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Combined Fenton–SBR process for bamboo industry wastewater treatment

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HIGHLIGHTS

- ▶ Fenton–SBR process was applied to treat bamboo industry wastewater.
- ▶ Orthogonal test was used to optimize the Fenton operation conditions.
- ▶ Effect of anoxic–aerobic duration and HRT on SBR effect were investigated.
- ▶ Major organic compounds in raw and treated wastewater were analyzed by GC–MS.

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ABSTRACT

Bamboo industry wastewater (BIWW) degradation is difficult because of its high organic matter content and low biodegradability. In this study, the Fenton process was coupled to a sequencing batch reactor (SBR) for the treatment of BIWW. The Taguchi method was used to optimize the Fenton process for partial mineralization (TOC removal) and biodegradability (BOD_5/COD ratio) enhancement. The optimum dosages at pH 4.0 were determined to be 52.9 mM H_2O_2 and 7.9 mM Fe(II). At the biological stage, the effect of anoxic–aerobic durations was evaluated. The best resulting operation mode was 4 h for the anoxic phase and 6 h for the aerobic phase. During this operation mode, a global chemical oxygen demand (COD) removal of more than 89% was achieved, along with nearly complete nitrification and decolorization. The effect of the hydraulic retention time (HRT) on SBR performance was also studied. Generally, effluents with HRTs of more than 1.5 d met China's second grade national discharge standard. Major organic compounds were identified with Gas Chromatography–Mass Spectrometer (GC–MS). Most of the benzene and ester derivatives were completely eliminated following the Fenton–SBR process. However, amide and alkane derivatives were generated mainly as by-products from the different stages of the combined treatment.

1. Introduction

The bamboo industry in China has grown rapidly in recent years. However, the by-products of this industry are problematic for the environment. Bamboo industry wastewater (BIWW) contains saccharides, organic acids, amino acids, flavonoids, tannins and phytochromes that are generated from the boiling process used in the bamboo industry [1]. BIWW is characterized by a high chemical oxygen demand (COD 20,000–50,000 mg/L), low pH values (2.5–5) and a strong color content [2]. Anaerobic methods, such as the upflow anaerobic sludge blanket (UASB) and expanded granular sludge bed (EGSB), are mainly used in BIWW treatment [1,3]. However, even with significant removal of organic content, most of the colored compounds remain in the anaerobic effluent and the COD value remains high (500–1000 mg/L). Moreover, the biodegradability of anaerobic effluent declines sharply, which makes treatment by further biological methods difficult [4]. A coupled aerobic membrane bioreactor (MBR)-ozone treatment method was applied in our previous research to eliminate the organic matter in BIWW anaerobic effluent [3]. However, because the biodegradability was limited, the final effluent COD concentration remained higher than 200 mg/L, which does not meet the discharge standard in China (COD $\leqslant$ 100 mg/L).

Advanced oxidation processes (AOPs) are effective for the degradation of most wastewater pollutants [5]. Among the different AOPs, the Fenton oxidation process is a promising and alternative wastewater treatment method. The Fenton oxidation process requires a low investment cost, is easily applied and uses mild reaction conditions [6]. This technique is highly effective for removing organic substances and color from wastewater [7]. Oxidation potential species, particularly hydroxyl radical (·OH, $E^0 = 2.8$ V) [8], are generated during the Fenton process. The reaction uses a combination of hydrogen peroxide and ferrous ions in the following critical steps [9]:

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