# Chapter 3

## REMEDIATION METHODS

**Çiğdem ÖTER**[1]

Our environment is polluted by chemical compounds that are harmful to all biological systems. Uncontrolled industrial development, population growth, urbanization, increased food demand, salinization of agricultural lands and the spread of hazardous chemicals to the environment are among the main causes of environmental pollution problems today [(1)].

Pollution is the discharge of toxic or pollutant substances that are likely to have a negative impact on the natural environment or life. Pollutants cause a place or substance (water, air or food) to lose its suitability for use. Improvement restores these sites so that contaminated areas return to their natural state. Environmental remediation is the removal of soil, water (both groundwater and surface water) and air from pollution or contaminants. These waste products are disposed not only to restore the environment but also to protect human health. These cleaned areas can also be used for urban development. Environmental remediation is subject to a range of legal conditions within a plan and generally based on human health and environmental risk assessments. Remediation projects can range from large, large-scale projects with great efforts to clean contaminated sites to smaller and less costly projects such as clearing highway accidents with a spill [(2)].

Environmental remediation is carried out in a variety of environmental environments, including soil (humus, subsoil and sediment), water (groundwater and surface water) and air. Soil contamination can be caused by chemical contamination, industrial activity, and some fertilizer and pesticide use. Soil contamination is caused by many of the same factors that lead to groundwater contamination. Water pollution can occur as a result of industrial applications (mining or natural gas and oil drilling) and direct release of pollutants into the water or flow from soil to underground. Air pollution, any substance produced by humans (greenhouse gases such as carbon dioxide ($CO_2$), methane, sulfur dioxide ($SO_2$) and chlorofluorocarbons) or natural causes (forest fires, volcanic eruptions, wind erosions, pollen dispersal, evaporation of organic compounds and natural radioactivity) is released by releasing into the atmosphere [(3)].

[1] (Asst. Prof. Dr.); Van Yüzüncü Yıl University, Turkey. E-mail: cigdem1414@gmail.com

tivation energy is in the order of a chemical reaction and its enthalpy is around 200 kJ / mol. Chemical adsorption (chemisorption, active adsorption) is specific and occurs by stronger forces than in physical adsorption. Chemical adsorption is generally not reversible. Chemical adsorption is caused by a real reaction between adsorbed molecules and surface molecules. Therefore, the rate of chemical adsorption increases with temperature. In many adsorption states, these two types of adsorption occur together. Some systems show physical adsorption at low temperatures and chemical adsorption at high temperatures [(71)].

### Exchange Adsorption

It is by electrical attraction between the adsorbed substance and the surface. Ion exchange is included in this class. Here, it becomes important that the adsorbed substance with opposite electric charges and the adsorbent surface attract each other. Ions with high electrical charge and ions with small diameters are better adsorbed. Despite all these adsorption types, it is difficult to explain an adsorption process with a single adsorption type [(72)].

### Biological Adsorption

The mechanism of biological adsorption process, which has gained importance in recent years, has not been fully explained. In biological adsorption, both physical adsorption and biological degradation occur together due to the transport of the microorganism on an inert substance. The transport of the microorganism on the inert material accelerates the adsorption and ensures the continuity of the process. While inert substances protect the microorganism carried during adsorption from the effects of toxic substances, they also provide the necessary environment for the biodegradation of the toxic substance [(73)].

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