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Some properties of a sequencing batch reactor system for removal of vat dyes

Suntud Sirianuntapiboon [a], Kanidta Chairattanawan [b], Sawanya Jungphungsukpanich [a]

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Abstract

Bio-sludge from a wastewater treatment plant could be used as an adsorbent of vat dye from textile wastewater. Resting bio-sludge gave a higher adsorption capacity than dead bio-sludge. The resting bio-sludge from a textile wastewater treatment plant gave relatively high COD, BOD_5 and dye adsorption capacity of 364.4±4.3, 178.0±9.0 and 50.5±1.3 mg/g of bio-sludge, respectively, in synthetic textile wastewater containing 40 mg/l Vat Yellow 1. Another advantage of the bio-sludge was that, after washing with 0.1 N NaOH solution, it was reusable without any activity loss. Through treatment with a sequencing batch reactor (SBR) system, both organic and dye in STIWW could be removed. The maximum dye (Vat Yellow 1), COD, BOD_5 and TKN removal efficiencies of the SBR system under an MLSS of 2000 mg/l and an HRT of three days were 98.5±1.0%, 96.9±0.7%, 98.6±0.1% and 93.4±1.3%, respectively. Although, the dye and organic removal efficiencies of the SBR system with real textile wastewater were quite low, they could be increased by adding organic matters, especially glucose. The dye, COD, BOD_5 and TKN removal efficiencies of the SBR system with glucose (0.89 g/l) supplemented textile industrial wastewater were 75.12±1.2%, 70.61±3.4%, 96.7±0.0%, and 63.2±1.1%, respectively.

Introduction

Textile wastewater causes significant environmental pollution (Slokar and Marechal, 1998; Clarke and Steinle, 1995, Horning, 1978, Banat et al., 1996). Textile wastewater contains high concentrations of both organic matter and colorants (dyes) (Slokar and Marechal, 1998; Clarke and Steinle, 1995, Horning, 1978). Vat dyes are mainly used in textile industry for dying cellulose and silk materials according to resistant with sunlight and detergent (Hu, 1996; Slokar and Marechal, 1998; Wong and Yuen, 1996, Graca et al., 2001, Gupta et al., 1992). They are water insoluble dye, but they were dissolved in the water after reduction under alkaline condition. Chemical treatment processes such as oxidation, ion exchange, precipitation, coagulation and adsorption are commonly used to remove the colorants from textile wastewaters (Slokar and Marechal, 1998; Ramakrishna and Viraraghvan, 1997). However, chemical treatment processes can be unsuitable due to the high chemical and operating costs and solid wastes generation. Conventional biological treatment processes such as activated sludge, oxidation ponds and aerated lagoons are also used in the textile industry. The organic matter producing biochemical oxygen demand (BOD_5) is easily removed by biological treatment processes, but almost all of the colorants remain in the wastewater (being poorly biodegradable compounds) (Slokar and Marechal, 1998; Kim et al., 2002, Banat et al., 1996). This means that the effluent quality of conventionally treated biological wastewater, especially color intensity and chemical oxygen demand (COD), is higher than the standard permitted by the Department of Industrial Works of Thailand (Department of Industrial Works, 1992). During the past 20 years, researchers have concentrated on the use of microorganisms for removing colorants from textile industrial wastewater (Banat et al., 1996, Fu and Viraraghavan, 2001, Hu, 1996; Slokar and Marechal, 1998; Aksu, 2001, Assadi and Jahangiri, 2001, Balan Doralice and Monteiro, 2001, Kapdan et al., 2000). The ability to biologically remove color was found in both aerobic and anaerobic microorganisms (Slokar and Marechal, 1998). Colorant removal mechanisms are based on either adsorption or degradation or both (Slokar and Marechal, 1998; Fu and Viraraghavan, 2001, Hu, 1996, Zaoyan et al., 1992, Walker and Weatherley, 2000). Colorants such as azo, diazo and reactive dyes could be adsorbed by both dead and living microorganisms (Nigam et al., 1995, Wong and Yuen, 1996, Mitta and Gupta, 1996, Fu and Viraraghavan, 2001). Also, both gram-negative and gram-positive bacteria in bio-sludge showed colorant removal ability (Hu, 1996). However, all these researchers used single strains of microorganisms to remove colorants from textile industrial wastewater. In the present study, bio-sludge from a biological wastewater treatment plant was used to remove the colorants of textile wastewater. Two types of bio-sludge namely wastewater treatment plant bio-sludge and textile industrial wastewater treatment plant bio-sludge were tested for colorant removal efficiency, especially for vat dyes. The optimum conditions for resting and autoclaved bio-sludge to remove colorant from wastewater were determined and the most suitable solvents to elute colorants from colorant adsorbed-bio-sludge were investigated. The color removal efficiency of living bio-sludge was tested in a sequencing batch reactor (SBR) system under various solid retention times (sludge age).

Section snippets

Bio-sludge

Two types of bio-sludge were used in this study: bio-sludge type A and bio-sludge type B. Bio-sludge type A was collected from the Bangkok municipal central wastewater treatment plant (Siphaya plant), Thailand. The bio-sludge type B was collected from an textile factory wastewater treatment plant in Samuthpakarn province, Thailand. The characteristics of bio-sludges were described in Table 1. Both types of bio-sludge were used as resting bio-sludge after washing with 0.1 M acetate buffer pH 6.0, …

The adsorption capacity of bio-sludge

The results are shown in Table 6. The Vat Yellow 1 was more extensively adsorbed by the bio-sludge than Vat Black 25. The adsorption capacity of bio-sludge on Vat Yellow 1 was about 20% higher than that on Vat Black 25 and bio-sludge type A showed higher dye adsorption capacity than bio-sludge type B. The adsorption capacity of resting bio-sludge on Vat Yellow 1 was about 49.3±1.7 mg/g bio-sludge while it was only 39.9±0.9 mg/g bio-sludge on Vat Black 25. For the adsorption of organics, neither …

Discussions and conclusions

Sludge from biological wastewater treatment plants could be used as the adsorbent of both organic matter and dyes in textile wastewater. Bio-sludge from the textile wastewater treatment plants showed a higher degree of dye adsorption than the other types of bio-sludge tested. This may be explained by the dye adsorption ability being induced by growth in presence of textile dye (Ohmomo et al., 1988, Sirianuntapiboon et al., 1991, Sirianuntapiboon et al., 1998). The dye adsorption capacity was …

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