a new, "green" one is often difficult and expensive, and there is currently no consensus on what constitutes a safe level of chemical or raw material input.[35,36] Lack of green chemistry will result from the high implementation costs and lack of information, since there will be no defined option for using chemical raw materials or alternative technologies for green processes. Additionally, there is a shortage of human capabilities. The future of green chemistry is ionic liquids. Despite the fact that their value in chemical synthesis is undeniable. Ionic liquids do not primarily look like green chemicals when the 12 criteria that characterise them are applied.Although it is commonly known that ionic liquids have a low vapour pressure and are therefore slightly volatile, this is only one of the many factors that contribute to a material being green. For instance, liquids based on ions, fluoro-anion, and imidazole are predicted to be toxic, but they cannot evaporate into the environment. The issue is that the majority of ionic liquids are water soluble and can easily enter the biosphere through this route.[36-39]



CONCLUSION:

Our ability to accomplish sustainable development with an effective bio-geochemical cycle, a decrease in waste generation, and the prevention of environmental deterioration is made possible by the implementation of green chemistry and its 12 principles in the design of chemical processes and products. In essence, it is sustainable chemistry that cleans our globe of dangerous, poisonous, and hazardous compounds. Green chemistry's ultimate goal is to completely reduce the amount of chemicals that are released into the environment. The green chemical research fields' advancement and their application through consecutive techniques will undoubtedly result in safer speciality chemicals and significantly more satisfying processes for the chemical industry, despite the fact that this goal currently appears to be unachievable.

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