


Chapter 19

The Role of Green Chemistry in Social System Reforms for a Sustainable Future

Saly Jaber

 <https://orcid.org/0000-0002-9328-1360>

Saint Joseph University of Beirut, Lebanon

ABSTRACT

The urgency of sustainable development has placed green chemistry at the forefront of scientific, economic, and social transformations. Green chemistry, a field dedicated to designing products and processes that reduce or eliminate hazardous substances, plays a crucial role in shaping sustainable industries and influencing social system reforms. This chapter explores how green chemistry serves as a fundamental driver of sustainable development by reducing environmental pollution, enhancing resource efficiency, and fostering social equity. The chapter begins by outlining the principles of green chemistry and its contribution to reducing ecological footprints, particularly in industrial and manufacturing sectors. It examines the impact of green chemistry on health and environmental policies, focusing on its potential to minimize toxic waste, improve water and air quality, and reduce reliance on non-renewable resources. Additionally, it explores how regulatory frameworks and governmental policies support or hinder the widespread adoption of green chemistry practices.

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INTRODUCTION

Green chemistry is a discipline that focuses on designing chemical products and processes to minimize or eliminate the use and generation of hazardous substances. This approach aims to reduce environmental impact and enhance sustainability in the chemical industry. The concept was notably advanced by Anastas and Warner, who outlined foundational principles guiding this field.

A key aspect of green chemistry is the emphasis on waste prevention. Instead of managing waste after its creation, green chemistry advocates for the design of processes that inherently produce minimal or no waste. This proactive approach not only reduces environmental pollution but also enhances efficiency and cost-effectiveness in chemical manufacturing. Another fundamental principle is atom economy, which focuses on maximizing the incorporation of all materials used in a process into the final product. By designing synthetic methods that optimize the use of reactants, chemists can reduce the generation of by-products, leading to more efficient and sustainable processes.

The selection of safer solvents and reaction conditions is also crucial in green chemistry. Traditional solvents can be volatile, toxic, or environmentally damaging. Green chemistry promotes the use of alternative solvents that are benign or the development of solvent-free reactions. This shift not only reduces health risks but also minimizes environmental contamination. Energy efficiency is another important consideration. Green chemistry encourages conducting reactions at ambient temperature and pressure whenever possible. By minimizing energy consumption, the environmental footprint of chemical processes can be significantly reduced. The use of renewable feedstocks is also emphasized. Green chemistry supports the utilization of raw materials that are renewable, such as biomass, over non-renewable resources like fossil fuels. This practice contributes to the sustainability of chemical production and reduces dependence on finite resources.

Catalysis plays a vital role in green chemistry by increasing the efficiency of chemical reactions. The use of catalytic agents can lower the energy requirements of reactions and increase selectivity, thereby reducing the formation of unwanted by-products. Designing chemicals and products that degrade into innocuous substances after use is another principle of green chemistry. This ensures that chemical products do not persist in the environment, thereby reducing long-term pollution and ecological impact.

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