SORPTIVE MEDIA FILTRATION 11

Sorptive media filtration is a unit process in which dissolved constituents are removed by attachment to filter media at the molecular level.

11.1 INTRODUCTION

With receiving water standards for metals based on the dissolved fraction, there is increasing interest in sorptive treatment systems. The removal of dissolved phosphorus is relevant to the control of eutrophication in lakes and excessive periphyton growths in streams. Nitrogen is of particular concern to marine waters. Sorption processes involve the transfer of dissolved solids, either ions or compounds called sorbates, from the water to a media, called the sorbent. The media may be a natural substance like plants or soil in a constructed wetland, or a manufactured product like activated carbon in a filtration system.

The conceptual framework for sorption is presented in Figure 11.1. The sorption process is defined by the type of media, its characteristics, and the effect of water chemistry on these characteristics. There are three distinct types of sorption of interest to stormwater treatment: ion exchange, adsorption, and absorption. Each is defined in this chapter. Given their distinctively different mechanisms of removal and characteristics, water and wastewa-

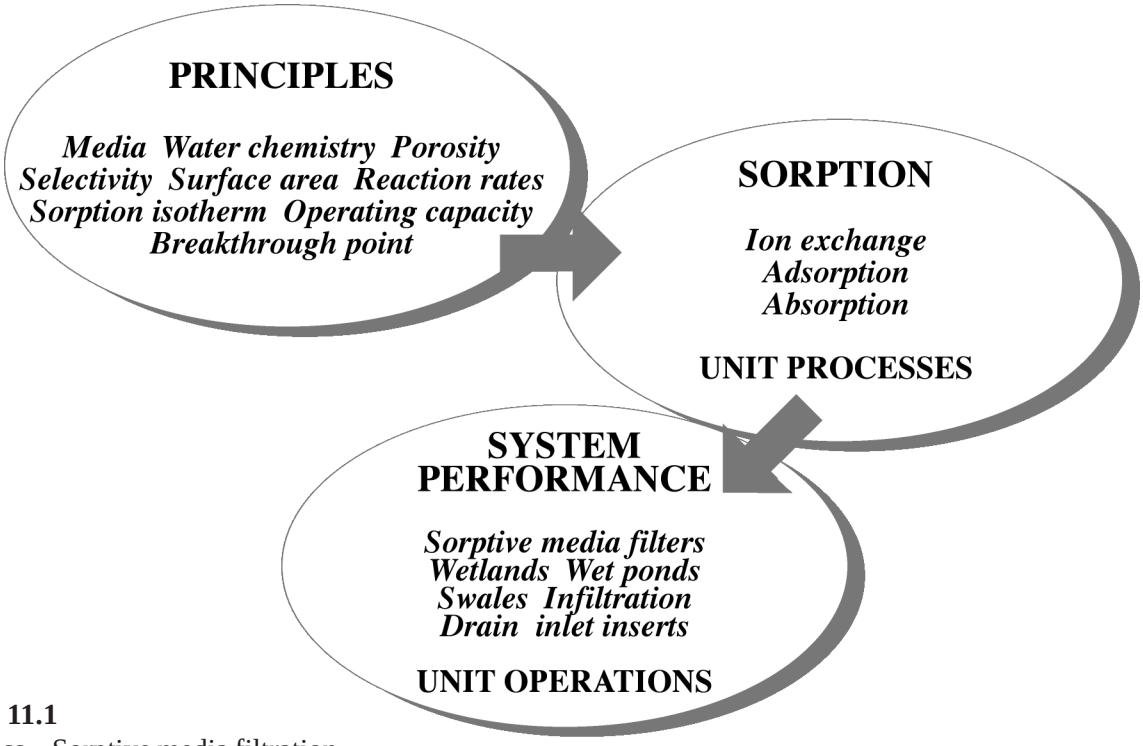

FIGURE 11.1
Unit process – Sorptive media filtration

ter engineers identify them as separate unit processes. In addition, precipitation and biological processes may also transform or remove dissolved pollutants.

The effectiveness of the three unit processes is directly related to the characteristics of the media and the stormwater. The complex nature of stormwater as described in Chapters 2 and 3 establishes the importance of the chemistry of stormwater and its variability to the performance of sorptive systems, including those that rely on soil. There are constituents in stormwater that are of no interest with respect to environmental harm, yet bear on the effectiveness of sorptive treatment systems. With media an important characteristic is the surface area available for sorption, which is directly related to the size and porosity of the media. Media differ in the preference for ions or compounds in stormwater, giving rise to more effective removal of some and the removal of some constituents that are of no interest. The later may reduce the capacity of the media to remove the pollutants of interest, increasing the frequency of media replacement. Media replacement is defined by its operating capacity, which is in turn prescribed by when the effluent concentration exceeds the performance goal, known as the breakthrough point.

Fundamental to stormwater itself is sorption of dissolved pollutants to suspended solids. With this in mind, sorption is perhaps the most important process, its understanding relevant to understanding stormwater quality as well. The mechanisms of sorption in engineered filtration systems are presented in this chapter. Sorption viewed from the perspective of water chemistry is presented in Chapter 3. Sorption in soil and plant systems is described in Chapters 12 and 13, respectively.

Many unit operations employ sorption. Sorption is the primary unit process in sorptive filters. It is also a significant process in constructed wetlands and wet ponds where sorption to soils occurs. Sorption is a primary means of pollutant removal in infiltration facilities, with soil as the media. Whether sorption occurs in vegetated swales and strips is debatable. Sorption may be minor in these unit operations as the grass inhibits contact between the stormwater and the soil, unless infiltration occurs. Sorptive filters have an advantage over wet ponds and wetlands in that they can be placed subsurface, a particular benefit in ultraurban areas.

Ion exchange has an ancient history.[1179] It is suggested that Moses made drinking water by casting a log into the waters of the Marah, thus using oxidized carboxyl groups on the log to remove the bitter salts of magnesium sulfate. The use of engineered systems explicitly designed with a recognition of the capabilities of sorption processes began with the 20th century. The first media were natural materials with relatively minimal modification such as zeolite, a natural aluminosilicate mineral. With time, media substantially manufactured or entirely synthetic replaced the natural media materials. Table 11.1 compares the contaminants of interest removed by sorption processes in treating four types of water: potable and industrial water supply, wastewater, contaminated groundwater, and stormwater. With time distinctions between the four categories of water in Table 11.1 increasingly blur with the growth of reuse.

TABLE 11.1
Contaminants removed by sorption processes

WATER TYPE	IONS COMMONLY OF MOST INTEREST
Water supply	Hardness (calcium and magnesium), odor causing natural organics, carcinogenic synthetic organics, fluoride, manganese, iron, nitrate, barium
Wastewater	Synthetic organics, total dissolved solids, radionucleotides, heavy metals
Groundwater remediation	Radionucleotides, anthropogenic organics
Stormwater	Heavy metals in particular copper, zinc, cadmium and lead, nitrogen and phosphorus, and organic toxicants such as pesticides and polyaromatic hydrocarbons