

Chapter 29: Water Treatment & Softening Methods

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Abstract

Water treatment and water softening methods are emphasized in this chapter as well as their functionality in industries and environment. Water which is used in the household, industrial and power plant applications is normally dissolved with salts, hard ions and impurities that affect the effectiveness and safety. The chapter explains the softening (lime-soda treatment, zeolite ion exchange, and reverse osmosis) and explains the principles of operation, parameters of operation, and the optimization strategies of the process. These advanced techniques as desalination and membrane filtration are discussed as the ones that are utilized in the process of receiving potable and industrial process water. Case studies reveal its application in practice in boiler water treatment, municipal water supply and wastewater treatment and that it has problems including scaling, sludge disposal and energy demand. The chapter is a mixture of theoretical chemistry, analytical monitoring and industrial practices thus enabling the students to understand design, selection and operation of water treatment systems. It is concerned with sustainability, reduction in environmental impact and management of water resources. Students will be able to know how to relate the taught chemical principles with the real-life process of water treatment that could be used in the spheres of environmental engineering, chemical industries, municipal water management and the study of the sustainable water solutions.

Keywords: Water treatment, Softening, Lime-soda, Zeolite, Ion exchange, Reverse osmosis, Desalination.

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29.1. Introduction

Since the beginning of times, water has been a crucial component in the life of the human civilization not only in drinking and farming, but also in household and industrial applications. The need of safe and clean water increased with the evolution of the societies, and the application of various water softening and treatment technologies was invented. As early as in 2000 BCE, the first attempts at water treatment had been practised by the ancient societies, which populated such classes as Indian valley, Egypt and Mesopotamia, such methods as sedimentation, boiling, sand-gravel filtration. Early Egyptians made use of the alum to purify the water through coagulation, the engineers of Greece and Rome constructed dams and aqueducts that had water which was relatively clean to the cities. The scientific knowledge on waterborne diseases gradually emerged in the Middle Ages, though there was very little knowledge. The major change that started during the 19 th century is the industrialization and urbanization that made water more contaminated and highlighted the linkage between the disasters of human health, including cholera, and water pollution. It was the period during which the modern methods of filtration and chlorination as a disinfection method was introduced. The concept of what hard water means and how it negatively affects boilers, pipes and soaps, too, led to the introduction of what are now conversations of the processes of water-softening namely, lime-soda treatment followed later by ion-exchange. Water treatment and water softening have become the indissoluble constituent of sustainable development and the performance of industrial and the ecological safety nowadays. The authors in this chapter address the principles, process, and significance of treating and softening water to ensure the use of water is safe and efficient.

29.2. Lime-Soda