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Green chemistry: Advancing Sustainable Practices for Greener

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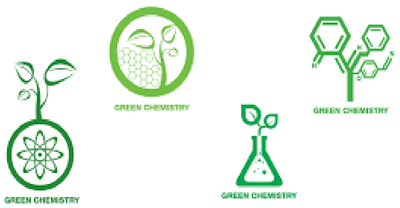
Abstract

Green chemistry is a new and rapidly emerging branch of chemistry. The beginning of green chemistry is considered a response to the need to reduce the damage to the environment by man-made materials and the processes used to produce them. Green chemistry could include anything from reducing waste to even disposing of waste in the correct manner. All chemical wastes should be disposed of in the best possible way without causing any damage to the environment and living beings. Those who practice chemistry in industries, universities, and research experience an extensive variety of challenges as a consequence of the green chemistry revolution. With these challenges, however, there are an equal number of opportunities to discover and apply new chemistry, improve the economics of chemical manufacturing, and enhance the much-tarnished image of chemistry. This article presents selected examples of implementing green chemistry principles in everyday life.

Keyword: Green Chemistry, Development, Environment.

Introduction

Green chemistry is defined as a branch of science that utilizes a set of principles for the invention, design, development, and implementation of chemical products and processes that reduce or eliminate the use and generation of hazardous substances. The approach in chemistry is protecting human health and the environment and it represents a significant departure from the traditional methods previously used. Prior to green chemistry, the main objective was to minimize exposure to chemicals; nevertheless, green chemistry puts an intense focus on creating and manufacturing chemicals that are safe both for individuals and the natural world.



It has been applied to a wide range of industrial and consumer products like technology, dry cleaning, energy production, paints, dyes, fertilizers, pesticides, polymers, medications, and water filtration.

The molecular structures of the chemicals decide their properties, which can be modified by changing the structures of the chemicals. Green chemistry addresses the various hazards that can be caused by the chemicals, which include physical hazards (being explosive or flammable), toxicity (being carcinogenic or cancer-causing, or lethal), or global hazards (climate change or stratospheric ozone depletion). Therefore, under green chemistry, the various substances can be synthesized in a non-hazardous way.

The main challenge for different industries and research organizations is to develop new methods of developing non-hazardous products under green chemistry. In India, various national and international programs have been organized for promoting green chemistry and collecting the views of different research workers about this particular field. We require governmental, nongovernmental bodies, and academic and industrial co-operations for achieving the desired goal.

Aim of Study

To explore the principles and practices of green chemistry, and its potential to promote sustainable development and reduce the environmental impact of chemical processes.

Origin Of Green Chemistry

"Green Chemistry" is defined in the Lindhorst article as having three major time periods of development. Before 1993, the early origins of pollution control and hazard awareness of pollution were observed. In this time period, Environmental Protection Agency evolved with strict command and control with end-of-the-pipeline technology to active efforts to prevent pollution before it happened with risk analysis early on in the process. The following time frame is from 1993 to 1998. This period saw the development of the chemistry theory. It is a combination of several chemical concepts and a conceptual framework that can be used in the design of chemical processes to achieve environmental and economic goals by way of preventing pollution. This comprises ambient reaction conditions, renewable feedstocks, and

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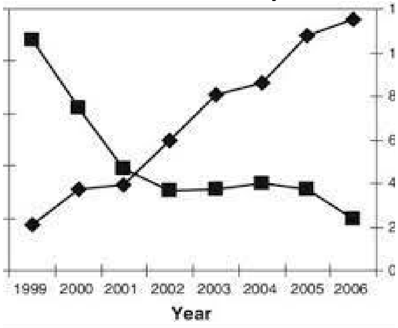
minimization of reaction steps. The third time period is from 1999 to know which has seen an explosion of Green Chemistry-based scientific articles.

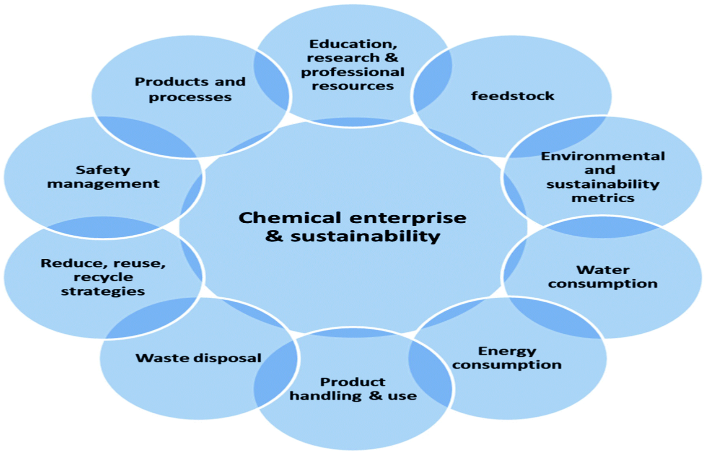


The Pollution Prevention Act (1990)

Instead of treating contaminants once they are created, it focuses on preventing contamination at the source. This goal became a formal objective of the Environmental Protection Agency (EPA) in 1991. The phrase "green chemistry" was first used by Anastas that year. Kenneth Hancock of the National Science Foundation (NSF) and Joe Breen, who retired from the NSF after twenty years of employment, were two of the most well-known and early proponents of green chemistry. The EPA then became the first director of the Green Chemistry Institute (GCI) during the late 1990s (Paul and Mary, 2002).

The Benefits Of Green Chemistry

Green chemistry has the potential to lessen harm to human health and the ecosystem. In the past we have focused on cleaning up toxic messes, is a movement to design chemicals that are safer for the environment and human.



1. Garbage prevention is preferable to garbage treatment or clean-up after it has already been produced.
2. Atom Economy: Synthetic processes should be created to incorporate as much of all the elements used as possible.
3. Less Dangerous Chemical Synthesis: When possible, synthetic techniques should be created to use and produce compounds that are safe for both the ecosystem and human health.
4. Creating Safer Chemicals: Chemical goods should be made with the least amount of toxicity possible while still performing the intended purpose.
5. Safer Auxiliaries and Solvents: It is recommended to use auxiliary substances (such as solvents, extraction agents, etc.). whenever feasible, and harmless when in use.
6. Design for Energy Efficiency: Chemical processes' energy needs should be considered in light of their effects on the climate and the economy, and they should be kept to a minimum. Synthetic procedures ought to be carried out at room temperature and pressure whenever feasible.
7. Use of regenerative Feedstocks: Whenever it is scientifically and monetarily feasible, a basic substance or feedstock should be regenerative rather than diminishing.
8. Reduce Derivatives: Wherever feasible, derivatization that is not absolutely required (such as the use of blocking groups, protection or deprotection, or transient alteration

of physical or chemical processes) should be limited or avoided. can produce garbage

9. In catalysis, more specific catalytic reagents perform better than stoichiometric reagents.
10. 10. Design for Degradation: Chemical goods should be made to degrade into harmless degradation products at the end of their useful lives and not linger in the environment.
11. Real-time analysis for pollution prevention: It is necessary to improve analytical methods so they can support real-time, in-process tracking and control before dangerous substances are formed.
12. Inherently Safer Chemistry for Accident Prevention: Materials and a substance's shape used in a chemical process should be selected to reduce the possibility of chemical mishaps, such as releases, blasts, and fires.

The Role Of Green Chemistry And Green Engineering In The Life Cycle Analysis Of Industrial Products

Technology that is seriously harming the ecosystem includes industrial chemical equipment and goods. It is necessary to evaluate and quantify their evaluation at each step, from the purchase of raw materials to production and disposal. For a holistic approach to the subject, scientists established the scientific method called Life Cycle Analysis (LCA). LCA is also known as life-cycle eco-balance. It is a method for evaluating the environmental effects of a product from birth to cemetery, including the extraction of raw materials, production, dissemination, use, repair, disposal, and recycling. (Baumgartner and Rubik, 1993; Athanasios et al., 2012).

1. The process of life cycle analysis of products

The process of LCA of a product is a systematic process that takes into account all the stages in the making of a product. It begins with the raw materials, moves through the various manufacturing steps, has a usable existence as a consumer good, and then goes through upkeep, recycling, or disposal in its final phases. The LCA process is a systematic, phased approach and consists of four components: goal definition and scoping, inventory analysis, impact assessment, and interpretation of the results.

2. Goal Definition and Scoping

Specify and explain the item, procedure, or action. Identify the limits and environmental impacts that will be examined for the assessment and establish the framework in which the assessment will be made. Setting the parameters of the study is crucial.

3. Inventory Analysis

Determine and measure the use of energy, water, and resources, as well as environmental emissions. e.g., air emissions, solid waste disposal, wastewater discharges). Simulation methods and computer programming for environmental leads to are essential component of the research. (for comparable or equivalent goods).

4. Impact Assessment

Assess the potential human and ecological effects of energy, water, and material usage and the environmental releases identified in the inventory analysis.

5. Interpretation

Ethe revaluate sults of the inventory analysis and impact assessment to select the preferred product, process, or service with a clear understanding of the uncertainty and the assumptions used to generate the results (Curran, 1993).

Green Chemistry And The Pharmaceutical Industry

Green Chemistry and Green Engineering have influenced in recent years the most important chemical industries and inevitably the pharmaceutical industry is at the forefront of big changes toward greener feedstocks, safer solvents, alternative processes, and innovative ideas (Athanasios, 2012; Cavan, 2009; Tucker, 2006).

The pharmaceutical industry depends on organic synthetic processes for its manufacturing of drugs and uses a variety of organic solvents for the separation and purification of its products. Organic solvents are known for their toxic properties and the cost of their waste. According to estimates, the major pharmaceutical firm Glaxo Smith Kline (GSK, UK) uses a lot of solvents in its manufacturing operations, and 85–90% of its non-water liquid waste is liquid organic solvents (Bruggink, 2003; Mazza, et al., 2008).

The pharmaceutical industry is embracing more and more “green” processes and technology operations. The research departments of many big drug manufacturers in developed countries are advancing new methodologies, better biocatalysts reactions, fewer solvents, and cuts in waste production. At the same time, the pharmaceutical industry introduces safety and health regulations to protect the workers and environmental criteria for their products (Slater, 2007).

Green Chemistry In India

India is ranked 2nd in producing pesticides, 12th in pharmaceutical production, and among the top 5 in the selected petrochemicals. These facts have also caused environmental disturbances due to the generation of hazardous materials. Due to the large-scale production of pesticides, pharmaceuticals, petrochemicals, and other consumer goods, there is great potential for green chemistry research in India to replace the existing methodology with environmentally benign methods. Currently, green chemistry research in India has been applied to areas of greener synthetic strategies, catalyst development, usage of biocatalysts, usage of nonconventional technologies, and analytical techniques (Gary, 2005).

Strategies: For the development of green strategies for the production of various substances, our main aim should be to concentrate on avoiding environmentally noncompatible reagents, solid-phase syntheses, modification of synthetic methods that simplify traditional reaction processes and use newer catalysts to reduce the number of stages and improve output overall. The combined approach of these above-mentioned methods is required for synthesizing green products. Our main aim is to avoid the use of organic solvents in product synthesis as the waste products from these productions are the more hazardous. The chemists in India are trying to develop benign reagents and carry out catalyst-based reactions that require ambient conditions.

Role Of Enzymes

Indian scientists have been working on improving the application of enzymes for years in order to create novel artificial sweeteners like high fructose corn syrup (HFCS), synthetic honey, and other culinary items like polysaccharide gums, thickeners, and flavour additives. There is a great need to develop newer enzymes that can work under ambient conditions (Anastasi et al., 2000).

Non-Academic Strategies

In India, there is a great need for improvement in industries from an environmental point of view. Most Industries tend to focus more on cost-effectiveness than eco-effectiveness. Some collaborative work has been done by academic institutes and some industries to bring eco-friendly lab technologies to industrial plants. The best examples are the applications of enzymes in various industries ranging from drugs to leather. The textile industry is one of the highly revenue-generating industries in India, and they are now switching over to microbial decolorization and degradation. Government can do a lot of good for the cause of green chemistry by increasing public awareness and by bringing and enforcing strict environmental legislation. One of the recent examples of government the initiative is the conversion of diesel vehicles to compressed natural gas (CNG) to reduce pollution in the capital city of Delhi.

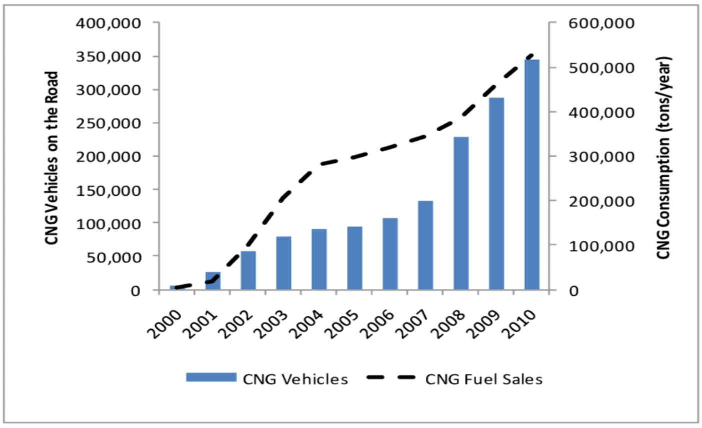


Fig 2: CNF Vehicles Per Year

India's Initiative Toward Green Chemistry

The green chemistry chapter of India has already started which emphasizes the utilization of green chemistry in India. A national seminar on green chemistry was organized in the Department of Chemistry, Delhi University in 1999 which brought together the different views and ideas of all the research workers active in this field. For education about green chemistry, a refresher course was organized for college teachers by the centre of professional development in higher education at the University of Delhi. The green chemistry chapter of India has been continuously planning on its development since its origin. The priority of it is to aware young researchers about green chemistry using workshops, scholarships, awards, and seminars. The aim of green chemistry in India is to encourage the collaboration of government policies, industrial techniques, and academics and establish a global partnership among them for proper environmental management.

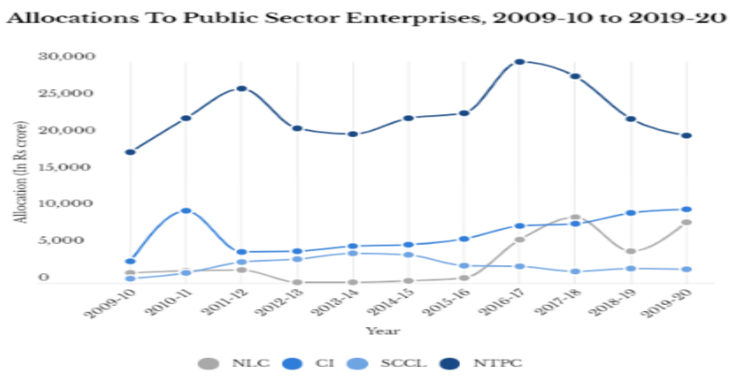


Fig 3: Budgets On Green Chemistry

Ideas For Activities

1. Develop a green chemistry website.
2. Make a green chemistry bulletin board.
3. Promote green chemistry on campus.
4. Give green chemistry demos.
5. Educate the community regarding "green products".
6. Run a seminar series on ecological chemistry subjects that is conducted by student chapters.
7. Explore a green science lab or plant on a field excursion.
8. Attend a green chemistry workshop.

Other Applications Include

Green cement: Cement manufacture releases approximately 6% of carbon dioxide of its total release in the atmosphere. For every 1 tonne production of cement at 1500°C, 100 kg of fossil fuel is used and nearly 1-tonne carbon dioxide is released into the environment (Romano and Rodrigues, 2008).

Silicates which are the primary constituents of cement are present in enormous amounts in some types of waste and low-value biomass. e.g., Rice hulls contain about 10% silicates in them. From them, these silicates can be created at 600° C and then further processing at 800° C. Rice hulls are produced in an extreme amount in the U.S.A., China, and Brazil.

Green chemistry in the food industry: Consumers safer foods but also foods that use natural rather than synthetic additives. Spices and essential oils are being researched as natural agents are demanded food preservation. In a publication from the USA, seven citrus essential oils were screened for antibacterial activity against 11 strains of Salmonella. The good inhibiting activity was shown by several oils with terpenes from orange essence showing the highest activity. This substance's composition was mostly made up of d-limonene, according to analysis. (Bryan et al., 2008).

Bio De-icing solutions are frequently used on highways, airport runways, and other substantial uses. Currently used de-icing fluids which include glycols when used in large volumes have a lot of impact on the environment. In a US patent, a group from the Battelle Memorial Institute in Ohio report the use of a novel, non-hazardous anti-icing agent based on a bio-derived freezing points depressant such as glycerol which can be mixed with other bio- polyols as well as a surfactant and an anti-oxidant (e.g. citric acid) can be used. Polymers like PVP can also be used in these formulations (Clark, 2008).

Green waxes: Plants are coated with some chemicals which perform multiple functions in different environmental conditions and at different times of the year. These chemicals, mainly waxes are extracted and further used in many applications. According to a research publication on green chemistry at York, by using the low environment impact supercritical carbon dioxide the surface waxes from low-value wheat straw have been extracted. From these waxes, different chemicals can be fractionated which are used in manufacturing cosmetics, nutraceuticals, and insect repellents. These natural and nonanimal-derived products also have a low environmental impact. These green products have gained popularity in recent years (Mazza, and Cottrell, 2008).

Refuse from agriculture was used as fuel and a source of sustenance for animals before being treated with wine refuse. But nowadays scientists have found this agricultural waste as a useful source of chemicals. In Canada and Turkey, some research workers have extracted useful phytochemicals from grape cane waste which is used in the manufacturing of Pinot Noir wine. These phytochemicals have shown significant success in the treatment of animal diseases such as cancer and cardiovascular diseases. These have good antioxidant properties as well. An environmentally safe mixture of ethanol and water is used to isolate trans-resveratrol and trans-vinifera which are the chief phytochemicals extracted from grape wine waste as contraindicated (Dalia, 2008).

Dry cleaning: The solution for dry cleaning clothing is also condensed phase carbon dioxide. Despite the fact that carbon dioxide alone is not an effective solution for oils, waxes, and greases, its use in conjunction with a detergent enables the substitution of perchloroethylene, which is the solvent used most often to dry clean clothes, although it poses hazards to the environment and is a suspected human carcinogen (Dalia, 2008).

Green energy: US-based food producer Heinz has made very ambitious plans so that it can reduce its emission of greenhouse gases by 20% by 2015. For this, they have planned to generate the energy required for various purposes from potato peel (Zhidong, 2008).

Heinz has set several goals towards greening their company that includes:

1. Reducing energy consumption by 20% through the use of alternative resources.
2. Reducing its solid waste by 20%.
3. Reducing carbon footprint by 15%.

Conclusion

Green Chemistry is a novel intellectual perspective that can support sustainable development by applying and expanding its guiding principles. Great efforts are still undertaken to design an ideal process that starts from non-polluting materials. The task for the chemistry industry of the future is to develop better goods and procedures using fresh insights from basic research. It has been said that the revolution of one day becoming the new orthodoxy of the next Green Chemistry is applied and must involve the successful implementation of more environmentally friendly chemical processes and product design. Most importantly we need relevant scientific engineering so, we can say that this approach in chemistry helps protect human health and the environment and it represents a significant departure from the traditional methods previously used.

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