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Treatment of vinasse from tequila production using polyglutamic acid

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ABSTRACT

Vinasse, the wastewater from ethanol distillation, is characterised by high levels of organic and inorganic matter, high exit process temperature (ca. 90 °C) and low pH (3.0–4.5). In this study, the treatment of tequila vinasse was achieved by a flocculation–coagulation process using poly-γ-glutamic acid (PGA). Results showed that the use of PGA (250–300 ppm) combined with sodium hypochlorite and sand filtration managed to remove about 70% of the turbidity and reduced chemical oxygen demand (COD) by 79.5% with the extra benefit of colour removal. PGA showed its best flocculating activity at pH 2.5–3.5 and a temperature of 30–55 °C. Such a treatment may be a solution for small tequila companies for which other solutions to deal with their vinasse may not be economically affordable.

1. Introduction

Vinasse is the wastewater produced from ethanol distillation (e.g. tequila). It is one of the most difficult waste products to dispose of, due to its low pH (3–4.5), high temperature, dark brown colour, high ash content and high biochemical oxygen demand (BOD) with values ranging from 35 to 50 g O_2/l (Nandy et al., 2002). Currently, two methods for disposal of vinasse are direct land discharge (Conde et al., 2009) and anaerobic digestion for methane production (Espinoza-Escalante et al., 2009). However, the former may result in severe damage to local agriculture (Conde et al., 2009).

In water treatment, flocculants are important in improving the efficiency of solid removal and reducing the processing time in solid–liquid separation for both water purification and wastewater treatment. At present, aluminium derived flocculants such as aluminium sulphate, poly-aluminium chloride (PAC) and synthetic polymers such as polyacrylamide (PAM) are widely used in coagulation treatment. However, aluminium is suspected to be related to Alzheimer's disease (Campbell et al., 2000) and the polyacrylamide monomer has been identified as a strong neurotoxin (Takahashia et al., 2005), two characteristics that could lead to their prohibition in the future. Thus, the search is on for alternative compounds without these drawbacks. Biodegradable flocculants could represent such an alternative to the presently used conventional flocculants. Reports are available on the production and application of bioflocculants such as polysaccharide from *Proteus mirabilis* (Zhang et al., 2010), and *Bacillus mucilaginosus* (Lian et al., 2008), polyamide from *Bacillus licheniformis* (Shih and Van, 2001), *Bacillus subtilis* DYU1 (Wu and Ye, 2007), and protein from *Bacillus* sp. DP-152 (Suh et al., 1997).

Among these bioflocculants, poly-γ-glutamic acid (PGA), a polyamide flocculant, is considered the best option because of its high yield, high flocculating activity and ability to flocculate a wide range of organic and inorganic compounds (Shih and Van, 2001). PGA is an anionic, naturally occurring, water-soluble homo-polyamide consisting of D- and L-glutamic acid monomers connected by amide linkages between α-amino and γ-carboxyl groups (Sung et al., 2005). It is biodegradable, edible, and non-toxic for humans and the environment (Shih and Van, 2001). The performance of polyglutamic acid-based bioflocculant PGA in processing kaolin suspension has been reported (Pan et al., 2009). It was observed that the efficiency of suspended solid removal was dose-dependent and that neither temperature nor pH were critical parameters affecting its flocculating activity. Practical applications of cross-

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