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Short Communication

Low-energy treatment of colourant wastes using sponge biofilters for the personal care product industry

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HIGHLIGHTS

- Treating hair colourant wastes in the PCP industry is very energy intensive.
- New biofilter designs were tested for treating high strength colourant wastes.
- Packed- and sponge-media designs removed by COD and TN > 90% and 60%, respectively.
- Aerated sponge biofilters tolerated high oxidant levels better than other designs.
- Sponge reactors can reduce energy costs by >40% over current practices.

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ABSTRACT

Four trickling biofilter designs were assessed as low-energy alternatives to aerobic activated sludge (AS) for the treatment of personal care product industry wastes. The designs included partially submerged packed-media and sponge reactors with and without active aeration. Partial submergence was used to reduce active aeration needs. Simulated colourant wastes (up to COD = 12,480 mg/L, TN = 128 mg/L) were treated for 201 days, including wastes with elevated oxidant levels. COD and TN removal efficiencies were always >79% and >30% (even without aeration). However, aerated sponge reactors consistently had the highest removal efficiencies, especially for TN (~60%), and were most tolerant of elevated oxidants. This study shows sponge biofilters have great potential for treating colourant wastes because they achieve high treatment efficiencies and reduce energy use by >40% relative to AS systems.

1. Introduction

Personal care product (PCP) industries manufacture a broad variety of cosmetic and related products, which have a business value of >$250 billion per year (PCPC, 2010). A major portion of the total cosmetic market is comprised of hair colourant products (~8%) that account for $3.2 billion in the European economy (EC, 2010). Four distinct classes of colourants exist (Kirkland et al., 2005), including permanent (oxidative), semi-permanent (non-oxidative), metal salts, and natural dyes, all of which are approved by the European Commission (EC, 2010) and the U.S. Food and Drug Administration (USFDA, 1997). Further, oxidative dyes account for ~80% of total hair colourant market (Corbett, 1999); therefore, treating wastes from colourant manufacture is both of economic and environmental importance.

Liquid wastes produced in PCP manufacturing are primarily treated by aerobic activated sludge (AS) systems coupled with physico-chemical methods (El-Gohary et al., 2010), although biological methods are generally favoured because they produce more tractable solids residuals (Kurt et al., 2007). Anaerobic biological processes typically are not used because of the presence of oxidants in colourant wastes that inhibit anaerobic microorganisms (Ahammad et al., 2012). Therefore, hair colourant waste treatment uses aerobic processes that require copious active aeration because of high organic loadings (e.g., up to 20,000 mg/L COD), making AS very expensive in terms of energy costs. In fact, up to 10% of the total operating budget of a PCP factory can be for oxygen provision in their aerobic waste treatment units. Therefore, there is an urgent need for alternate biological waste treatment approaches, which both consider the relative toxicity of constituents in the waste and also the cost of energy for aeration.

A new approach is examined here for the treatment of colourant wastes that is designed to reduce energy consumption and sustain treatment performance. Given that aerobic conditions are better for oxidant-containing colourant wastes and active aeration is

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