Abstract

Microplastics (MPs), as emerging environmental contaminants, and heavy metals are raising concerns due to their potential negative impacts on ecosystems. This study investigates the combined effects of microplastics (MPs; PE, PP, PET) on the adsorption-desorption behavior and vertical migration of hexavalent chromium Cr (VI) in the aquifer beneath municipal solid waste (MSW) landfills. Batch experiments revealed that red beds soils exhibit a high Cr (VI) adsorption capacity (101.83 $mg \cdot kg^{-1}$), primarily driven by chemisorption and partial reduction to Cr (III). However, the presence of MPs interrupts these processes, reducing adsorption efficiency by up to 16.46% and enhancing desorption by 20.92%. Column transport experiments further demonstrated that MPs significantly accelerated Cr (VI) migration rates, particularly at higher concentrations (5–10%) and with larger particle sizes. The maximum migration rate reached 0.079 $cm \cdot h^{-1}$, representing a 51.92% increase compared to controls. At the same time, the penetration time was shortened to 25 days. Redox analysis indicated that MPs inhibited the Cr (VI)-to-Cr (III) transformation, weakening the soil's natural attenuation capacity. These findings highlight the potential environmental risks posed by microplastics in landfill systems, as they enhance the mobility and persistence of toxic heavy metals in subsurface environments.