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Evolution of Green Chemistry: A Review

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ABSTRACT

The rising industrialization process was a game changer in the development of the global economy. Social movements have changed green chemistry since the 1940s and resulted in shifts in industrial positions and sustainable processes with improvements in environmental effect and awareness of businesses and the general public. The 12 principles of "green chemistry," which were developed by Paul Anastas and John Warner in the 1990s, are centered on limiting or avoiding the use of harmful solvents in chemical processes and analyses as well as the formation of residues from these procedures. The creation of analytical techniques, which gave rise to the term "Green Analytical Chemistry," is one of the most active fields of research and development in green chemistry. This research exercise tries to explore the evolution of Green chemistry.

INTRODUCTION:

As we look across the field of Green Chemistry since its emergence as a cohesive field of study beginning with the development of environmentally friendly processes in the early 1990s[1] it is possible to identify certain trends where much research has focused and where significant advances have been made. Certainly the area of environmentally

benign solvents has been one of the leading research areas of Green Chemistry with great advances seen in aqueous (biphase) catalysis[2] and the use of supercritical fluids[3] in chemical reactions. While the greenness of ionic liquids and fluorous media[4] will ultimately depend on their individual properties with respect to health and the environment, the sustainability of new biobased solvents[5] has to be proven as well.

Chemists and chemistry, in general, have made an enormous contribution to the history of humankind. Beginning with the early alchemists, these contributions include several developments that changed the course of history for the better or, in some cases, for the worse. Many of them may seem to be simple by today's standards, but at the time, they were groundbreaking discoveries and inventions.

The fabrication of simple soaps made the formation of large cities possible by improving personal hygiene. The production of dyes and paints contributed significantly to fashion and art over the centuries. As the usefulness of chemistry became clear, more people decided to pursue such endeavors, which brought exponential growth in this field.[6] As Dalton, Avogadro, and Lavoisier made their famous discoveries, chemistry became viewed more and more as science than as black magic. Significant advancements in chemical theory sped up the creation of new applications, which spurred even further development. However, there were issues at some points along the route. Several innovations that had the best of intentions turned out to be harmful to human health or the environment. Before Rowland and Molina published their research on the disastrous impact of these chemicals on the ozone layer that shields the world from dangerous UV radiation, the use of freons as inflammable carrier gasses in a variety of sprays in the 1960s and 1970s looked to be ideal. After World War II, antibiotics were in high demand—that is, until it was discovered that germs could become resistant to them, making them more challenging to treat. Plastics initially appeared like a blessing, but

EMERGENCE OF GREEN CHEMISTRY:

Early on in the development of the chemical industry, scientists were already implementing some of the much later developed concepts of green chemistry, albeit unknowingly. For instance, heterogeneous catalytic petrochemical processes were first developed in the 1930s. Following a number of significant industrial accidents and environmental calamities, such thinking started to become more conscious. The aforementioned issues are only a few examples that show how chemicals can be potentially dangerous when used and introduced into the biosphere without enough care and ahead planning. The 1962 book Silent Spring by Rachel Carson, which detailed how hazardous chemicals were destroying local ecosystems, probably served as a wake-up call for society to solve the problems or suffer serious repercussions. The National Environmental Policy Act was approved by the US Congress in 1969 as the first significant move to address these challenges. President Nixon created the US Environmental Protection Agency (US EPA) in 1970. Many environmental laws have been put into effect during the 1970s, including the Safe Drinking Water Act of 1974 and the Clean Air Act of 1970, which highlighted the government's determination to address the issues through regulations. Since it was passed in 1976, the US Toxic Substances Control Act has listed over 80,000 substances. The EPA Office of Pollution Prevention and Toxins first used the phrase "green chemistry" in the early 1990s. The US EPA created the Presidential Green Chemistry Awards in 1995 as a yearly awards programme to honor innovators in both business and academia. At the University of Massachusetts Boston, the first PhD in Green Chemistry programme was created in 1997. The American Chemical Society Green Chemistry Institute was established the same year as the Green Chemistry Institute. Original research and review articles in the topic have been published in a number of scientific publications focused on green chemistry since the 1990s. Today, every major publisher offers numerous books and at least one journal focused on green or sustainable chemical research. and

PRINCIPLES OF GREEN CHEMISTRY

1. Prevention: It is better to prevent waste than to treat or clean up waste after it has been created.
2. Atom economy: Synthetic methods should be designed to maximize the incorporation of all materials used in the process into the final product.
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.
4. Designing safer chemicals: Chemical products should be designed to affect their desired function while minimizing their toxicity.
5. Safer solvents and auxiliaries: The use of auxiliary substances (e.g., solvents, separation agents, etc.) should be made unnecessary wherever possible and innocuous when used.
6. Design for energy efficiency: Energy requirements of chemical processes should be recognized for their environmental and economic impacts and should be minimized. If possible, synthetic methods should be conducted at ambient temperature and pressure.
7. Use of renewable feedstocks: A raw material or feedstock should be renewable rather than depleting whenever technically and economically practicable.
8. Reduce derivatives: Unnecessary derivatization (use of blocking groups, protection/ deprotection, temporary modification of physical/chemical processes) should be minimized or avoided if possible, because such steps require additional reagents and can generate waste.
9. Catalysis: Catalytic reagents (as selective as possible) are superior to stoichiometric reagents.
10. Design for degradation: Chemical products should be designed so that at the end of their function they break down into innocuous degradation products and do not persist in the environment.
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.
12. Inherently safer chemistry for accident prevention: Substances and the form of a substance used in a chemical process should be chosen to minimize the potential for chemical accidents, including releases, explosions, and fires.

WHY IS GREEN CHEMISTRY IMPORTANT?

According to the Toxic Release Inventory of the United States Environmental Protection Agency, 30 billion pounds of chemicals were released into the atmosphere, the ground, and the water in 1993. Although this data contains emissions from a range of industrial sectors, it only includes 365 of the about 70,000 chemicals that are now sold in commerce. The toxic release inventory covers a variety of industrial sectors, but the chemical manufacturing industry releases the most chemicals into the environment—more than four times as many pounds as the next biggest sector. A number of rules and regulations have been passed over the years, creating the current state of environmental protection in the US.

IMPLEMENTATION OF GREEN CHEMISTRY PRINCIPLES INTO PRACTISE:

In some industrial chemical processes, not only waste products but also the reagents used for the production, may cause a threat to the environment. The risk of exposure to hazardous chemical compounds is limited in daily work by protective equipment such as goggles, breathing apparatus, face-guard masks, etc. According to the principles of green chemistry, a threat can be eliminated in a simpler way, by applying safe raw materials for the production process. Large amounts of adipic acid [HOOC(CH2)4COOH] are used each year for the production of nylon, polyurethanes, lubricants and plasticizers. Benzene — a compound with convinced carcinogenic properties — is a standard substrate for the production of this acid. Chemists from State University of Michigan developed green synthesis of adipic acid using a less toxic substrate. Furthermore, the natural source of this raw material — glucose — is almost inexhaustible. The glucose can be converted into adipic acid by an enzyme discovered in genetically modified bacteria.[7] Such a manner of production of this acid guards the workers and the environment from exposure to hazardous chemical compounds.

Green chemistry tries, when possible, to utilize benign, renewable feedstocks as raw materials. From the point of view of green chemistry, combustion of fuels obtained from renewable feedstocks is more preferable than combustion of fossil fuels from depleting finite sources. For example, many vehicles around the world are fueled with diesel oil, and the production of biodiesel oil is a promising possibility.[8]

CONCLUSION:

Industrial chemicals and consumer items containing chemicals should be viewed as having inherent properties, and their potential negative effects on the environment and human health should be kept to a minimum during design. First of all, the only method for designing less or ideally harmless products is to comprehend at the molecular level how chemical structure and toxicity relate to one another. While reducing the inherent toxicity of chemical-based consumer products ought to be the main goal, knowledge of secondary toxicity helps to ensure that the chemical's mode of action targets a particular biological pathway that is specific to the pest, lowering the risk of endangering other living systems. Additionally, it will be necessary to create molecules that exist and maintain their structural integrity only for as long as is necessary.Last but not least, the success of Green Chemistry ultimately depends on the working chemists who will employ the same brilliance and innovation that have been a part of chemistry for a long time with the fresh viewpoint for revolutionary breakthroughs in sustainability.

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