Chapter 8: Catalysis in the Chemical Industry

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Abstract
The author goes into detail in this chapter by reflecting on the phenomenon of catalysis and its preeminence in the chemical industries insofar as the homogeneous and heterogeneous catalytic processes are concerned. The catalysts promote the rate of reactions by lowering the activation energy, and they are neither consumed, which enhances the efficiency and selectivity. The chapter explains the catalysis mechanisms (adsorption, product formation, and product desorption), which are related to theory and practical implementation. Industries such as the Haber process to produce ammonia, the Contact process to produce sulfuric acid and the Ziegler-Natta catalysis to produce polymers, among others, are explained to demonstrate real-life applicability. Saving on energy, minimization of wastes and maximization of product yields are some of the economic and environmental advantages of catalysis that are pointed out by the chapter. The students are introduced to the parameters of ideal catalyst selection and catalytic reactor design applied in the industry. The chapter is an integration of mechanistic understanding and industrial experience, where it identifies how catalysis was used in large-scale chemical production and modern industrial chemistry. It is also with the help of catalytic knowledge that enables the simplification of reactions, new industrial reactions are produced, and improved green and sustainable chemical reactions.

Keywords: Catalysis, Homogeneous catalysis, Heterogeneous catalysis, Industrial processes, Haber process, Ziegler-Natta, Reaction mechanism.

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8.1. Introduction

The chemical industry has positioned itself on the level of catalysis since it facilitates the reaction to take place at a convenient rate, at opportune conditions and very specific. A catalyst is a substance that accelerates the pace of a chemical reaction but does not participate in the reaction. The large scale chemical reaction is safe and sustainable and can take place on large scale as well as it offers catalysts with the opportunity to offer an alternative reaction pathway, which has a lower activation energy. The reason is that the impossibility of carrying out industrial chemical processes without the aid of catalysis has led to the establishment of its absolute need which is utilised in over 90 % of all the processes today. Catalysis has a direct effect on the productivity of the processes in the industries, the amount of energy used and the quality of products produced. A large number of the most significant chemicals including ammonia, sulfuric acid, nitric acid, methanol, polymers, fuels and pharmaceuticals may be formed by catalytic reaction. An example is, iron-based catalysts are used in the Haber-Bosch process to produce ammonia, vanadium pentoxide is used in the contact process to produce sulfuric acid, and platinum-group metals are used in the petroleum refining and automotive catalytic converters. These reactions would need very high temperatures and pressure which are not possible in the cases of both commerce and environment without the use of catalysts. The chemical industry can be defined to have an intense basis on the catalysis on homogeneous catalysis, catalysis heterogeneous, and biocatalysis. Heterogeneous catalysts often exhibit selectivity and are highly specific, which is why they are commonly used in the same phase as the reactants, whereas their counterparts, the heterogeneous catalysts, are literal solids, and hence a much sought after technology in the industry due to separation, reuse and longevity. It has attracted more interest because of the mild nature of operation and high specificity of the biocatalysis especially

Deep Science Publishing, 2026
https://doi.org/10.70593/978-93-7185-430-6_8