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A Tool for the Sustainable Development of the Chemical Industry: Green Chemistry

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Abstract

One or more chemical processes are used in almost all produced goods. We can't conceive what our lives would be like without the chemical industry's goods. However, in today's chemical processes, only a small percentage of the resources we extract from the Earth gets transformed into the required goods, resulting in enormous volumes of waste and dangerous pollutants. One of the most significant disciplines is green chemistry. Although this field has grown quickly in the previous 20 years, it is still in its infancy. Promoting green chemistry is a long-term endeavor that requires the resolution of several difficult scientific and technological challenges relating to chemistry, material science, engineering, environmental science, physics, and biology. Scientists, engineers, and business owners should collaborate to advance this subject. There is no question that the research and use of green chemistry will significantly contribute to our society's long-term growth.

Keywords: Green chemistry; Synthesis; Solvents; Catalysis; Volatile organic solvents

Introduction

Green chemistry, which has been around for approximately two decades, has gotten a lot of attention. It represents academic and industrial efforts to solve the issues of chemical industry sustainability, and it shows that progress is being achieved in both academia and industry. In a nutshell, green chemistry is the use of a set of principles in the design, production, and application of chemical products to decrease or eliminate the use or production of hazardous chemicals. Synthesis, solvents, catalysis, raw materials, products, and efficient procedures are all covered by green chemistry, which is a multidisciplinary discipline.

Efficient synthetic routes

Most modern chemical manufacturing methods squander a lot of feedstocks and create a lot of trash. Increased atom economy is critical for minimizing both raw material depletion and waste creation. In a perfect world, all of the atoms in the reactants would be converted into the required products. However, it is unrealistic to expect 100% atom economy in all industrial chemical processes. Integration of various reactions and processes, in which the by-product of one reaction is the feedstock of another, is another approach to minimize waste. Exploration of atom-economic synthetic protocols and methods to improve synthetic efficiency while reducing or eliminating waste is a long-term project.

Greener and functional solvents

To prepare chemicals and materials, massive quantities of toxic, combustible, and volatile organic solvents are utilized. The use of greener solvents in chemical processes, such as water, supercritical fluids, ionic liquids, non-toxic liquid polymers, and their many combinations, has become a significant focus of academic and industrial study. Low toxicity, ease of supply and recycling, and great process efficiency are all prerequisites for a green solvent. It is well known that the characteristics of the solvents used have a significant impact on the efficiency of a process. Green solvents may be utilized to optimize chemical processes, reduce solvent use and processing stages, and develop new pathways and technologies that fulfill sustainability criteria due to their unique characteristics and functionalities.

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Greener catalysis

Catalysis is important in the chemical industry as most chemical processes require catalysts to speed up reactions, improve selectivity, and reduce energy consumption. Catalysts today are frequently made of costly, poisonous, hazardous, or noble metals. Green catalysts should have some properties, such as high activity, selectivity, and stability, as well as ease of separation and reuse, and should be made from ecologically friendly and widely available raw materials, such as plentiful metals, organic molecules, and enzymes. Progress in catalysis is critical for the research and development of new synthetic pathways and chemical processes. The development and application of green catalysts and catalytic systems to fulfill the dual aims of environmental preservation and economic advantages is a critical job for the chemical industry's long-term viability.

Use of green and renewable feedstocks

Our current energy supply and feedstocks for manufacturing organic compounds and materials are mostly dependent on nonrenewable and depleting fossil fuels. In the chemical and energy sectors, the utilization of renewable carbon resources, such as biomass and CO_2, is critical, and many methods and techniques have been created. However, converting biomass and CO_2 into fuels and chemicals presents thermodynamic, kinetic, and technological difficulties. Many present routes are technically possible but economically unviable, and only a tiny percentage of the available resources are now utilized. The discovery of effective techniques for converting biomass and CO_2 into usable chemicals and liquid fuels through industrial processes that are both energetically and economically feasible is critical, but difficult. Furthermore, the employment of greener, cheaper, and safer reactants as well as sustainable energy sources in chemical processes, such as oxygen, hydrogen peroxide, and solar energy, is of interest.

Green engineering and products

It is important to note that green chemistry encompasses both engineering and green products. Industrial chemical processes create chemicals and materials, thus clean, energy-efficient, and mass-efficient processes and technologies are critical to accomplishing the objective of optimizing efficiency and reducing wastes. Many medicines, fine chemicals, commodity chemicals, and polymers on the market today are hazardous. To replace hazardous items, products that are safe for human health and the environment must be created and manufactured. Clearly, the discovery of novel synthetic pathways, the development of sustainable products and solvents, and the discovery of new catalysts and chemical processes are all intertwined and should be integrated.