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Modeling organics biodegradation and ammonia nitrification by entrapped mixed microbial cell carriers

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ABSTRACT

Entrapped mixed microbial cell (EMMC) process offers good capability to remove organics and nitrogen compounds from wastewater in a single aerobic chamber. This research modeled quantitatively the hydraulic characteristics and biochemical process of immobilized activated sludge process (ASP) for the removal of COD and NH_4^+-N, providing insights to mass and oxygen transfer limitation in EMMC spherical carriers. Based on the conceptual kinetic model and previous experimental results, hydraulic and reaction rate constants were determined for both COD degradation and NH_4^+-N nitrification with the EMMC carrier. The dissolved oxygen (DO) distribution profile along the radius of EMMC carriers was also simulated. The depletion of DO in the EMMC carrier was very rapid resulting from COD removal and ammonia nitrification given the mass transport condition of DO. The anoxic/anaerobic zone developed in the EMMC carrier within 1 cm from its external surface in contact with the bulk water phase. Beyond this anoxic/anaerobic boundary, denitrification of nitrate occurred utilizing the residual COD. The efficiency of organics biodegradation and nitrification was not influenced by the thickness or diameter of the EMMC carriers. EMMC carriers of 1 cm in thickness supported removal of organics by biodegradation and nitrogen compounds via nitrification and denitrification processes. The EMMC carrier enabled combined nitrification and denitrification in the aerobic chamber, which signified the enhancement of a traditional ASP to an anoxic/oxic (AO) or anaerobic/anoxic/oxic reactor system via the EMMC carrier in an aeration tank.

Keywords: Modeling; Entrapped mixed microbial cells; Nitrification; Denitrification

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