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Application of bioplastic moving bed biofilm carriers for the removal of synthetic pollutants from wastewater

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HIGHLIGHTS

- Moving bed biofilm carriers (MBBC) are widely used for the clean-up of wastewaters.
- In this study MBBC were used for the removal of xenobiotics from wastewater.
- MBBC were manufactured from existing bioplastic-based products.
- Bioplastic MBBC were effective in the removal of bisphenol, oseltamivir and atrazine.

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ABSTRACT

In this series of laboratory experiments, the feasibility of using moving bed biofilm carriers (MBBC) manufactured from existing bioplastic-based products for the removal of bisphenol A, oseltamivir, and atrazine from wastewater was evaluated. After 10-d incubation, cumulative evolution of $^{14}CO_2$ from control (no MBBC) wastewater spiked with ^{14}C-labeled bisphenol A, oseltamivir or atrazine, accounted for approximately 18%, 7% and 3.5% of the total added radioactivity, respectively. When wastewater samples were incubated with freely moving carriers, greater removal of the three chemicals was observed. More specifically, cumulative $^{14}CO_2$ evolution of the three xenobiotics increased of 34%, 49%, and 66%, with respect to the control, respectively. Removal efficiency of MBBC was significantly increased by inoculating these bioplastic carriers with bioremediation bacterial strains. Results from this study suggest that the concept behind the moving bed biofilm reactor technology can also be extended to biodegradable carriers inoculated with bioremediation microorganisms.

1. Introduction

Increasing concerns over preserving water quality have stimulated the development of a variety of technologies for reducing the environmental impact of human activities on this non-renewable and vulnerable resource (Kümmerer, 2009). Among the different approaches that have been proposed in these last decades, the technology known as moving bed biofilm reactor (MBBR) is successfully applied in the clean-up of wastewaters from urban, industrial and agricultural uses (McQuarrie and Boltz, 2011). The MBBR technology is based on the usage of small cylindrical carriers which move freely in the wastewater reactor. These cylinder-shaped carriers are specifically designed to provide a large surface area for the growth of attached microbial biofilm. Typically, a variable fraction of the total reactor volume is filled with these moving bed biofilm carriers (MBBC) which are then kept in continuous movement by aeration or mechanical stirring of the fluid. First proposed in the early 1990s mainly for the purpose of BOD/COD abatement in small wastewater treatment plants, this technology is now applied worldwide in reactors of different size categories (Ødegaard et al., 1994; Rusten et al., 1998; Wessman et al., 2004). In MBBR, microbial growth is mainly confined to the surface of the moving carriers, also known as Kaldnes, and especially to their sheltered internal surfaces. This results in the formation of a stable and sheltered biofilm, protecting microbes from alteration of wastewater parameters which are eventually caused by variability of effluent characteristics and operating procedures. Beside promoting microbial activity, major advantages of MBBR also include reduced head losses and elimination of backwashing costs. In their original design, MBBC consist in small cylinders (10 mm diameter and 10 mm height approximately) with longitudinal fins on their external surface. The internal volume of the beds is divided in four parts by two intersecting edges. Beds are typically manufactured with high density polyethylene having a density slightly less than water, thus facilitating their movements inside the fluid mass (Ødegaard et al., 1994). Although most of the MBBC launched in

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