

# Chapter 30: Industrial Water Problems

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## Abstract

This chapter explores the issue of industrial water, where the issues of problems, chemical nature, and mitigation are considered, especially in the case of boilers, cooling towers, and process industries. Dissolved salts, hardness ions, dissolved gases and impurities are common elements of industrial water and thus cause operation problems which include scaling, sludge, corrosion and caustic embrittlement. The chemical processes involved in these issues are described in the chapter, and they are the deposition of calcium and magnesium salts, acidic or alkaline corrosion of metals, and local corrosion. Controlling measures of these issues, including chemical dosing, water softening, blowdown, corrosion inhibitors, as well as the choice of material, are also elaborated on. Some examples of power plants, chemical manufacturing, and metallurgical industries also demonstrate the practical methods of solving problems and optimising processes to sustain the efficiency, life of equipment, and environmental aspects. The focus is on the combination of chemical analysis, process control, and engineering of industries in order to detect, remove, and alleviate water-related challenges. The integration of theory and practical solutions helps the students to acquire knowledge on industrial water management, environmental engineering, chemical process design, and sustainable industrial operations. The knowledge of industrial water issues can guarantee the safe, efficient and economically viable functioning of industrial systems, which is aligned with the current sustainability requirements and regulations.

**Keywords:** Industrial water, Scaling, Sludge, Corrosion, Caustic embrittlement, Water treatment, Boiler water.

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## 30.1. Introduction

Water is the crucial and most common raw material in nearly all types of industries. It is a key coolant in power plants and a solvent as well as a reactant in chemical industries, a medium of processing in the textiles and food industry, and a source of steam in boilers. Water is used in most industrial operations, as compared with other fluids, because it is readily available and has good heat transfer capabilities. Nevertheless, water that is procured through natural processes like rivers, lakes, underground water, and seas is never pure in a chemical way. It always has dissolved salts, suspended particles, dissolved gases and microorganisms. These impurities cause severe operational issues, including scaling and sludge deposition, which lowers the heat transfer efficiency; corrosion, which ruins metal coating; caustic embrittlement, which dilutes boiler material and microbial growth, especially in cooling towers when untreated water is used in industrial equipment. They cause a high rate of breakdowns, an increase in fuel use, safety risk, and shortening of equipment life. Therefore, industrial water treatment and conditioning will be necessary to provide efficient, safe and economical run of the boilers, cooling facilities and other industrial units.

## 30.2. Scaling

Scaling is a severe issue that is experienced in commercial water systems, especially boilers, cooling towers, heat exchanger and pipelines. It is used as the formation of hard, adhering, and crystalline films of insoluble salts over the inside surfaces of equipment. Scaling is a process that takes place when water which has dissolved salts is heated, evaporated, or its pressure is altered, in a manner that the salts in the solution surpass their solubility level, and become precipitated. Such common scale-forming materials as calcium carbonate ( $\text{CaCO}_3$ ), calcium sulfate ( $\text{CaSO}_4$ ), magnesium hydroxide [ $\text{Mg}(\text{OH})_2$ ] and silica ( $\text{SiO}_2$ ) are used. These scales