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Full Length Research Paper

Textile Wastewater Treatment Using Sawdust as Adsorbent

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Abstract
The role of sawdust in the removal of pollutants from textile wastewater has been investigated. The textile wastewater was treated by using sawdust as adsorbent and then filtered. The various physicochemical characteristics of sawdust treated and untreated textile effluent were analyzed. The maximum percent removal of 37% was observed for total suspended solids while minimum removal of 9% for chemical oxygen demand. The investigations revealed that after treatment with sawdust, the treated effluent had lower values of all the parameters than the untreated effluent. The reduction in pollution load of treated effluent may be attributed to the adsorption of chemicals in effluent by sawdust through hydrogen bonding and ion exchange mechanism.

Keywords: *Adsorption, Dyes, Pollution, Sawdust, Textile effluent*

Introduction

Textile industry is one of the most important and rapidly developing industrial sectors. India has a large network of textile industries of varying capacity i.e. about 10,000 garment manufacturing and 2,100 bleaching and dyeing industries (Nagajyothi *et al.*, 2010). These are well developed and scattered all over the country with its main centers at Ahmedabad, Mumbai, Chennai, Coimbatore, Bangalore and Kanpur. Al-Kdasi *et al.* (2004) reported that the textile wastewater is characterized mainly by high BOD (80-6,000 mg L^{-1}), COD (150-12,000 mg L^{-1}), suspended solids (15-8000 mg L^{-1}), dissolved solids (2900-3100 mg L^{-1}) and chloride (1000-1600 mg L^{-1}). Wastewater generated by different production steps of a textile mill also have high pH, temperature, detergents, oil, suspended and dissolved solids, dispersants, colour, chlorinated compounds and alkalinity (Garg & Kaushik, 2008). This when discharged into the receiving water bodies not only affects the aesthetic nature but also interferes with the transmission of sunlight and reduces the photosynthetic activity of plants thereby disturbing the natural equilibrium present in the water body (Kadirvelu *et al.*, 2000; Namasivayam *et al.*, 2001).

The conventional biological treatment processes are not very effective in treating textile wastewater due to the chemical stability of the dye components (Garg *et al.*, 2003). Various methods have been used to remove colour from industrial effluents to decrease their impact on the environment. These technologies include adsorption on inorganic or organic matrices, decolourisation by photo-catalysis or photo-oxidation processes, microbiological decomposition, chemical oxidation, ozonation and coagulation (Shukla *et al.*, 2002; Malaviya & Rathore, 2007). Among these, photo-oxidation, microbiological decomposition, chemical oxidation, ozonation and coagulation are considered very expensive in terms of energy and reagents consumption (Churchley, 1994; Stern *et al.*, 2003). However, adsorption process is considered very effective in textile wastewater treatment as it proves superior to the other processes by being sludge free and can completely remove even very minute amounts of dyes in wastewaters (Nigam *et al.*, 1996). The most widely used sorbent for industrial applications is activated carbon (Walker and Weatherley, 1997; Khalil & Girgis, 1998), but it is very expensive. Hence, numerous studies on adsorption properties of naturally occurring and low cost adsorbents, such as agricultural byproducts and natural fibers, namely; waste coir pith (Namasivayam *et al.*, 2001), corncob and barley husk (Robinson *et al.*, 2002), ash (Isa *et al.*, 2007 and sawdust (Garg *et al.*, 2003; Khattri & Singh, 2009) have been reported in recent years. In the present study an attempt has been made to use sawdust as an adsorbent for removal of pollutants from textile effluent.

Materials and Methods

The chemicals used during the course of study were of GR (Guaranteed Reagent)/AR (Analytical Reagent) grade. The sawdust was collected from the local saw mill and sieved through a mesh of size 0.5 mm. Then, it was washed with distilled water to remove the surface adhered particles and dried at a temperature of 60-80^{0}C in an oven (Khattri & Singh, 2009). The textile wastewater was collected from outlet drain of Chenab Textile Mills, Kathua, Jammu in precleaned 20 litres plastic containers and one part of the effluent was treated by using sawdust as adsorbent at the rate of 2 g L^{-1} and then filtered (Izadyar & Rahimi, 2007). This part of effluent was termed as sawdust treated effluent and the other part was termed as untreated effluent. The sawdust treated and untreated effluent were analyzed for pH, E.C. (Electrical conductivity), TSS (Total suspended solids), TDS (Total dissolved solids), TS (Total solids), Cl^- (Chloride), COD (Chemical oxygen demand), hardness, Mg (Magnesium) and Ca (Calcium) by standard methods (Greenberg *et al.*, 1995).

Results and Discussion

The physicochemical characteristics of sawdust treated and untreated textile effluents are presented in Table 1. The physicochemical analysis of wastewater indicated that the untreated effluent was dark brown in colour with unpleasant smell while sawdust treated effluent was light brown in colour and odourless. The pH (8.30), E.C. (1.641 mS cm^{-1}), COD (544 mg L^{-1}), TSS (233.33 mg L^{-1}), TDS (1358 mg L^{-1}), TS (1591.33 mg L^{-1}), Cl^- (749 mg L^{-1}), hardness (481.6 mg L^{-1}), Mg (289 mg L^{-1}) and Ca (192.6 mg L^{-1}) of untreated effluent exhibited higher values than the pH (8.06), E.C. (1.1545 mS cm^{-1}), COD (495 mg L^{-1}), TSS (146.66 mg L^{-1}), TDS (1187.66 mg L^{-1}), TS (1334.33 mg L^{-1}), Cl^- (623 mg L^{-1}), hardness (406.3 mg L^{-1}), Mg (243.8 mg L^{-1}) and Ca (162.5 mg L^{-1}) of treated textile effluent (Table 1). The percent removal of 9%, 37%, 12%, 16%, 15%, 16%, 15.6% and 15.6% was observed for COD, TSS, TDS, TS, hardness, Cl^-, Mg and Ca, respectively (Figure 1).

Table 1: Physicochemical characteristics[1] of sawdust treated and untreated textile effluent

Parameters	Units	Untreated effluent	Treated effluent
Temperature	^0C	38	25
Colour	-	Dark brown	Light brown
Odour	-	Unpleasant	Odourless
pH	-	$8.30^a \pm 0.02$	$8.06^b \pm 0.017$
Electrical conductivity	mS cm^{-1}	$1.64^a \pm 0.003$	$1.54^b \pm 0.002$
COD	mg L^{-1}	$544^a \pm 2.33$	$495^b \pm 4.58$
Total suspended solids	mg L^{-1}	$233.3^a \pm 1.45$	$146.6^b \pm 1.2$
Total dissolved solids	mg L^{-1}	$1358^a \pm 2.08$	$1187.7^b \pm 4.33$
Total solids	mg L^{-1}	$1591.3^a \pm 3.48$	$1334.3^b \pm 5.48$
Hardness(as $CaCO_3$)	mg L^{-1}	$481.66^a \pm 2.04$	$406.33^b \pm 1.36$
Chloride	mg L^{-1}	$749^a \pm 1.73$	$623.6^b \pm 3.28$
Magnesium	mg L^{-1}	$289^a \pm 1.22$	$243.8^b \pm 0.81$
Calcium	mg L^{-1}	$192.67^a \pm 0.81$	$162.5^b \pm 0.54$

Within each column, values not followed by the same letter are significantly different at $p \leq 0.05$
[1]Mean $\pm$ SE of three replicates

The difference in the physicochemical characteristics of sawdust treated and untreated textile effluents may be attributed to the adsorption of chemicals in the effluent by sawdust through ion exchange and hydrogen bonding as reported by Ajmal *et al.* (1998) and Schipper *et al.* (1998). The cell walls of sawdust mainly consist of cellulose and lignin, and many hydroxyl groups, such as tannins or other phenolic compounds. All these components are active ion exchangers and based on their electron-donating nature and the electron-accepting nature of heavy metal ions, the ion exchange mechanism and hydrogen bonding could be explicated (Suemitsu, *et al*., 1986; Shukla *et al.*, 2002).

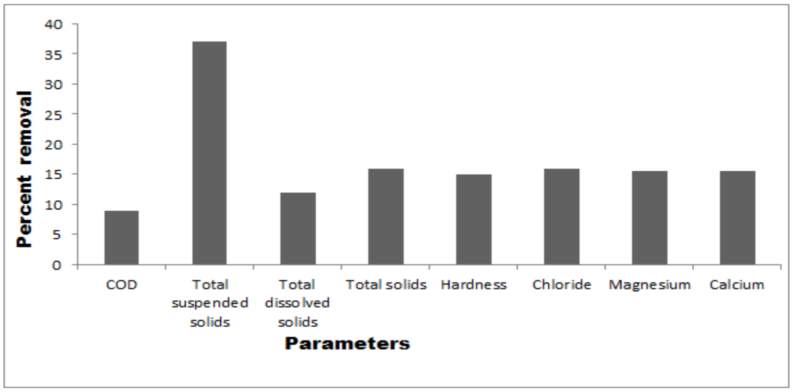

Figure 1: Percent removal of various pollution parameters in sawdust treated textile effluent

Conclusion and Recommendation

The textile effluent was treated using sawdust as adsorbent. The physicochemical characteristics of sawdust treated and untreated textile effluent were analyzed. The analysis showed reduction in all the parameters of sawdust treated effluent which may be attributed to the adsorption of chemicals in effluent by sawdust through hydrogen bonding and ion exchange mechanism. The adsorption can be influenced by a number of factors, such as, adsorbent mass and size, contact time, agitation speed, temperature and pH etc. Hence, there is a need to optimize these factors to maximize the treatment efficiency of sawdust and minimize the treatment cost for textile wastewater.

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