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Short Communication

Treatment of spentwash using chemically modified bagasse and colour removal studies

Jyoti D. Mane [a,*], Shweta Modi [a], Swati Nagawade [a], S.P. Phadnis [a], V.M. Bhandari [b]

[a] *Vasantdada Sugar Institute, Manjari, Pune 412 307, India*
[b] *National Chemical Laboratory, Pune 411 008, India*

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Abstract

Studies were carried out on derivatisation of bagasse into an ion exchange material and application of this chemically modified bagasse in the treatment of distillery wastewater. It was found that CHPTAC bagasse with HCl treatment and DEAE-bagasse in its free base form were most effective in colour removal and the mechanism of colour removal indicated significant contribution of both, the conventional ion exchange and the chemical sorption.

Keywords: Vinasse; Decolourisation; Distillery effluent; Modified biomass

1. Introduction

The Indian distillery industry uses sugarcane molasses as a preferred raw material because of its easy and large-scale availability, relatively high sugar content and low price. However, production of alcohol by molasses fermentation simultaneously generates 8–151 of wastewater per litre of alcohol. This (spentwash) is acidic (pH 4.5–4.8) dark brown liquid with high BOD (45,000–100,000 mg/l) and COD (90,000–210,000 mg/l), and emits obnoxious odour. Although it does not contain toxic substances, its discharge without any treatment brings about immediate discolouration and depletion of dissolved oxygen in the receiving water streams posing serious threat to the aquatic flora and fauna. Hence its treatment has assumed importance from the point of view of pollution abatement and environmental protection. A variety of treatment e.g. concentration and incineration or composting biomethanation etc. have been suggested on spentwash prior to its release into water stream However, even after these treatments, the effluent possesses high COD and colour, which restrict its disposal into rivers or its use for irrigation (Gokarn et al., 1998). Guidelines for the disposal of distillery effluent clearly recommend removal of unpleasant odour and colour from it. So far, only limited information is available in this regard in the literature. Thus, there is need to develop a strategy for the effective removal of colour from spentwash. In our earlier work, chemical modification of bagasse and application of the resultant chemically modified bagasse (CMB) for decolourisation of clarified cane juice were reported (Mane et al., 2001). These revelations prompted us to extend the application of CMB as a decolourising agent for spentwash.

2. Methods

Bagasse was obtained from a local sugar factory. Prior to use, it was dried, depithed and ground to a particle size of 0.5–0.8 mm. Spentwash collected from a storage tank of a local semi-continuous distillery was used for all decolourisation experiments.

* Corresponding author. Tel.: +91 20 26902 367/100; fax: +91 20 26902244.
E-mail address: jyotijdm@yahoo.com (J.D. Mane).

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Table 1
Effect of CMB decolourisation on characteristics of the treated spentwash

Parameters	Untreated spentwash	Spentwash treated with	
		DEAE-bagasse (free base) N = 2.5%	CHPTAC-bagasse (HCl treated) N = 1.9%
pH	4.26	5.07	4.99
Colour (units)	44,670	21,534	22,246
Reduction in colour, %	–	51.8	50
Turbidity (NTU)	11,924	45,737	18,153
Reduction in turbidity, %	–	47	36
COD, mg/l	1,24,000	74,000	92,000
Reduction in COD, %	–	40.32	26
BOD_5, mg/l	50,000	25,000	30,000
Reduction in BOD, %	–	50	40
Total solids, mg/l	1,44,000	91,275	92,510
Reduction in total solids, %	–	36.62	35.76

Note: In each experiment 100 ml of 1:4 (v/v) spentwash:water solution was treated with 0.6 g CMB and the mixture allowed to equilibrate for 4 h with intermittent swirling.

2.1. Preparation of chemically modified bagasse (CMB)

CMB products were prepared using 2-diethylaminoethyl chloride hydrochloride and 3-chloro-2-hydroxypropyltrimethylammonium chloride under conditions reported earlier (Mane et al., 2003). The CMB products were labeled as DEAE-bagasse and CHPTAC-bagasse. CMB products obtained in a step prior to the final HCl treatment, were referred to as CMB products in their free base form. Products with variation in their nitrogen content (indicating the extent of substitution of amino group in the CMB) were prepared by varying the quantity of amino reagent used for the etherification reactions.

2.2. Characterisation of spentwash

Spent wash samples were characterized for various parameters viz pH, colour, turbidity, COD, BOD and total solids by standard procedures (Clesceri et al., 1989) (Table 1).

2.3. Evaluation of CMB as a decolourising agent

The equilibrium colour removal studies were carried using known quantity of CMB in conical flask and equilibrating it with 1:4 dilute samples of spentwash. These batch experiments were carried out at room temperature with intermittent shaking of the flasks. Colour of the treated spentwash was measured by drawing small aliquots at definite time intervals. To evolve a strategy for the effective utilisation of CMB, the operating conditions were determined as follows:

(a) Time for attainment of equilibrium: Diluted spentwash (500 ml) was treated separately with CMB (3 g) in two different forms viz DEAE-bagasse and CHPTAC-bagasse in their HCl treated forms, and having comparable nitrogen content (1.89% and 1.9%, respectively) for different duration of time.
(b) Quantity of CMB: Optimum quantity of CMB required for the colour removal was determined by treating separately a fixed quantity of the diluted spentwash with different quantity of CMB (0.2–1.0 g per 100 ml of diluted spentwash) and measuring in each case at equilibrium the colour removal as its function.
(c) Dilution of spentwash: Experiments were conducted using both the CMBs under comparable conditions by using spentwash diluted with 1–5 times with water.
(d) Extent and type of substitution in CMB: Diluted spentwash was decolourised using HCl treated and untreated (free base) samples of both the CMBs having comparable N content, under similar conditions, and decolourisation measured at equilibrium to select the effective form of CMB. To ascertain the effect of degree of substitution of the ionic groups in CMB, experiments were performed under comparable conditions using CMBs with varying N content and the extent of colour removal was determined at equilibrium.
(e) Effect of pH: Decolourisation of the diluted spentwash was studied at acidic (4.16), neutral (7) and alkaline (8) pH.

2.4. Effect of CMB-treatment on characteristics of spentwash

Samples of spentwash treated with CMB products were also investigated for properties such as pH, colour, turbidity, COD, BOD and total solids.

3. Results and discussion

CMB products have been successfully used for decolourisation of sugarcane juice (Mane et al., 2001) and textile effluent (Laszlo, 1996). Hence, extension of its utility as decolourising agent for spentwash appeared feasible. Colour of spentwash is mainly due to the presence of melanoidins,