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Green chemistry as ecofriendly chemistry: a review

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ABSTRACT

The green chemistry movement has aimed to make the sector safer and more competitive over the last two decades. Yet mindset is evolving gradually, and the transition still has a long and challenging path ahead. Green Chemistry is a revolutionary philosophy that began 20 years ago and aims to unify government, academic and industrial societies. Through making the early stages of innovation and development, more focus on environmental impacts and addressing through green chemistry could be a viable alternative to protect our environment and reduce industrial emissions. In this review article, we will discuss the Green chemistry as ecofriendly chemistry. This review also synthesis the foundation, principals and future directions of green chemistry.

Key Words: *Green chemistry, Industry, Emissions and Eco-innovations*

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I. Introduction

Green chemistry is a modern branch of chemistry that aims to reduce emissions from other chemical manufacturing processes to the lowest possible extent. It also aims to invent new chemicals that are good for the environment and chemicals that work as alternatives to other chemicals that manufacture processes return negative results to the environment; or, they act as substitutes for chemicals extracted from endangered species such as liver oils that threaten extraction from whales and sharks to completely extinction these species within a few decades. Green chemistry is called sustainable chemistry that contribute in environmental protection (Sheldon et al., 2007; Clark et al., 2012).

According to EPA (United States Environmental Protection Agency) Green Chemistry can be defined as "Green chemistry is the design of chemical products and processes that reduce or eliminate the use of hazardous substances or their generation. Green chemistry occurs during a chemical product's life cycle, including its design, production, usage and final disposal. Green chemicals are also known as sustainable chemicals." The benefits of green chemistry is manifold. The functions, usability and the need for acceptability of green chemistry can be summarized as: it prevents molecular emission; it is a theory that refers to all aspects of chemistry and not to a particular chemistry discipline; it applies groundbreaking scientific approaches to environmental real-world problems; it results in a reduction in the source, as it prevents pollution; it reduces adverse effects on human health and the atmosphere from industrial products and processes; it reduces the risk from current products and processes and

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often removes it; and it designs chemical products and processes to minimize their inherent dangers (EPA, 2020).

It is a field of chemistry and chemical engineering concerned with designing products and processes that reduce the use and production of dangerous materials. While environmental chemistry is concerned with the effects of chemical pollutants on nature, green chemistry focuses on technological approaches to preventing pollution and reducing the consumption of non-renewable resources (Sanderson, 2011). Therefore, in this review we have summarized the emergence, principles and future directions of green chemistry that would be future of industrial sectors for combating emissions and environmental protection.

II. Literature Review

In this review article, we have highlighted information associated with the emergence of green chemistry, its foundation, related principals and future directions.

Emergence of green chemistry

With the signing of the Pollution Prevention Act, which sought to protect the atmosphere by eliminating toxic pollution from the same source, green chemistry started in the US in 1990. Under the statute, the government of the United States has provided grants to produce chemicals through various institutes and universities to reduce the risk of such chemicals. Grant goals developed to manufacture chemicals that work to neutralize hazardous compounds, mitigate emissions, and create alternatives to chemicals that contribute to their environmental pollution extraction processes. Green chemistry aims to make chemistry an integrated science by reducing emissions in the food, pharmaceutical, petroleum and plastic industries caused by significant chemical production by preventing these emissions from developing in the first place (Mulvihill et al., 2011).

Green chemistry emerged from a variety of existing research ideas and efforts (such as corn economics and catalysis) in the pre-1990s period, in the context of a growing interest in chemical pollution problems and resource depletion. The development of green chemistry in Europe and the United States is associated with a shift in strategies to solve environmental problems: the transition from command and control regulation and the reduction of industrial emissions at the "end of the tube", towards effective pollution prevention through the innovative design of production technologies themselves. The set of concepts has now recognized that green chemistry was grouped in the mid to late 1990s, along with a broader adoption of the term (which prevailed over competing terms such as "clean" and "sustainable" chemistry). In the United States of America, the Environmental Protection Agency has played an important role in promoting green chemistry through pollution prevention programs, financing, and professional coordination. At that time in the UK, researchers at York University contributed to the creation of the Green Chemistry Network within the Royal Society of Chemistry, and the launch of the Journal of Green Chemistry (Clark, 1999).

Foundation of green chemistry

The book entitled Green Theoretical Chemistry and Practice, Oxford University, through its professors Paul Anastas and John Warner, developed 12 items to help chemists activate the concept of green chemistry. Among the most important of these principles are:

- Start from a safe starting point: select safe materials that can be used to create a desired product.
- Using materials from renewable sources, such as materials extracted from safe plants, instead of relying on oil and natural gas supplies.
- Use safe solvents and try to reduce the level of toxic solvents in the reactions.
- Work on the economy of the atoms. Attempting to rely on the reactions in which most of the atoms through which the reaction started originate in the substance to be accessed, not in the secondary materials and wastes (Woodhouse and Breyman, 2005).

Principles of green chemistry

In 1998, Paul Anastas (who then led the US Environmental Protection Program's green chemistry program) and John C. Warner (then the Polaroid Corporation) published a set of principles to guide the practice of green chemistry. It deals with twelve principles that combine the methods that limit the environmental and health effects of chemical production. It also indicates research priorities for the development of green chemistry technologies. The principles cover concepts such as:

- Design processes to make as much raw material as possible ends up in the product.
- Use of renewable resources as raw materials and energy sources
- Use safe and environmentally benign materials, including solvents, whenever possible.
- Design processes using energy efficient.
- Avoid waste production, which is seen as the ideal form of waste management.

Principles of green chemistry are:

- The prevention of waste formation is better than treating or cleaning waste after it is formed.
- Industrial methods should be designed to maximize the incorporation of all materials used in the process into the final product.
- Where practicable, synthetic methodologies should be designed to use and generate substances of little or no toxicity to human health and the environment.
- Chemical products should be designed with efficacy and function while reducing toxicity.
- The use of auxiliary materials (such as solvents, separating agents, etc.) should be minimal and harmless when used.
- Attention should be paid to the impacts of environmental and economic energy requirements, and they should be minimized. Synthetic methods are performed at ambient temperature and pressure.
- Raw materials or raw materials should be renewable where technically and economically feasible.
- Reducing the production of derivatives - unnecessary derivation of chemical compounds should be avoided whenever possible.
- Catalytic reactions (characterized by selectivity) are preferred over equal reagents.
- Chemical products should be designed so that they do not settle at the end of their environmental functions or degrade into harmful products. Further development of analytical methodologies to allow real-time monitoring and control before the hazardous material formation process.
- The materials should be selected and designed when used in chemical processes so that they reduce the possibility of chemical accidents, including emissions, explosions, and fires.

Directions of green chemistry

Numerous attempts are made not only to measure the greenness of chemical processes but also to control other variables such as chemical yield, reaction component price, chemical safety, hardware requirements, power coil, production and product purification equipment. In a quantitative study, reducing nitrobenzene to aniline receives 64 points from 100 and is described as a generally acceptable combination while amide preparation using HMDS is described only as sufficient with a combination of 32 points (Linthorst, 2010).

The goal of green chemistry was never just a cleansing; green chemistry revolves around a redesign of chemical processes from the ground up. It revolves around making industrial chemistry safer, cleaner and more energy-efficient through the stages the product goes through, from assembly to disinfection and disposal. It also revolves around using renewable raw materials as much as possible, making interactions at the temperature and pressure of the surrounding environment, and above all reducing or reducing toxic waste from the beginning, rather than continuing spending to clean up the mess after it occurs.

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