



Green Chemistry: A practical elegance in chemical synthesis

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ABSTRACT

Green chemistry expresses an area of research developing from scientific discoveries about pollution awareness and it utilizes a set of principles that reduces or eliminates the use or generation of hazardous substances in all steps of particular synthesis or process. Chemists and medicinal scientists can greatly reduce the risk to human health and the environment by following all the valuable principles of green chemistry. The most simple and direct way to apply green chemistry in pharmaceuticals is to utilize eco-friendly, non-hazardous, reproducible and efficient solvents and catalysts in synthesis of drug molecules, drug intermediates and in researches involving synthetic chemistry. Microwave synthesis is also an important tool of green chemistry by being an energy efficient process.

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INTRODUCTION

During the twentieth century, chemistry changed the way people lived. And the greatest perceived benefits came from pharmaceutical industries with development of organic medicinal molecules. Pharmaceutical chemistry encompasses major chemicals, reagents, solvents, catalysts and almost all type of organic reactions for synthesis of active pharmaceutical molecules. Herein, many chemicals and chemical processes are very hazardous, toxic and may have adverse effects on the environment and on human health. Industries associated with pharmaceuticals and fine chemicals are employing much more complex chemistry and produce relatively much more waste, which is not at all suitable for environment and nature¹.

During the early 1990s the US Environmental Protection Agency (EPA) coined the phrase Green Chemistry to promote innovative chemical technologies that reduce or eliminate the use or generation of hazardous substances in the design, manufacture and use of chemical products. Green chemistry is designed to reduce or eliminate negative environmental impacts such that the use and production of chemicals may involve reduced waste products, non-toxic components, and improved efficiency. Green chemistry is not a particular set of technologies, but rather an emphasis on the design of chemical products and processes. This approach offers environmentally beneficial alternatives to more hazardous chemicals and processes, and thus promotes pollution prevention²⁻⁴.

PRINCIPLES OF GREEN CHEMISTRY

Green chemistry is a highly effective approach to pollution prevention as it applies innovative scientific solutions to real-world environmental situations. The following 12 principles of Green Chemistry provide a way for chemists to implement green chemistry⁵.

- 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** Synthetic methods should be designed, wherever practicable, 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 achieve their desired function while minimizing their toxicity.
- 5. Safer Solvents and Auxiliaries** Unnecessary use of auxiliary substances (e.g., solvents, separation agents, etc.) should be avoided wherever possible and made 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.