Chapter 16: Industrial Electrochemical Production

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Abstract

The author in this chapter focuses on the processes of industrial electrochemical production, but the major focus is mostly on the large-scale production of chemicals and metals produced through the process known as electrolysis. The chlor-alkali process that entails the preparation of NaOH and Cl_2, and electrolysis of aluminium and copper, are some of the major processes. The chapter elaborates on the principles, cell design, electrolyte composition, electrode materials, current efficiency and energy considerations that would be required in the operation at the industrial level. These processes have proved to be economically and technologically important since they are used in chemical industries, metallurgy, water treatment, and material production. The other challenges that are addressed in the chapter are high energy use, electrode degradation, environmental effects, and optimization of the process, and they provide measures of increasing the efficiency and sustainability. Case analyses show that the concepts of chemical engineering, process control, and industrial safety are electrochemically manufactured to ensure that operations are efficient and effective. Being provided with a chance to integrate theory and practical examples in the industrial environment of design, operation, and optimization of the electrochemical plant, the students will be equipped to occupy positions in the industrial chemistry and materials production, along with the design and optimization of the electrochemical plant. In the context of the chapter, the author mentions the importance of the electrochemical methods in the modern industry, thus demonstrating that it is possible to produce chemicals in an energy-saving and environmentally-friendly manner.

Keywords: Industrial electrochemistry, Chlor-alkali process, Electrolysis, Aluminium, Copper, Energy efficiency, Industrial production.

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16.1.Introduction

Electrochemistry is very important in the contemporary industries of chemistry, metallurgical and electricity. It concerns itself with the redox reagents of converting chemical energy into electrical energy and vice versa. Electrical energy in the field of industrial electrochemistry is utilized to catalyze both non-spontaneous chemical reactions. This is a controlled use of electricity that helps in the large scale production of high-purity chemicals and metals more efficiently, precision and controlled environmentally than the conventional chemical process. The processes of industrial electrochemistry are essential as they enable the reaction to be conducted at much lower temperatures, offer a better control of the reaction rates as well as produce products of extremely high purity. These benefits are especially significant within the sphere of metallurgy, electronics, pharmaceuticals, and energy storage where the quality of materials is extremely significant. The electrolysis of the brine (aqueous sodium chloride solution) in order to obtain the sodium hydroxide (NaOH), chlorine gas (Cl_2), and hydrogen gas (H_2) is a type of most significant industrial electrochemical process. Such commodities are the foundation of a good number of chemical industries. Sodium hydroxide is heavily utilized in the manufacture of soaps and detergents, pulp and paper, and textile industries and chlorine is necessary in manufacture of plastic materials such as PVC, disinfectants and bleaching agents. Hydrogen gas is a clean fuel and a significant reducing agent in the different chemical activities. Correspondently, the extraction and refining of metals like aluminium, copper through electrolytic methods are basic to the modern world. The Hall Héroult process involves the electrolytic reduction of alumina to produce aluminium which is used in

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