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REVIEW ARTICLE

Green Chemistry: A Revolution in the Organic Era

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ABSTRACT

Green chemistry has become the important philosophy since the 21st century. The aim of this review is to provide the concise information related to green inventions in the organic era for the benefit of Scio-economic balance. Many useful organic research is going on in a industry on large scale but as the new organic product comes into existence there side product, wastage of manufacturing process, chemical, equipments toxin not only causing health problems but also diverging the Eco-friendly environment which is deadly sign for the new generation. The present article is based on the techniques used to prevent the chemical, physical and biological hazards. The researcher should emphasize the basic principles of green chemistry while starting their innovation which will helpful to the universe.

KEYWORDS

Green Chemistry, lifecycle, Green analytical, Tools, Principles

INTRODUCTION

General View

The field of green chemistry is entering in third decade. The fathers of Green Chemistry were Paul Anastas and John C. Warner formulated some rules in the United State Environmental Protection Agency and first prepared the program, "Alternative Synthetic Pathways for Pollution Prevention"[1]. As per the definition of green chemistry it is define as **Green Chemistry is invention, design, development and application of chemical products and processes to reduce or to eliminate the use and generation of substances hazardous to human health and environment[2].**

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This review highlights the recent illustrative disclosures of the green revolution in chemistry, real fact behind the research, problems coming in future to the universe due to the tremendous use of toxic and poisonous substances. The design of chemical products and processes that reduce or eliminate the use or generation of hazardous substances. Green chemistry applies across the life cycle of a chemical product, including its design, manufacture, and use[3].

Real Case Study

Case I

In the discoverer of mustard gas, a potent blistering agent used as a warfare agent in World War-I, reported the terrible effects of his newly prepared compound on the nasal membranes when sniffed. In keeping with sound organic chemical practice of the times, he then tasted his

compound! (If you are curious about the outcome, it caused a violent headache, dutifully reported in the manuscript reporting the isolation and analysis of mustard gas.[4-5]

Case II

An early chemist exploring the class of compounds known as isocyanides, The chemist moved his research outdoors when the overpowering disgusting odor of the compounds drove him there, then ceased work with them entirely when the complaints of the neighbors became too loud.[6]

Case III

Bhopal gas tragedy was the biggest chemical disaster took place around midnight on December 2–3, 1984, in India (Figure 1). A massive cloud of toxic gas leaked from storage tanks at a Union Carbide pesticide plant in December 1984. Release of methyl isocyanate in Bhopal, killed 3800 people and permanently disabled another 2700 people. Still after 30 years the people of Bhopal are battling for survival.[7]

Figure 1: Many survivors of the December 1984 Union Carbide gas leak suffered eye damage.

Case IV

Love Canal- Niagara Falls, New York, was originally constructed by William T Love in the 1890's to be a "dream community." However, technology being created for a hydroelectric power system was never completed and in the 1920's, the canal was turned into a municipal and industrial dumping site (Beck, 1979). Since 1920-1950 nearly 21,000 tons chemical waste causing many problems and also the nearby residential areas were affected. In the late 1970's, there was a record amount of rainfall causing the leaching of hazardous chemicals through the topsoil and exposure of these chemicals to the people living on the canal. The people of the Love Canal that were exposed to these harmful chemicals developed many precursors to cancer and also saw an elevation of miscarriages and birth defects. Approximately 950 families were evacuated from a 10-square-block area surrounding the landfill.[8]

Case V

In November 29-30, 2001, the proceeding of THE LONG ISLAND SOUND LOBSTER SYMPOSIUM shows the massive survey report of the habitat of lobster at different climate regions with different species and also the variety of parameters were studied to see the effect of exposure different chemical environment as per the geographical area. In that they had also shown in September 19-22, 1999, Lobster died in large number due to the mosquito pesticides, which affect the environmental balance.[9]

Associated Problem

Waste prevention and environmental protection are major requirements in an overcrowded world of increasing demands. The global use of tremendous chemicals causing the disaster to the environment. The lists of environmental disaster are as follows

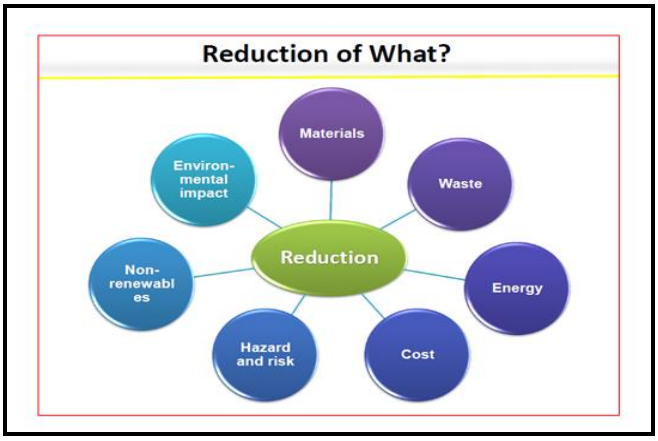

Figure 2: Associated Problems to be reduce

Environmental Impact on Agriculture

A. Climate Change

Climate change and agriculture are interrelated processes, both of which take place on a global scale. Global warming is projected to have significant impacts on conditions affecting agriculture, including temperature, precipitation and glacial run-off. Rising carbon dioxide levels would also have effects, both detrimental and beneficial, on crop yields. The overall effect of climate change on agriculture will depend on the balance of these effects.[10]

B. Deforestation

One of the causes of deforestation is to clear land for pasture or crops. According to British environmentalist Norman Myers, 5% of deforestation is due to cattle ranching, 19% due to over-heavy logging, 22% due to the growing sector of palm oil plantations, and 54% due to slash-and-burn farming.[11-12]

C. Irrigation

Irrigation may cause the Depletion of underground aquifers through over drafting. Under irrigation gives poor soil salinity control which leads to increased soil salinity with consequent build-up of toxic salts on soil surface in areas with high evaporation. This requires either leaching to remove these salts and a method of drainage to carry the salts away. Irrigation with saline or high-sodium water may damage soil structure owing to the formation of alkaline soil.[13]

Biodiversity

Biodiversity is the degree of variation of life. This can refer to genetic variation, species variation, or ecosystem variation within an area, biome, or planet. Terrestrial biodiversity tends to be highest at low latitudes near the equator, which seems to be the result of the warm climate and high primary productivity. Marine biodiversity tends to be highest along coasts in the Western Pacific, where sea surface temperature is highest and in mid-latitudinal band in all oceans.[14-15]

Human Health

Biodiversity's relevance to human health is becoming an international political issue, as scientific evidence builds on the global health implications of biodiversity loss. This issue is closely linked with the issue of climate change, as many of the anticipated health risks of climate change are associated with changes in biodiversity (e.g. changes in populations and distribution of disease vectors, scarcity of fresh water, impacts on agricultural biodiversity and food resources etc.) This is because the species most likely to disappear are those that buffer against infectious disease transmission, while surviving species tend to be the ones that increase disease transmission, such as that of West Nile Virus, Lyme disease and Hantavirus, according to a study done co-authored by Felicia Keesing, an ecologist at Bard College, and Drew Harvell, associate director for Environment of the Atkinson Center for a Sustainable Future (ACSF) at Cornell University.[16-17]

Industrial

Many industrial materials derive directly from biological sources. These include building materials, fibers, dyes, rubber and oil. Biodiversity is also important to the security of resources such as water, timber, paper, fiber, and food. As a result, biodiversity loss is a significant risk factor in business development and a threat to long term economic sustainability.[18-19]

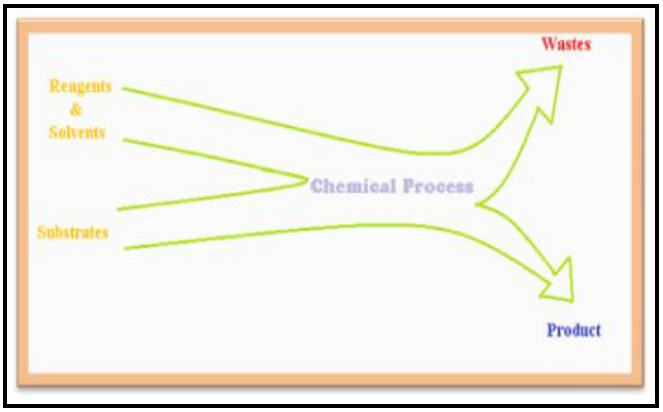

Figure 3: Green Chemical Process

Mining

Coal mining

Oil industry

Nuclear

Air/land/water

Marine

Green Principals

Many researches had given the basic of green chemistry and also the 12 Principles of green chemistry which are useful for the prevention, protection and safety universe from the toxin. The 12 Principles of green chemistry are as follows[20-21]

1. Yield products with minimum side or toxic risk.
2. Eco-friendly with low toxicity inputs and intermediates.
3. Use of recycle material as process input.
4. Atom economy
5. Maximum use of eco-friendly catalyst to enhance the productivity.
6. Involves minimum use of chemical derivatives.
7. Minimized use of reagents and solvents.
8. Less energy consumption for productivity and more product life.
9. Yield less or no waste product.
10. Design products to undergo degradation in the environment
11. Minimization of potential risk for accidental release.
12. Pollution Monitoring during the Production or manufacturing.

Tools of Green Chemistry[22]

1. Green Reagent
2. Green catalyst
3. Phase transfer catalysis (PTC) in green synthesis
4. Microwave induced green synthesis
5. Ultrasound assisted green synthesis
6. Biocatalyst in organic synthesis
7. Aqueous Phase reactions
8. Organic synthesis in solid state
9. Versatile ionic liquids as green solvent
10. Supercritical Fluid: $ScCO_2$
11. Tellurium in organic synthesis

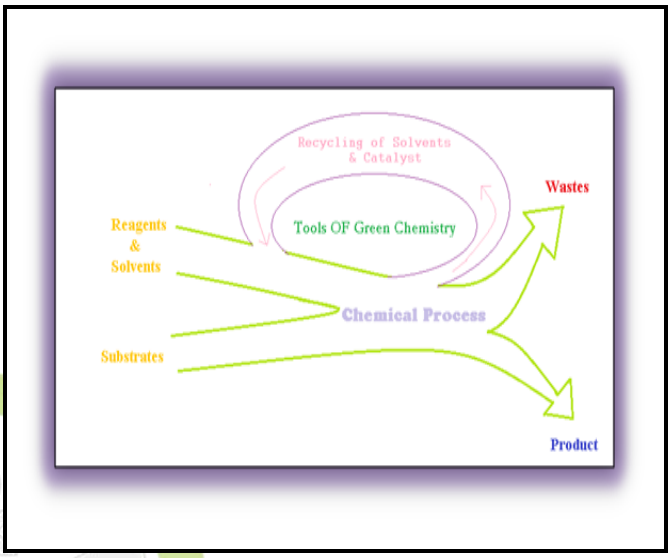

Figure 4: Recycling of Reagents with the help of tool of Green Chemistry

Green Chemistry and Engineering

There are many options for researcher to work under the centre for green chemistry, and many useful technologies are available with the help of that newer techniques (experimental) will improve the yield and reducing the duration of the reactions, which provides the need and new ideas for a good synthetic design. Various newer methods of kinetic activation, which minimize the energy input by optimizing reaction conditions, some of they are given bellow.[23]

Crystal Engineering

Crystal engineering and Co-crystal solid forms are gaining increased significance in the pharmaceutical and chemical industry as an efficient way to modify the physicochemical properties of organic molecules like Active Pharmaceutical Ingredients (APIs), intermediates and other synthetic products since last two decades.[24]

Noncovalent Derivatization

The noncovalent derivatization is one of the principles of green chemistry which includes the processes of molecular recognition and self-assembly are inherently benign in terms of impact on human health and the environment.[25]

Photo Polymers

A photopolymer is a polymer that changes its properties when exposed to light, often in the ultraviolet or visible region of the electromagnetic spectrum, [26] the changes in the structure and chemical property intended by the chromophore which is internally present in the molecules.[27]

Ambient Metal Oxide Semiconductors

The metal oxides semiconductors have wide range of application in the field of industry and other sources, the gas metal oxide semiconductor were widely utilized because they are relatively inexpensive compared to other sensing technologies, robust, lightweight, long lasting and benefit from high material sensitivity and quick response times.[28]

Reaction Design

Designing of reaction is also very important as they will provide the complete details related to the raw material, catalyst, processing time, input energy required and finally the yield and purity of product. The designing of reaction plays a backbone in any process of chemical reaction and acts as rough frame work for the researches.[29]

Medicinal Chemistry

Now a day's, invention of many new drugs and process are in tremendous use but some are against the green chemistry principle they are harmful to the environment as well as for the human beings. Green chemistry tools influence a medicinal chemistry and research chemistry based organization for the quality and effective process.[30]

Green Policy

The environmental control on the pollution and waste is one of the biggest cleaning problems for the developing or undeveloped countries. There should be one department or organization which keeps the watch on the cleaning issues and should be revised time to time as per the condition and situation. Different Organization which are helping in building, enhancing, devoting the people for the green chemistry principles. Some of these organizations are as follows.[31-32]

A. World Health Organization [Health Impact Assessment (HIA)]
B. Broad-Focus Environmental Groups
C. Environmental Groups Focused on Climate Change
D. Environmental Groups Focused on Energy and Mining
E. Forest Protection Groups
F. Other Specific-Focus Environmental Groups
G. International-Focus Environmental Groups
H. Environmental Research and Public Policy Groups
I. Conservation Groups
J. Natural Resource Defense Council

Motives for Organizations Implementing Sustainability Strategies

Ecological Motives

A. Conserving energy
B. Conserving resources
C. Reducing pollution
D. Reducing waste

Economic Motives

A. Generating revenue
B. Cost reducing potential
C. Social License - does contribute to revenue generation but worthy of own section

Legal and Regulatory Pressures

A. US Clean Air Act
B. US Resource Conservation and Recovery Act
C. US Clean Water Act

Figure 5: Green Sustainability

CONCLUSION

The term Green chemistry is also called sustainable chemistry and is a philosophy of chemical research and engineering that encourages the design of products and processes that minimize the use and generation of hazardous substances. The following review provides the complete detail related to the application of green zone in the world of chemistry. Although we are known the best knowledge of the cleanliness and principles of green chemistry but not applicable in practical life. The above article provide the information related what are the hazardous and toxic substance than can be replace by the other useful substance and process.

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