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Green Chemistry- A Present Need and Its Scenario

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ABSTRACT: Green chemistry involves the development of chemical products and synthetic proce Green chemistry is are environment friendly and have reduced health risks with the search for more efficient methods to do chemistry. Its roots stem back ten years from a simple idea to a prominent concept which permeates all areas of modern chemistry. Chemistry is undeniably a very prominent part of our daily lives. Food and drink has been made safe to consume, the development of cosmetics has enabled us to beautify and admire our appearances and the whole area of pharmaceuticals has allowed the development and synthesis of new cures for illnesses and diseases, all as a result of chemistry. However, additional chemical developments also bring new environmental problems and harmful unexpected side effects, which result in the need for 'greener' chemical products. Green chemistry looks at pollution prevention on the molecular scale and is an extremely important area of Chemistry due to the importance of Chemistry in our world today and the implications it can how on our environment. The Green Chemistry program supports the invention of more environment friendly chemical processes which reduce or even eliminate the generation of hazardous substances. This program works very closely with the twelve principles of Green Chemistry as shown below:

- Safer Solvents and Auxiliaries
- Design for Energy Efficiency
- Use of Renewable Feedstocks
- Reduce Derivatives
- Catalysis
- Design for Degradation
- Real-time analysis for Pollution Prevention
- Inherently Safer Chemistry for Accident Prevention
- Prevention
- Atom Economy
- Less Hazardous
- Designing Safer Chemicals

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] While environmental chemistry focuses on the effects of polluting chemicals on nature, green chemistry focuses on the environmental impact of chemistry, including reducing consumption of nonrenewable resources and technological approaches for preventing pollution.

The twelve principles of green chemistry are:

- Prevention. Preventing waste is better than treating or cleaning up waste after it is created.
- Atom economy. Synthetic methods should try to maximize the incorporation of all materials used in the process into the final product. This means that less waste will be generated as a result.
- Less hazardous chemical syntheses. Synthetic methods should avoid using or generating substances toxic to humans and/or the environment.
- Designing safer chemicals. Chemical products should be designed to achieve their desired function while being as non-toxic as possible.
- Safer solvents and auxiliaries. Auxiliary substances should be avoided wherever possible, and as non-hazardous as possible when they must be used.
- Design for energy efficiency. Energy requirements should be minimized, and processes should be conducted at ambient temperature and pressure whenever possible.

- Use of renewable feedstocks. Whenever it is practical to do so, renewable feedstocks or raw materials are preferable to non-renewable ones.
- Reduce derivatives. Unnecessary generation of derivatives—such as the use of protecting groups—should be minimized or avoided if possible; such steps require additional reagents and may generate additional waste.
- Catalysis. Catalytic reagents that can be used in small quantities to repeat a reaction are superior to stoichiometric reagents (ones that are consumed in a reaction).
- Design for degradation. Chemical products should be designed so that they do not pollute the environment; when their function is complete, they should break down into non-harmful products.
- Real-time analysis for pollution prevention. Analytical methodologies need to be further developed to permit real-time, in-process monitoring and control before hazardous substances form.
- Inherently safer chemistry for accident prevention. Whenever possible, the substances in a process, and the forms of those substances, should be chosen to minimize risks such as explosions, fires, and accidental releases.

I. INTRODUCTION

Chemists have used their knowledge and skill to prepare a large number of new materials which are far better and more useful than the natural products, such as high-tech polymers, liquid crystals, tough ceramics, nonlinear optical substances, novel electronics, designer drugs, genetic materials and new energy sources. The term Green Chemistry was coined in 1991 by Anastas. The purpose is to design chemicals and chemical processes that will be less harmful to human health and environment. Green chemistry protects the environment, not by cleaning up, but by inventing new chemical processes that do not pollute. Green chemistry seeks to reduce pollution at source, whereas environmental chemistry focuses on the study of pollutant chemicals and their effect on nature. Designing Safer Chemicals: Newproducts can be designed that are inherently safer for the target application. Safer Solvents and Auxilliaries: Solvents are extensively used in most of the syntheses. Use of RenewableFeedstocks Chemical transformations should be designed to utilize raw materials and feedstocks that are renewable, but technically and economically practicable. Use of Catalyst: Catalysts are used in small amounts and can carry out a single reaction many times and so are preferable to stoichiometric reagents, which are used in excess and work only once. They can enhance the selectivity of a reaction, reduce the temperature of a transformation, reduce reagentbased waste and potentially avoid unwanted side reactions leading to a clean technology. The values and positive impact of green chemistry to tomorrow's in different fields.[1]

The growing process of industrialization was a milestone for world economic evolution. Since the 1940s, social movements have revolutionized green chemistry and provided shifts in industrial positions and sustainable processes with advances in environmental impact and awareness of companies and population. Paul Anastas and John Warner, in the 1990s, postulated the 12 principles of Green Chemistry, which are based on the minimization or non-use of toxic solvents in chemical processes and analyzes, as well as, the non-generation of residues from these processes. One of the most active areas of Research and Development in Green Chemistry is the development of analytical methodologies, giving rise to the so-called Green Analytical Chemistry. The impacts of green chemistry on pharmaceutical analyzes, environmental, population, analyst and company are described in this review and they are multidimensional. Every choice and analytical attitude has consequences both in the final product and in everything that surrounds it. The future of green chemistry as well as our future and the environment is also contemplated in this work.

Chemistry brought about medical revolution till about the middle of twentieth century in which drugs and antibiotics were discovered. The world's food supply also increased enormously due to the discovery of hybrid varieties, improved methods of farming, better seeds, and use of insecticides, herbicides and fertilizers. The quality of life on earth became much better due to the discovery of dyes, plastics, cosmetics and other materials. Soon, the ill effects of chemistry also became pronounced, main among them being the pollution of land, water and atmosphere. This is caused mainly due to the effects of by-products of chemical industries, which are being discharged into the air, rivers/ oceans and the land. The use of toxic reactants and reagents also make the situation worse. The pollution reached such levels that different governments made laws to minimize it. This marked the beginning of Green Chemistry by the middle of 29th century. Green Chemistry is defined as environmentally benign chemistry. As on today, maximum pollution to the environment is caused by numerous chemical industries. Therefore, attempts have been made to design synthesis for manufacturing processes in such a way that the waste products are minimum, they have no effect on the environment and their disposal is convenient. For carrying out reactions it is necessary that the starting materials, solvents and catalysts should be carefully chosen. For example Benzene (C6H6) as a solvent must be avoided at any cost since it is carcinogenic in nature. If possible, it is best to carry out reactions in the aqueous phase. With this view in mind, synthesis methods should be designed in such a way that the starting materials are consumed to the maximum extent in the final product. The reaction should also not generate any toxic by-products[2,3]

II. DISCUSSION

The limitations of a command and control system for environmental protection have become more obvious even as the system has become more successful. In industrialized societies with good, well-enforced regulations, most of the easy and inexpensive measures that can be taken to reduce environmental pollution and exposure to harmful chemicals have been implemented. Therefore, small increases in environmental protection now require relatively large investments in money and effort. Is there a better way? There is, indeed. The better way is through the practice of green chemistry. Green chemistry can be defined as the practice of chemical science and manufacturing in a manner that is sustainable, safe, and non-polluting and that consumes minimum amounts of materials and energy while producing little or no waste material. The practice of green chemistry begins with recognition that the production, processing, use, and eventual disposal of chemical products may cause harm when performed incorrectly. In accomplishing its objectives, green chemistry and green chemical engineering may modify or totally redesign chemical products and processes with the objective of minimizing wastes and the use or generation of particularly dangerous materials. Those who practice green chemistry recognize that they are responsible for any effects on the world that their chemicals or chemical processes may have. Far from being economically regressive and a drag on profits, green chemistry is about increasing profits and promoting innovation while protecting human health and the environment. To a degree, we are still finding out what green chemistry is. That is because it is a rapidly evolving and developing subdiscipline in the field of chemistry. And it is a very exciting time for those who are practitioners of this developing science. Basically, green chemistry harnesses a vast body of chemical knowledge and applies it to the production, use, and ultimate disposal of chemicals in a way that minimizes consumption of materials, exposure of living organisms, including humans, to toxic substances, and damage to the environment. And it does so in a manner that is economically feasible and cost effective. In one sense, green chemistry is the most efficient possible practice of chemistry and the least costly when all of the costs of the practice of chemistry, including hazards and potential environmental damage are taken into account. Green chemistry is sustainable chemistry. There are several important respects in which green chemistry is sustainable:[4]

• Economic: At a high level of sophistication green chemistry normally costs less in strictly economic terms (to say nothing of environmental costs) than chemistry as it is normally practiced.

• Materials: By efficiently using materials, maximum recycling, and minimum use of virgin raw materials, green chemistry is sustainable with respect to materials.

• Waste: By reducing insofar as possible, or even totally eliminating their production, green chemistry is sustainable with respect to wastes.[5]

III. RESULTS

From the preceding discussion, it should be obvious that there are certain basic principles of green chemistry. Some publications recognize "the twelve principles of green chemistry."2 This section addresses the main ones of these. As anyone who has ever spilled the contents of a food container onto the floor well knows, it is better to not make a mess than to clean it up once made. As applied to green chemistry, this basic rule means that waste prevention is much better than waste cleanup. Failure to follow this simple rule has resulted in most of the troublesome hazardous waste sites that are causing problems throughout the world today. One of the most effective ways to prevent generation of wastes is to make sure that insofar as possible all materials involved in making a product should be incorporated into the final product. Therefore, the practice of green chemistry is largely about incorporation of all raw materials into the product, if at all possible. We would not likely favor a food recipe that generated a lot of inedible byproduct. The same idea applies to chemical processes. In that respect, the concept of atom economy discussed in Section 1.6 is a key component of green chemistry. The use or generation of substances that pose hazards to humans and the environment should be avoided. Such substances include toxic chemicals that pose health hazards to workers. They include substances that are likely to become air or water pollutants and harm the environment or organisms in the environment. Here the connection between green chemistry and environmental chemistry is especially strong. Chemical products should be as effective as possible for their designated purpose, but with minimum toxicity. The practice of green chemistry is making substantial progress in designing chemicals and new approaches to the use of chemicals such that effectiveness is retained and even enhanced while toxicity is reduced. Chemical synthesis as well as many manufacturing operations make use of auxiliary substances that are not part of the final product. In chemical synthesis, such a substance consists of solvents in which chemical reactions are carried out. Another example consists of separating agents that enable separation of product from other materials. Since these kinds of materials may end up as wastes or (in the case of some toxic solvents) pose health hazards, the use of auxiliary substances should be minimized and preferably totally avoided.[6] Energy consumption poses economic and environmental costs in virtually all synthesis and manufacturing processes. In a broader sense, the extraction of energy, such as fossil fuels pumped from or dug out of the ground, has significant potential to damage the environment. Therefore, energy requirements should be minimized. One way in which this can be done is through the use of processes that occur near ambient conditions, rather than at elevated temperature or pressure. One successful approach to this has been the use of biological processes, which, because of the conditions under which organisms grow, must occur at moderate temperatures and in the absence of toxic substances.[7,8]

IV. CONCLUSION

New chemistry is required to improve the economics of chemical manufacturing and to enhance the environmental protection. The green chemistry concept presents an attractive technology to chemists, researchers, and industrialists for innovative chemistry research and applications.[9]

Primarily, green chemistry is characterized as reduction of the environmental damage accompanied by the production of materials and respective minimization and proper disposal of wastes generated during different chemical processes. According to another definition, green chemistry is a new technique devoted to the synthesis, processing, and application of chemical materials in such manner as to minimize hazards to humankind and the environment.Numerous new terms have been introduced associated with the concept of "green chemistry," such as "eco-efficiency," "sustainable chemistry," "atom efficiency" or "atom economy," "process intensification and integration," "inherent safety," "product life cycle analysis," "ionic liquids," "alternate feedstocks," and "renewable energy sources."Hence, there is an essential need to improve the synthetic and engineering chemistry either by environmental friendly starting materials or by properly designing novel synthesis routes that reduce the use and generation of toxic substances by using modern energy sources.Green chemistry is generally based on the 12 principles proposed by Anastas and Warner [10]. Nowadays, these 12 principles of green chemistry are considered the fundaments to contribute to sustainable development. The principles comprise instructions to implement new chemical products, new synthesis, and new processes [11]

In synthetic organic chemistry, effecting a successful chemical transformation in a new way or with a new molecule or in a new order is what matters regarding the principles of green chemistry. Various researchers have clearly demonstrated the direct relation of toxicity and the associated hazards and risks allied with chemical reactions to the matrix of matter present in the reaction vessel. Generally, the holistic toxicity spectrum of products or processes, together with most other sustainability and green chemistry criteria, is highly impacted by the chemistry behind a process and the transformation contributing to a chemical synthesis chain. An exception is identified in such cases where a molecule is produced by purpose, which is designed to display toxicity and/or biologically activity. For example, this scenario is found in the case of various molecules synthesized for pharmaceutical or agricultural applications; such compounds exhibit toxicity and/or impact living organisms.Selection of compounds and materials to be used to increase the efficacy of chemical transformations is a pivotal point in process development; chemists should dedicate increased attention to the decision on which materials to be put into reaction vessels. It is simple to disregard all the other materials and to dedicate all efforts exclusively to the chemosynthetic pathway, which provides us with the desired product. However, discounting all the other matter present in a production process ultimately results in a high price to be payed, and we finally have to get rid of this scenario. Sometimes, chemists actually produce hazardous molecules, and, therefore, the subsequent principle is dedicated to the design of molecules which are intrinsically safer in their nature [12]

Intrinsically, safe chemistry can also be carried out in flow mode, using tubular microreactors with reaction channels of tiny diameter. Such flow chemistry approaches drastically reduce the reaction volume, the reaction time, and catalyst requirement, intensifies the processes by boosting the space/time yield, opens new process windows in terms of extreme temperature and pressure conditions to be applied, and, moreover, even allows to carry out highly dangerous reactions in a safe way. In addition, the application of flow chemistry in microreactors also displays a strategy to overcome classical drawbacks of microwave-driven processes, such as the restricted penetration depth of microwaves into absorbing media.

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