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Process Biochemistry 40 (2005) 453–460

PROCESS BIOCHEMISTRY

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Effects of Cu(II) and Cd(II) on the performance of sequencing batch reactor treatment system

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Received 20 September 2003; received in revised form 10 December 2003; accepted 18 January 2004

Abstract

The effects of Cu(II) and Cd(II)-containing wastewater on activated sludge microorganisms were investigated. The addition of Cu(II) and Cd(II) affected significantly the activities of activated sludge microorganisms in the bio-oxidation process, as indicated by drastic reduction in the specific oxygen uptake rate (SOUR) values. The sequencing batch reactor (SBR) system was operated with FILL, REACT, SETTLE, DRAW, and IDLE modes in the time ratio of 0.5:3.5:1.0:0.75:0.25 for one cycle time of 6 h. The addition of Cu(II) and Cd(II)-containing synthetic wastewater into the SBR system decreased the chemical oxygen demand (COD) and metals removal efficiencies. The examination of the pseudo first-order rate constant, k', providing a quantitative estimate of the inhibitory effect of the metal, showed that the k' value with the metals addition was around 10 times lower than that without metals addition.

Keywords: Wastewater treatment; Sequencing batch reactor; Heavy metals; SOUR

1. Introduction

Heavy metals are commonly found in effluents from electroplating and other metal-processing industries. Conventional methods of heavy metal removal from aqueous solutions usually involve physico-chemical treatments such as precipitation, filtration, ionic exchange, adsorption, electron-deposition, reverse osmosis etc. [1–4]. Although the mechanisms by which heavy metals affect biological treatment processes are not well defined, the general response of these processes to varying concentrations of metals is well documented [5]. It was reported that activated sludge microorganisms and process efficiency were inhibited by cadmium, chromium and nickel at concentration above 10 mg/l [6,7]. However, trace amounts of heavy metals are still required by microorganisms for optimum growth [8]. The deleterious effects of toxic compounds on biological processes are complex and are generally related to the species, and the solubility of the metal concentration of the toxicant [9].

Sequencing batch reactors (SBRs) are an attractive alternative to conventional biological wastewater treatment systems, mainly because of their simplicity and flexibility of operation. A numbered of papers providing a good description and evaluation of the SBR systems had been published [10,11]. The SBR is a periodically operated, fill-and-draw reactor [10,12]. Each reactor in a SBR system has five discrete periods in each cycle: FILL, REACT, SETTLE, DRAW, and IDLE. Reactions imitated during FILL and completed during REACT. After REACT, the mixed liquor suspended solids (MLSSs) are allowed to separate by sedimentation during SETTLE in a defined time period; the treated effluent is withdrawn during DRAW. The time period between the end of the DRAW and the beginning of the new FILL is termed IDLE [13]. SBRs have been successfully used to remove various types of pollutant including dyes [14] and chlorinated compounds [15]. Moreover, filamentous bacteria growth can be easily controlled by varying the FILL:REACT ratio or varying the operating strategies during FILL mode [16,17].

In fact, a single metal species exists very seldom in wastewater. The presence of more than one metal often gives rise to interactive effects. Although the interactive effects of a mixture of heavy metals are extremely complex, it has been shown that the final expression of heavy metal toxicity in

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doi:10.1016/j.procbio.2004.01.021