Chapter 10: Catalysts in Green Chemistry

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Abstract

In this chapter, the author draws attention to the role of the catalysts in the realization of green and sustainable chemistry. The green catalysis deals in green, recyclable, and efficient catalyst systems that lower the wastage and energy consumption and environmental impacts, and maintain a high reaction rate and selectivity. The chapter discusses the various types of recyclable catalysts, solid acid catalysts, bio-catalysts, and nanoparticle-based system and their advantages in the sustainable chemical processes. The case studies done on industries indicated that the green catalysts could be utilized in the production of pharmaceuticals, fine chemicals, the synthesis of polymers and in the remediation of the environment. The green catalysts were demonstrated to assist in reducing the number of hazardous by-products that are formed and also improve the efficiency of the process. The chapter also incorporates other design principles applied in the selection of catalysts, strategies of extending the life of catalysts, green catalysis and integration of green catalysis and industry. The practical illustrations, with a combination of theoretical understanding, assist the students to learn the part of the catalytic innovations in the production of energy-saving, economical, and ecologically friendly chemical production. The chapter explicates the applicability of the sustainable chemistry practice and the future of green catalysts in transforming industry, resource conservation and limiting pollution.

Keywords: Green chemistry, Eco-friendly catalysts, Recyclable catalysts, Industrial applications, Sustainable processes, Biocatalysts, Nano catalysts.

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10.1.Introduction

Green chemistry is an emergent and imperative science, which is concerned with the structure of chemical products and processes that reduce or eradicate the generation and usage of hazardous substances. Green chemistry has its core goals that include waste minimisation and energy conservation, use of renewable raw material and minimisation of environmental and health risks of chemical lifecycle. Among the list of the strategies that are applied to green chemistry, catalysis occupies the leading position since it facilitates chemical reactions that are highly efficient, specific, and sustainable. The catalysts are highly significant in green chemistry as it plays a significant role in increasing the rate of the reaction; it operates in the mild conditions of temperature and pressure. This will lead to the reduction in the operational and power expenses. The objective of high catalytic selectivity is when a reaction is taking place then it will not only produce the product desired but the least amount of by-products and therefore utilizes atoms in the most economical manner and also minimizes the number of wastes formed. In addition, the modern green catalysts are usually recyclable, non-toxic and stable, which is also consistent with the concept of sustainability. Green catalysis also enables renewable feedstocks such as biomass-based compounds to be utilized since they may be substituted by traditionally utilized raw products that are based on petroleum. Enzyme catalysis, heterogeneous catalysts and metal free catalytic systems are also being explored in order to deal with the environment and regulatory implications. The contemporary industries are characterized by the use of green catalysis. In the pharmaceutical sector, it reduces the application of toxic solvents and other risky reagents, which leads to safer medicines. Selectivity and yield are maximized and wastage minimized through catalysts of the fine chemical industry. The green catalysts are significant in the production of biofuels, hydrogen, and conversion of carbon

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