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13. Green Chemistry: A Strategy to Improve Environmental Toxicity

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Abstract:

The term green chemistry was invented in the 1990s to highlight the growing interest in developing more environmentally friendly chemical processes and products. The United States Environmental Protection Agency reports that "Green Chemistry is the design of chemical products and processes which reduce or eliminate the manufacture of hazardous substances". One of the main causes of pollution and environmental degradation is chemistry. While this is not a new field, the importance of green chemistry has been gained recently because of increasing environmental issues.

Green chemistry involves design and synthesis of environmentally sound chemical processes, green pollution and/or treatment approaches, biofuels and bioenergy development, biocatalysts, green chemistry policies and ethics. For all aspects of Green Chemistry, improved chemical research and advanced techniques, the experimental tasks are made easier for new investigators. This increase is positive and harmless in the field of chemistry. It is a long-term task for the promotion of green chemicals, with many environmental science and technology challenges that need to be overcome, including chemical engineering, physics and biology.

13.1 Introduction:

Environmental issues have become very serious and need government attention. The environmental budget allocation in Indonesia will be Rp 15,428.4 billion in 2018[1]. The increasing diversity of industries is demanding a diversified lifestyle and pattern of human consumption. In addition to increasing waste, diversity in the patterns of consumption affects how material content of waste is composed naturally and pollutes and threatens human health [1]. In addition, waste can be decomposed in an increasingly difficult way. Green chemistry is extremely important for reducing or preventing damage to the environment.

The lack of use of green chemical products will affect environmental damage, such as harmful chemicals for the environment and the health of human beings.

A lack of use of green chemistry will impact the environmental damage or pollution in the overcoming of environmental issues by the government and companies.

The declining environmental quality will also affect economic growth and lead to different sustainability social conflicts, including various social, entrepreneurial and governmental elements.

Green chemistry is known as a study aimed at reducing or eliminating the risk of the adverse environmental effects of chemicals, including humans.

Green chemistry is, according to [2], a very effective approach to pollution prevention because it can be used directly in the current situation by scientists.

Green Chemistry is the design, design, production and end-of-life, of chemical products and processes reducing or eliminating the use and production of dangerous chemicals throughout the entire life cycle.

Green chemistry builds on conventional chemistry and technical engineering by using twelve basic principles that guide sustainable chemicals and processes molecular design.

Adherence to these principles prevents contamination and waste, leads to a less dangerous and more efficient synthesis of chemical products, promotes renewable feed materials and contributes to the development of more secure chemical substances.

Green chemistry incorporates every component in your business, including the way companies manage their businesses to engage their customers throughout our supply chain from product design to feedstock selection and the production to finished products.

Whereas green chemistry is mainly used for chemical discovery, development and formulation, product developers, manufacturers, brands and retailers play a significant role in its execution.

You do this through changes to design specifications, the procurement of materials and products which incorporate green chemistry, changes in production practises in order to substitute for or reduce the use of hazardous chemicals, and the development and implementation of policies that limit the chemicals of concern in products they produce, produce or sell.

The first sustainability report (2012) of the European Chemical Industry outlines the sector's vision of playing a key role in global sustainable development.

The chemical industry seeks, through the application of green science and technology, natural resource efficiency and safe chemical products to chemist and consumer, to ensure its operation is sustainable and a key enabler for a sustainable society.

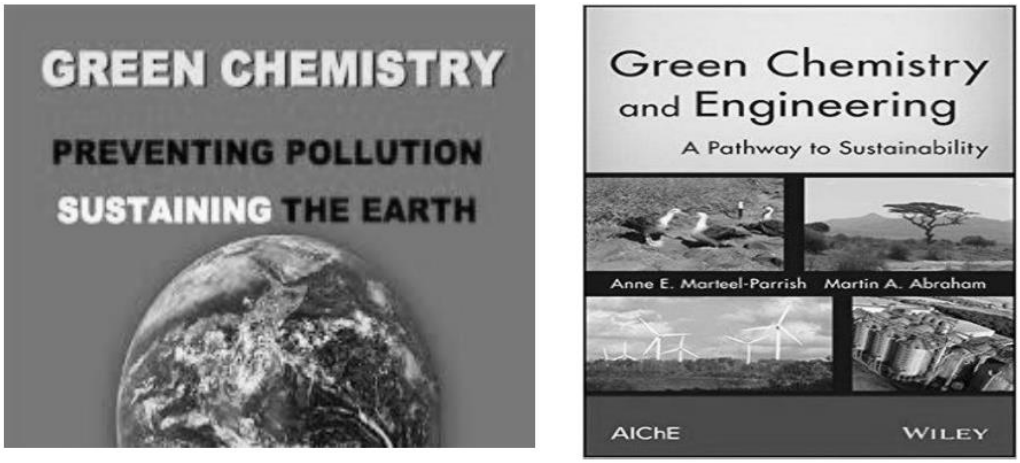

Figure 13.1: A number of books on green chemistry and sustainable development have been published. Figure 1. AE, Abraham MA. Marteel-Parrish. Engineering and Green Chemistry: a path to sustainability. Wiley-AlChE NYC, 2013

A. Methodology:

This study describes green chemistry and its economic impact. The literature review [3] indicates that a method is used to collect data to seek information through books, newspapers, magazines and other literature. The research review articles came from a number of journal studies on green chemistry and its impact on the economy.

B. Findings:

The Green Chemical Concept The new paradigm of green chemistry is solutions for contemporary, ecological and sustainable challenges. Green chemistry is often used to conserve environmental and resources [4] and also to redesign chemicals to eliminate toxicological and environmental consequences [5]. Green chemistry seeks to minimise waste generation, encourage the use of renewable and recycled resources, and ensure maximum energy efficiency [6]. In the article [7] green chemistry was frequently described as 'a novel approach to sustainability that is not regulatory and economically driven.'

In paper[8] it has been mentioned that Green Chemistry offers an excellent framework for systems consistent with the circular economy (consider especially the principles of waste prevention, optimise atom economy, use harmless components, the using of renewable raw materials, and also design for degradation). Green chemistry's concern is to remove or minimise toxic waste generation, which is more serious than treating previously generated waste [9].

According to [10], twelve green chemistry principles exist, in particular:

- Prevention: Preventing production of waste is better than treating or purifying waste after generation.

- Atomic Economy: Synthetic methods should be designed to maximise the integration into the final product of all materials used during the process, i.e. the molecular level reduction of waste.
- Less dangerous chemical synthesis: synthetic methods should be designed where possible for the purpose of using and creating substances with little or no toxicity for the human health and the environment.
- Safer Chemicals design: Chemical products should be designed to finish their desired function while minimising their toxicity and environmental impact throughout the process design.
- Solvent and auxiliary products: for any given step, safe solvents available must be selected and organic solvents should be avoided whenever possible.
- Energy efficiency design: select the chemical method that is least energy demanding. Temperature and pressure are ideal for the ambient environment.
- Use of feed stocks for renewable energy: use chemicals produced from renewable sources (i.e. plant-based) rather than from aggravating resources.
- Reduce derivatives: Minimize the temporary derivative route such as the blocking group and groups of protection.
- Catalysis: In reactions use catalytic instead of stoichiometric reagents.
- Degradation design: Design chemicals which, at the end of their function, degrade to harmless substances which do not persist in the environment.
- Real-time contamination prevention: monitor chemical reaction before the formation of hazardous substance in real time, during processes and before control.
- Safer accident chemistry: select and develop safe and minimise potential for chemical accidents, explosion and fire chemistry techniques and substances.

C. Green Chemistry:

Green chemistry is an approach used to overcome environmental problems in terms of produced chemicals, processes or reaction phases. This concept underlines a method that reduces the use and production, both in design and process, of hazardous chemicals [11]. A range of threats both to human health and the environment, including toxicity, physical dangers, global climate change, and the depletion of natural resources, form part of the Green chemistry concept[11]. Green Chemistry focuses on the application to or manufacturing of chemical substances to reduce the use or production of dangerous substances that can affect the health of lives and protect the environment of a range of chemicals [12].

Rashmi Sanghi quoted from [13] that Green Chemistry is a vital part of a comprehensive human health and environmental protection programme. Green chemistry is generally concerned with waste-minimization issues, the use of catalysts in reactions, the use of harmless reagents, the use of renewable base materials, increased cost-effectiveness and recycling of eco-friendly solvents [13]. Green chemistry is a study designed to improve the environmental and health consequences of the chemical industry [14]. There are 12 green chemistry principles[10], namely the prevention principle: It means that waste prevention is better than waste treatment or waste clean-up; Atomic economy implies the development of synthetic methods to maximise the incorporation into the final product of materials used from process; Lower risky #chemical synthesis; Safer chemical engineering; safe solvents

and auxiliary equipment; energy efficiency design; the use of reusable feedstocks; derivatives reduction; catalysis; degradation design; Real-time pollution prevention analysis; more accident prevention chemistry inherently safe.

13.2 Environmental Sustainability:

The concept of sustainability originated in the 1970s and 1980s and was driven by environmental and catastrophic incidents and concerns about the contamination of chemical and resource depletion [12]. The concept of sustainability was first introduced in a meeting and report. The three-pronged theory in three fields – social, economic and environmental – was historically based on sustainability as well. The theory underlines that the integration and balance between the economy, society and the environment should be ensured in the implementation of development [15]. Sustainability, as well as the design of human and industrial systems can be defined by ensuring that the use of natural resources and the human cycle does not result in a decreased quality of life and a decrease in environmental quality [16]. Environmental sustainable performance can be achieved through the reduction of solid/liquid waste, emissions reduction, resource reduction and consumption of dangerous/dangerous/ toxic material, reducing environmental accident frequency and improving health [17]. Sustainable development has been agreed as a development to meet existing needs without compromise or sacrifice the freedom to meet the needs of future generations' lives There are two important ideas: one is that of the "needs," namely, the essential requirements for the continuation of human life, and b) is that of limitations on the environment's ability to meet current and future needs, as a result of technological and social organizations [18].

Economic Impact:

Using green chemistry can help protect the environment by preventing pollution before it happens. Green chemistry can also help companies become more efficient and save money while doing so. The application of green chemistry, according to the same expert, can improve economic performance. In a paper [9], it was stated that the advantages of economics on the implementation of green chemistry include the need for companies to invest less in waste storage and treatment, as well as environmental damage compensation payments. One of the concepts in green chemistry is recycling, which is crucial for promoting a circular economy, a new paradigm of sustainability that reduces environmental impacts while also opening up new business opportunities [19].

Environmental chemistry is crucial for business and the economy as well as for people and the environment. Finding methods and techniques to speed up chemical reactions with small amounts of reactants and deliver the same results and price for the same product is made easier with this tool. Reduced synthetic steps allow for increased production and plant capacity while using less energy and water. Reducing the amount of chemicals used in product manufacturing reduces waste, which lowers the cost of removing chemical waste and toxic waste treatments. Green chemistry's advancement is largely fueled by the potential financial rewards. In the chemical industry, green chemistry methodologies are being adopted because they improve the bottom line. Green chemistry reduces a wide range of operational costs [2].

Other economic benefits can be obtained from the application of green chemistry, as stated by [9] that the economic benefit of green chemistry such as the reduction in investment in waste storage and treatment and compensation payments for environmental damage.

13.3 Fields of Green Chemistry with New Technological:

A wide range of chemical products and technological innovations have advanced in the last decade due to advances in Green Chemistry/Green Engineering research and practical applications in these fields. Solutions are among the most important areas of GC and GE's research and development. For example: decreasing global warming and using carbon dioxide (CO2) as a raw material in chemistry; microwave and electrochemical synthesis methods; syntheses without solvents (or using water as a solvent); phytoremediation; waste management/wastewater; eco-friendly pigments; innovative food products; biopolymer technology; renewable materials; renewable energy sources; and so on. Other examples: Although GC and GE products have many innovative fields, we've listed some of the most basic here.

- Practical synthetic reaction biocatalysis and biotransformation processes
- The process of evolution is being guided. Synthetic organic synthesis enzymes that are new to science
- Green chemistry and synthetic pharmaceutical processes
- Generating hydrogen from water via catalytic splitting
- Sources of energy that are both green and renewable
- Environmentally friendly chemistry and agricultural technologies
- Green chemistry. Multicomponent reactions
- Chemical industry green flow chemistry and continuous processes
- Green chemistry and biodegradable polymers
- Green chemistry and organic solar cells
- In industrial synthesis, the choice of solvent and solvent

In addition to the aforementioned, numerous other technological fields, such as Green Chemistry and Green Engineering, have advanced recently. Existing innovative inventions have already been put to use and improved sustainability while decreasing environmental pollution and releasing safer chemical products.

Five Strategies:

The agenda identifies five main strategies for accelerating green chemistry innovation and adoption. These are the approaches to:

A. Enhance market dynamics by continuing to develop a thorough understanding of the enablers, market drivers, and obstacles associated with green chemistry. These are some examples of the details:

- Companies across the value chain face numerous and distinct obstacles.
- Green chemistry's key leverage points

- How the market for green chemistry solutions can be developed.
- Models for lowering the high costs of scaling up and sharing market and other risks.
- Priority challenges in green chemistry that must be overcome.
- Why some green chemistry chemicals, materials, and finished goods have been successful while others have failed in the market..
- How to meet green chemistry companies' labour requirements.

B. Support smart policies by developing and promoting policies at the state and federal levels that increase the supply and demand for green chemistry-based products. Smart policies include the following elements:

- Open green chemistry research and manufacturing centres or provide financial support for such efforts.
- Encourage green chemistry research and commercialization by providing financial support, incentives, and/or prizes.
- Manufacturers of green chemistry chemicals and products should be able to get permits more easily.
- Increase the number of people who are educated about green chemistry and have access to green chemistry-related jobs.
- Contribute to expanding the global market for green chemistry innovations from the U. S.
- Develop regulatory frameworks that assist industry in reducing uncertainty.

C. Foster collaboration by making it easier for suppliers and product manufacturers to share information about green chemistry solutions and forming alliances to address key challenges. Collaborations should aim to achieve the following results:

- Make it possible for businesses facing chemistry challenges to connect with those working on green chemistry solutions. Create these opportunities.
- Incorporate more up-and-down supply chain information flow improvements (such as those relating to chemicals and demand).
- Develop design criteria and green chemistry solutions together by identifying opportunities and deploying pre-competitive strategies.
- Encourage the alignment of supply chains for new technologies.
- Enhance green chemistry education and hire more people with green chemistry backgrounds.
- Assist a company's culture in incorporating green chemistry and green engineering practices.

D. Inform the marketplace spreading knowledge about the business, economic, and health benefits of green chemistry, as well as funding options. Included in this type of data would be the following details:

- Funding options from the federal and state governments, as well as financial incentives offered by the location itself.

- Green chemistry's advantages for businesses, public health, and the environment are quantified.
- Employers in the green chemistry industry have specific labour requirements.
- Using green chemistry as an alternative to conventional chemistry in certain chemical processes.
- Information on the societal costs of accidents and incidents resulting from the use of hazardous chemicals.

E. Track progress by enhancing metrics for green chemistry and collecting and reporting progress data on a regular basis. These figures ought to show:

- Examine how far a company, industry or economy has come in terms of green chemistry.
- Make use of and expand on currently-effective economic and sustainability tools and criteria.
- Improve chemistries, materials, products, and processes by establishing benchmarks.
- Green chemistry can help to build business and policy cases by quantifying business risk from conventional chemistry, revenues, job growth and economic benefits as well as trends in capital flow.
- Be evaluated on a regular basis to make sure they're still working.

13.4 Result and Discussion:

Green manufacturing and green chemistry play a role in improving the environment's quality, according to a review of the relevant literature conducted recently.

Reduce the use of harmful chemicals that have an impact on the environment and human health is a goal of green manufacturing and green chemistry, two distinct fields.

While green manufacturing and green chemistry have environmental benefits, they also benefit the economy.

According to [9], some of the economic benefits generated by the implementation of green chemistry in industrial chemical processes, such as reduced investment in waste storage and treatment as well as compensation payments for environmental damage, can be predicted.

The results obtained for humic complex systems lead us to believe that the combination of green chemistry and nature-inspired technology can lead to a new direction in science – ecoadaptive chemistry and technology, which implies manipulation and reproduction of complex natural matter and systems in Figure 13.2.

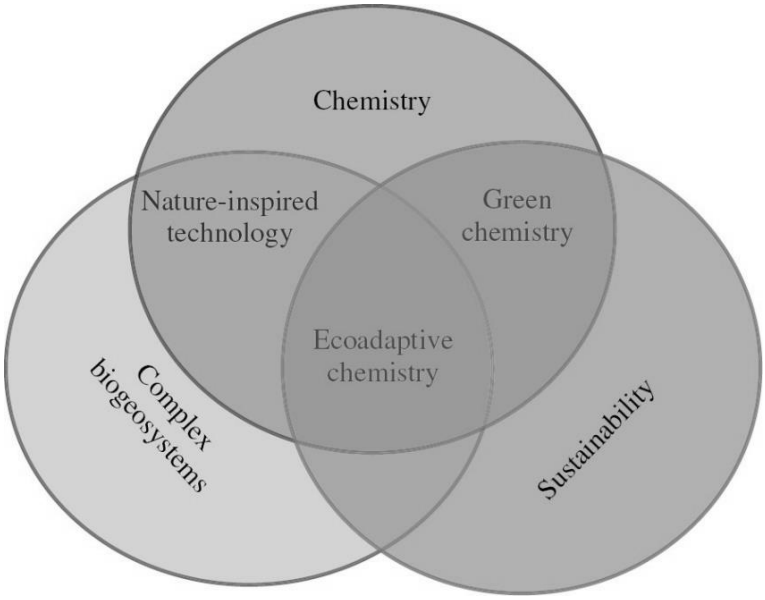

Figure 13.2: Ecoadaptive chemistry as a merge of green chemistry and nature-like technology at the crossing of chemistry, complex systems, and sustainability

13.5 Conclusion:

Research into green manufacturing and green chemistry aims to minimise the negative effects of industrial activity on the environment. There is a positive impact on both the environment and human health when products are made with eco-friendly processes and chemistry. Consequently, the implementation of green manufacturing and green chemistry is an investigation that needs to be carried out in the course of business activities by various companies.

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