

Xenobiotic biodegradation under anaerobic conditions such as in groundwater, sediment, landfill, sludge digesters and bioreactors has gained increasing attention over the last two decades. This review gives a broad overview of our current understanding of and recent advances in anaerobic biodegradation of five selected groups of xenobiotic compounds (petroleum hydrocarbons and fuel additives, nitroaromatic compounds and explosives, chlorinated aliphatic and aromatic compounds, pesticides, and surfactants). Significant advances have been made toward the isolation of bacterial cultures, elucidation of biochemical mechanisms, and laboratory and field scale applications for xenobiotic removal. For certain highly chlorinated hydrocarbons (e.g., tetrachlorethylene), anaerobic processes cannot be easily substituted with current aerobic processes. For petroleum hydrocarbons, although aerobic processes are generally used, anaerobic biodegradation is significant under certain circumstances (e.g., O₂-depleted aquifers, oil spilled in marshes). For persistent compounds including polychlorinated biphenyls, dioxins, and DDT, anaerobic processes are slow for remedial application, but can be a significant long-term avenue for natural attenuation. In some cases, a sequential anaerobic-aerobic strategy is needed for total destruction of xenobiotic compounds. Several points for future research are also presented in this review.