WATER

Intimately Coupling of Biocatalytic Electrolysis with Biodegradation to Deeply Remove Recalcitrant Compounds from Wastewater: from Control Strategy to System Construction

Abstract

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In China, we are facing the unprecedented “Water Crisis” because of rapid economic growth and accelerated urbanization progress. The development and centralization of industries further intensified the critical shortage of water resources and raised serious problem of water pollution. To sustainably use the limited water resources, we urgently need to develop advanced solutions to reuse the industrial wastewaters. However, due to the residue of low concentration and recalcitrant compounds (LRCs) in secondary effluents of industrial wastewater treatment plants, environmental security is a challenging problem for the water recycling. Thus, it is very important to develop highly efficient technology to remove or eliminate those LRCs in secondary effluents. In 2011, we have firstly proposed the concept of “biocatalytic electrolysis” with the inspiration from bioelectrochemical principal, and raised idea of innovative biocatalytic electrolysis stimulated wastewater biotreatment technology. Principally, biocatalytic electrolysis assisted by tiny electric power input could supply extra “reducing power” to accelerate the selective biotransformation of recalcitrant organic pollutants (detoxification, decolorization, dehalogenation, etc.). In this work, we elucidated the most likely way of electron capture by cathodophilic microorganisms to accelerate the nitroaromatics reduction and uncovered the mechanism of enhanced biotransformation of multiple LRCs. Based on this, we developed and newly designed two types of high rate hybrid-bioreactors (HB) with electrochemical modules imbedded into anaerobic treatment processes to efficiently remove LRCs. Additionally, we have developed two microbial stimulating strategies, namely “cathode potential regulation” and “electrode polarization reversal regulation”, to enhance the electron transfer between microorganisms and electrode micro/nano interface. These stimulated the anaerobic respiratory activity of functional microorganisms, realized the directional assembly of highly active electrode biofilm, and speeded up the start-up and performance of hybrid bioreactors (HB). Targeting the practical use of this innovative technology, we have proposed multiple patterns to refer intimately coupling of biocatalytic electrolysis with biodegradation, with which, the effluent could meet the wastewater reuse standard. Overall, this work provided remarkable theoretical and technical support to implement the safety recycling of industrial wastewaters/ micropolluted wastewater. Currently, we are in process of constructing two demonstrations plants in the southern China.