ISSN: 2456–4397 RNI No.UPBIL/2016/68067 Vol-5* Issue-6* September-2020
Anthology : The Research

Green Chemistry: A Brief Review

Paper Submission: 13/09/2020, Date of Acceptance: 23/09/2020, Date of Publication: 24/09/2020

Praveen Kumar Mishra
Assistant Teacher ,
Dept. of Basic Education
Gorakhpur, U.P., India

Shikha Vishwakarma
Assistant professor,
Dept. of Chemistry
Dr. B.R.Ambedkar Govt. Degree College,
Maharajganj, U.P., India

Abstract

This paper provides an overview of applicability and future trends of Green Chemistry. It is an area of chemistry and chemical engineering focused on the designing of products and processes that minimize or eliminate the use and generation of hazardous substances. While environmental chemistry focuses on the effects of polluting chemicals on nature, green chemistry focuses on the environmental impact of chemistry. The overarching goals of green chemistry are more resource-efficient and inherently safer design of molecules, materials, products, and processes which can be pursued in a wide range of contexts.

Keywords: Hazardous, Polluting Chemical, Resource Efficient.

Introduction

There are ambiguities in the definition of green chemistry, and how it is understood among broader science, policy, and business communities. Even within chemistry, researchers have used the term "green chemistry" to describe a range of work independently of the framework put forward by Anastas and Wamer[1].

More broadly, the idea of green chemistry can easily be linked (or confused) with related concepts like green engineering, environmental design, or sustainability in general. The complexity and multifaceted nature of green chemistry makes it difficult to devise clear and simple metrics[2]. Over the past few years, the chemistry community has been mobilized to develop new chemistries that are less hazardous to human health and the environment. This new approach has received extensive attention and goes by many names including Green Chemistry. Simply stated, Green Chemistry is the use of chemistry techniques and methodologies that reduce or eliminate the use or generation of feedstock, products, by-products, solvents, reagents, etc., that are hazardous to human health or the environment. Green Chemistry is an approach to the synthesis, processing and use of chemicals that reduces risks to humans and the environment. 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 show on our environment. Chemical developments also bring new environmental problems and harmful unexpected side effects, which result in the need of ‘greener’ chemical products. The Green Chemistry program supports the invention of more environmentally 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. Green Chemistry influences the way of practicing chemistry – be it in teaching children, researching a route to an interesting molecule, carrying out an analytical procedure, manufacturing a chemical or chemical formulation, or designing product.

Aim of the Study

Chemistry is undeniably a very prominent part of our daily lives. Chemical developments also bring new environmental problems and harmful unexpected side effects, which result in the need for ‘greener’ chemical products. A famous example is the pesticide DDT. So, this paper provides an overview of applicability and future trends of Green Chemistry.

Principles of Green Chemistry

The practice of eliminating hazards from the beginning of the chemical design process has benefits for our health and the environment, throughout the design, production, use/reuse and disposal processes[3]. In 1998, two US chemists, Dr. Paul Anastas and Dr John Warner outlined Twelve Principles of Green Chemistry to demonstrate how chemical production could respect human health and the environment while also being efficient and profitable[4]. Guidelines for developing Green Chemistry technologies are summarized in the “Twelve Principles of Green

Chemistry". The concept of green chemistry incorporates a new approach[5-10] to the synthesis, processing and application of chemical substances in such manner as to reduce threats to health and environment. This new approach is also known as:

1. Environmentally benign chemistry
2. Clean chemistry
3. Atom economy
4. Benign-by-design chemistry

The "Twelve Principles of Green Chemistry," is as follows

1. Prevention it is 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 Synthesis whenever 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 toxicity.
5. Safer Solvents and Auxiliary: The use of auxiliary substances should be made unnecessary wherever possible.
6. Design for Energy Efficiency: Energy requirements of chemical processes should be recognized for their environmental and at low temperature and pressure.
7. Use of Renewable Feedstock: A raw material or feedstock should be renewable rather than depleting whenever technically and practicable.
8. Reduce Derivatives: Unnecessary derivatization should be avoided whenever possible.
9. Catalysis: Catalytic reagents are superior 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 Chemicals 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.

Green Chemistry in Practices

Solvent Free Reactions

Environmental concerns in synthetic chemistry have led to a reconsideration of reaction methodologies. This has resulted in investigations into atom economy[11], the use of supercritical CO2[12], ionic liquids[13], and other procedures to reduce the disposal problems associated with most chemical reactions. One obvious route to reduce waste from reagents in the absence of solvents[14]. Therefore the design of green processes with no use of hazardous and expensive solvents, e.g., "solvent-free" reactions, has gained special attention from synthetic organic chemists[15].

Synthetic techniques

There are many advancement and progression in chemical synthesis which leads to the formation of greener products, closely resemble and acquired all the property which is under the category of principles of green chemistry. For example: Yves Chauvin, Robert H. Grubbs and Richard R. Schrock, were awarded by noble prize for the contribution to green chemistry and "smarter production"[16].

Carbon dioxide as blowing agent

Water is undesirable in some reactions. Therefore some reactions are modified as such process to use the water. The properties different from water i.e. green solvents are nevertheless needed. CO_2 is such supercritical liquid. For the production, some energy is consumed for this natural solvent. If we talk about the properties of carbon dioxide, it is renewable, non-flammable and work well as a blowing agent.

Biocatalysis

Through millions of years of evolution and "sustainability," nature developed highly efficient and selective means to achieve the desired transformations. The potential usefulness of various catalysts of Nature, such as enzymes[17], whole cells, and catalytic antibodies[18] for organic synthesis, has become more and more recognized. Biological catalysts or enzymes are high molecular weight globular proteins.Their composition may change at the end of reaction. Their catalyzing effect is very high. i.e faster than chemical catalyst. are reaction specific. i.e one enzyme or biological catalyst may catalyze only particular type of reaction and not many. They are intolerant to temperature and pH changes.

Nonnatural Solvents

In addition to the two "natural green solvents", various non natural ones have also been intensively studied as green alternatives. The most widely studied ones are ionic liquids[19]. The greatest advantage of these solvents is their low vapor pressures, which offer advantages in reducing volatile organics in the air. Such novel solvents also offer various interesting new chemistries such as dissolving cellulose[20] and changing the outcome of reactions[21]. Another innovative discovery is the recently developed "switchable solvents" by Jessop, Liotta, Erckert, and others[22]. Such solvents change their properties with different needs. Beside these solvents, other synthetic solvents such as fluorous[23,24] and property-changing soluble polymer systems[25] have been evaluated as potential green alternatives.

Conclusion

Green chemistry addresses such challenges by inventing novel reactions that can maximize the desired products and minimize by-products, designing new synthetic schemes and apparatus that can simplify operations in chemical productions, and seeking greener solvents that are inherently environmentally and ecologically benign. Such fundamental innovations in chemical sciences will lead us to a new generation of chemical syntheses. The Chemistry that have been developed to date include almost all areas of chemistry, including organic, inorganic, biochemistry, polymer synthesis, environmental, physical, technological, etc. Through the several prevailing trends of the green program such as catalysis, biocatalysis alternative: renewable feedstock (biomass), reaction media (water, ionic liquids and supercritical fluids), reaction conditions (microwave) new synthetic pathways (photocatalytic reaction), the dual goals – environmental protection and economic benefit can be achieved. The examples of the prevailing trends in ways that Green Chemistry reduces the impact of chemical processes and technologies. For the future chemical industry, it is based on safer products and processes designed by utilizing new ideas in fundamental research. Furthermore, the success of green chemistry depends on the training and education of a new generation of chemists. The more successful chemistry researchers and educationalists will be those that can appreciate the value of green chemistry in innovation, application and teaching as well as recognizing the important role that green chemistry can play in enhancing the attractiveness of chemistry as a discipline. While many exciting new greener chemical processes are being developed, it is clear that a far greater number of challenges lie ahead.

References

1. *Linthorst, J. A. (2009). "An overview: Origins and development of green chemistry". Foundations of Chemistry. 12: 55–68.*
2. *Matus, K. J. M.; Clark, W. C.; Anastas, P. T.; Zimmerman, J. B. (2012). "Barriers to theImplementation of Green Chemistry in the United States" https://dash.harvard.edu/bitstream/handle /1/9639957/Clark Barriers Implementation.pdf?sequence=1) (PDF). Environmental Science &Technology. 46 (20): 10892–10899.*
3. *Martyn Poliakoff, J. Michael Fitzpatrick, Trevor. Farren Paul I, Anastas,Science, 2002, 2, 297.*
4. *http://www.epa.gov/ greenchemistry/index.html*
5. *P.T. Anastas, I.T. Hovarsth, Innovations and Green Chemistry, Chem.Rev.107, 2169 (2007).*
6. *S. Ravichandran, Int. J. Chem Tech Res., 2(4)2191 (2010).*
7. *B. M. Trost, Atom economy-A challenge for organic synthesis: Homogeneous catalysis leads the way. Angew Chem Int ., Ed., 34, 259 (1995).*
8. *R.A. Sheldon, Green solvents for sustainable organic synthesis: State of the art. Green Chem., 7, 267 (2005).*
9. *V.B. Bharati, Resonance, 1041 (2008).*
10. *V.K. Ahluwalia and M. Kidwai, New Trends in Green Chemistry, Anamaya Publisher, New Delhi (2004).*
11. *Trost, B. M. Acc. Chem. Res. 2002, 35, 386.*
12. *Wells, S.; DiSimone, J. M. Angew.Chem., Int. Ed. 2001, 40, 519.*
13. *Seddon, K. R. J. Chem. Technol. Biotechnol.1997, 68, 351.40.*
    (a) Tanaka, K.; Toda, F. Chem. Rev. 2000, 100, 1025.
    (b) Bradley, D. Chem. Br.2002, 42 (Sept).
    (a) Tanaka, K. Solvent-Free Organic Synthesis; Wiley-VCH: Weinheim, Germany, 2003. (b) Tanaka, K.; Toda, F. Chem. Re. 2000, 100, 1025-1074.
14. *"The Nobel Prize in Chemistry 2005" (http://nobelprize.org/nobel _prizes/chemistry /laureates /2005/press.html). The Nobel Foundation. Retrieved 2006-08-04.*
15. *Wong CH, Whitesides GM (1994) Enzymes in Organic Chemistry (Elsevier, Oxford).*
16. *Lerner RA, Benkovic SJ, Schultz PG (1991) At the crossroads of chemistry and immunology—Catalytic antibodies. Science 252:659–667.*
17. *Wasserscheid P, Welton T (2002) Ionic Liquids in Synthesis (Wiley-VCH, Weinheim, Germany).*
18. *Rogers RD, Voth GA (2007) Ionic liquids. Acc Chem Res 40:1077–1078. 21. Earle MJ, Katdare SP, Seddon KR (2004) Paradigm confirmed: The first use of ionic liquids to dramatically influence the outcome of chemical reactions. Org Lett 6:707–710.*
19. *Liu Y, Jessop PG, Cunningham M, Eckert CA, Liotta CL (2006) Switchable surfactants. Science 313:958–960.*
20. *Gladysz JA, Curran DP, Horvath IT (2004) Handbook of Fluorous Chemistry (Wiley-VCH, Weinheim, Germany).*
21. *Fish RH (1999) Fluorous biphasic catalysis: A new paradigm for the separation of homogeneous catalysts from their reaction substrates and product. Chem Eur J 5:1677–1680.*
22. *Bergbreiter DE (1998) The use of soluble polymers to effect homogeneous catalyst separation and reuse.Catal Today 42:389–397*