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Biogeochemistry of selenium in engineereed ecosystems from pollution prevention to ressource recovery

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Selenium, if present at trace concentration levels, is an essential nutrient in the diets of all living organisms; in contrast when in excess (i.e., several micro grams per liter), it is quite toxic to many organisms, including humans and can bioaccumulate in aquatic ecosystems [1,2]. Selenium is often reported as a contaminant deriving from global industrial activities (e.g. coal and mineral mining, metal smelting, oil extraction and refining, and agricultural irrigation). Due to increased enforcement of selenium regulations and a better understanding of its health and environmental effects, the need to efficiently remove selenium from contaminated streams has taken on an increased importance. Different treatment approaches may be applied for the removal and recovery of selenium from wastewater including physico-chemical approaches as well as biological approaches (i.e. by using a pure bacterial strain or by using microbial consortia mostly developing in engineered anaerobic conditions) that is largely applied at industrial scale [4]. In order to comply with discharge limit of treated effluent it is highly important to ensure that a final selenium concentration is within the order of μg Se L^{-1} in the effluent (e.g. 5 μg Se L^{-1} limit has been set by the United States Environmental Protection Agency [4]). However, due to its complex biogeochemistry in anaerobic conditions, selenium represents an extremely difficult contaminant to remove and recover from wastewater due to its range of solubility and state of matter (e.g. formation of colloidal Se(0) particles or volatile organic selenium compounds) over different chemical oxidation states [3]. The biological treatment of selenium contaminated streams aims first at decreasing selenium concentrations in order to meet the discharge limits, but additional challenges remain to be considered when aiming at recovering and reusing selenium for further applications, including agriculture, animal feed, and pharmaceuticals [4].

References

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