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Enhancing the removal of pharmaceuticals in biological wastewater treatment: is MBBR the answer?

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Moving bed biofilm reactors (MBBRs), as alternative to conventional activated sludge systems (CAS), are based on biofilm growing on specifically designed floating plastic carriers. Through prolonged physical retention of biomass as compared to CAS, MBBRs are particularly advantageous in the enrichment of slow growing bacteria within the microbial community. Recently, moving bed biofilm reactors (MBBRs) have been observed to improve the removal of a number of organic micropollutants under aerobic conditions. However, no study previously attempted to comprehensively elucidate micropollutant removal capabilities of MBBRs at different stages of biological wastewater treatment. In this study, we investigated the potential of MBBRs for the removal of micropollutants (n=22), mainly pharmaceuticals, in three laboratory-scale configurations: pre-denitrification (MBBR1), nitrification (MBBR2) and post-denitrification (MBBR3). Figure 1 summarizes the pseudo-first-order biotransformation rate constants (k_{bio}) obtained for the beta-blocker atenolol. The three MBBR systems presented improved k_{bio} as compared to CAS for atenolol and for a number of pharmaceuticals (e.g., sulfamethoxazole, erythromycin). The post-denitrifying MBBR3, which was supplemented with more readily degradable carbon sources (ethanol, methanol) compared to MBBR1, exhibited the highest k_{bio} (Fig. 1). The availability of primary substrates (carbon and nitrogen) was found crucial for the biotransformation of pharmaceuticals in the three MBBR systems, suggesting removal via cometabolism. Typically recalcitrant substances (e.g., diclofenac) were only removed under nitrifying conditions, with k_{bio} values comparably higher than CAS. Overall, our results suggest that MBBR can be a valuable alternative to CAS in enhancing the removal of micropollutants both under aerobic and anoxic conditions.

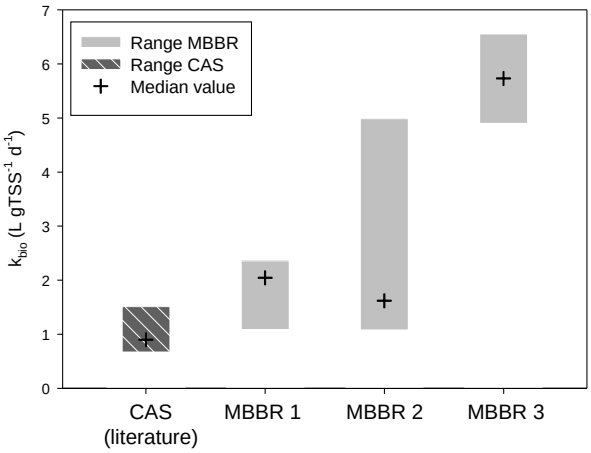

Figure 1 Comparison of biotransformation rate constants (k_{bio}) for atenolol in MBBR1–3 with literature values from conventional activated sludge systems (CAS).

Keywords: cometabolism, pharmaceuticals; biotransformation; wastewater; nitrification; denitrification