Nature Environment and Pollution Technology © Technoscience Publications	Vol. 7	No. 3	pp. 505-508	2008

Removal of Colour from Tannery Dye Wastewater Using Ozone

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Key Words:
Tannery dye waste
Navitan Bordeaux MB
Ozone treatment
Decolourisation

ABSTRACT

Colour removal of wastewater containing acid dye (Navitan Bordeaux MB) by ozone treatment has been studied in an attempt to abate pollution caused by leather dyeing houses. The Navitan Bordeaux MB dye is commonly used in commercial leather manufacturing. The effluent has been synthetically prepared using water with 100 ppm concentration of dye. Passing ozone in a bubble column reactor containing the dye solution carried out the decolourisation process of the pre-metallised acid dye. The effect of dye concentration, ozone dose and pH on the rate of decolourisation has been studied. The efficiency of the decolourisation has been evaluated by measuring absorbance of the dye solution.

INTRODUCTION

While massive industrialization improves the economy, many industries contribute highly coloured effluents. Major industries like textile, leather and paper produce large quantities of effluent with dye colour present in it. The wastewater containing dyes, mordants, sizing agents and dyeing acids are deep in colour and highly pollutant that creates an environmental and aesthetic problems. The dyeing effluent treatment is more complex than any other industrial wastewater purification. Various methods used for colour removal are chemical oxidation, adsorption, reverse osmosis, chemical coagulation, biological methods and natural processes. In the present study ozone is used as a chemical oxidant in the tannery dye wastewater. Ozone treatment has been demonstrated that it has the ability to destroy dyestuffs. Ozonisation of dyestuffs does not generate more biologically toxic chemicals. The main objective of the present study is to understand the effect of ozone on the removal of colour, COD and total solids occurring in dyeing effluents.

Colour sensation is the interpolation of the brain, the stimulation of the retina by light in the visible range (Allen 1971, Judd 1952). Colour realization is physical, chemical, physiological and psychological phenomena. All coloured effluents, dyes and pigments have the power of absorbing radiation (Coaster 1967). The effect of the sunlight on removal of colour, COD and suspended solids of Vat dyeing effluents was studied by Manjula et al. (2006). This natural ageing process is also similar to oxidation method without any expenditure, but it is a long run process. Huseyin Selcuk (2005) studied ozonisation treatment techniques for textile wastewater and concluded that coagulation increases toxicity level of COD in the wastewater. In the present study, dye employed in the colouring of leather is taken for ozonisation treatment without coagulation. Navitan Bordeaux MB (CI Acid Violet 90) is one of the pre-metallised acid dyes which is widely used in the application of dyeing in leathers.

MATERIALS AND METHODS

Chemical structure of Navitan Bordeaux MB (C.I. Acid Violet 90) is shown below. The experimen-

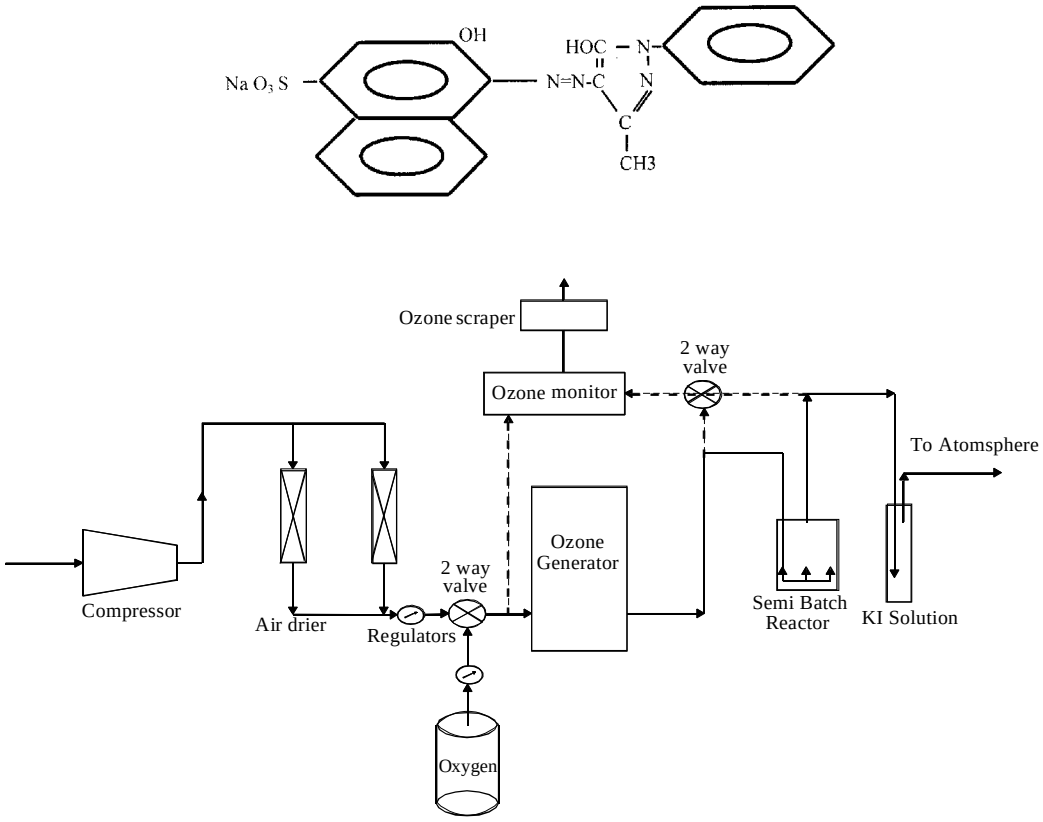

Fig. 1: Experimental setup for air/oxygen feed generated zone.

tal setup is shown in Fig. 1. Ozone has been generated by atmospheric oxygen in air and by using pure oxygen. The industrial oxygen cylinder was used as feed gas. The air was compressed and maintained at 5 bar pressure using an automatic cutout setting. The compressed air was then sent to the air drier to remove residual moisture in the air and to maintain low humidity. One bar pressure was maintained using a pressure regulator at the output of air drier. The ozone concentration has been measured using an on-line ozone monitor (make : PCI-WEDECO, USA). The flow rate maintained throughout the process was 10 LPM. The input from the generator and output from the reactor was measured using an on-line monitor.

Dye solutions of 100 ppm of Navitan Bordeaux MB were taken for the experimental studies as normally tannery spent dye wastewater contains 100 ppm only. Two litres volume of the dye solution was maintained constantly throughout the experimental study. The 5-L glass column reactor of 12 cm diameter and 50 cm height with flanges with inlet, outlet and drain was used. The ozone diffuses through ceramic spurges into dye solution. The unspent ozone is sent through KI solution for chemical decompositions before sending it to atmosphere.

The samples were collected from the reactor by the valve provided at the bottom of the reactor at regular intervals of time. The absorbance values were measured at λ_{max}560 nm using UV-VIS spectrophotometer, Shimadzu 2101 PC, Japan. The percentage of removal of the dye colour for different ozone concentrations is tabulated and plotted. Graphs were drawn for both oxygen and air feed gases.

RESULTS AND DISCUSSION

Effect of ozone concentration on colour removal: Percentage colour removal for different ozone concentrations for air as feed gas is shown in Figs. 2 and 3. The percentage decolourisation of the dye at first 5 minutes is significant for low and high concentrations. At high ozone dosage, up to 90% colour removal was obtained in 1-2 minutes. With low ozone doses, 90% colour removal was obtained in 4-5 minutes. The complete colour removal takes 7 minutes and 5 minutes for air and oxygen feed respectively.

Percentage colour reduction against consumed ozone dose plotted for different ozone concentrations is shown in Figs. 4 and 5. For 100 ppm dye concentration solution, 50mg/L of ozone (air feed)

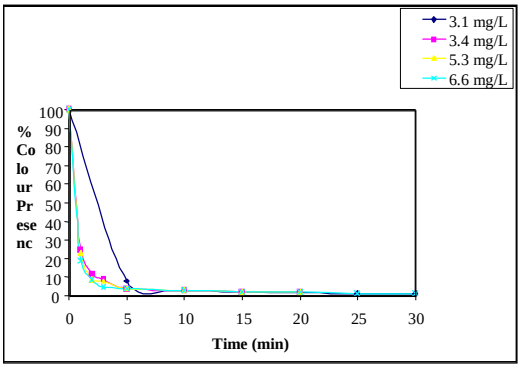

Fig. 2: % Colour presence Vs time for 100 ppm dye solution (air feed).

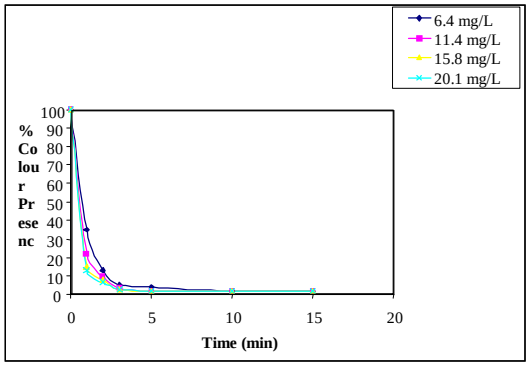

Fig. 3: % Colour presence Vs time for 100 ppm dye solution (oxygen feed).

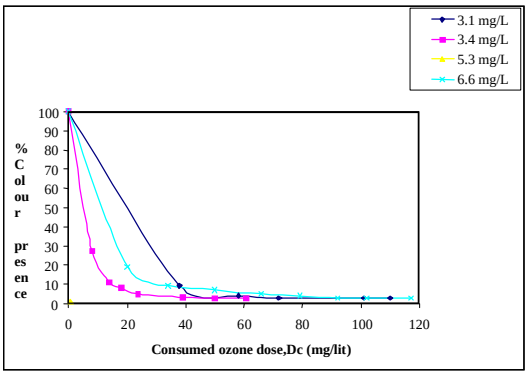

Fig. 4: % Colour presence Vs Consumed ozone dose for 100 ppm dye solution (air feed).

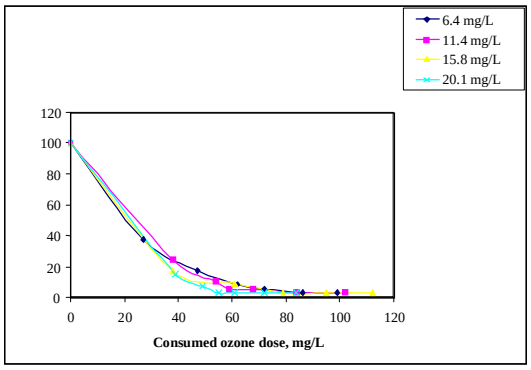

Fig 5: % Colour removal Vs Consumed ozone dose for 100 ppm dye solution (oxygen feed).

Table 1: Effects of air feed ozone on spent dye effluent of Acid violet 90.

Time (min)	COD (mg/L)	TDS (mg/L)	TSS (mg/L)
0	11065	22400	4600
15	9254	21200	4400
30	6631	19200	4100

Table 2: Effects of oxygen feed ozone on spent dye effluent of Acid violet 90.

Time (min)	COD (mg/L)	TDS (mg/L)	TSS (mg/L)
0	11067	22800	4200
15	8955	21100	3800
30	5821	19000	3350

is required to achieve 90% colour removal efficiency. Similarly for 100 ppm dye concentration, 30 mg/L of ozone (oxygen feed) is required to achieve 90% colour removal efficiency. While higher concentration of ozone can remove colour faster, an optimum concentration required to remove colour up to 90% has been studied in this work.

Table 1 and Table 2 show effects of ozone on COD, TDS and TSS removal. Results show that COD reduction of 40% and 47% is attained for ozone concentrations of 4.8 and 7.2 ppm respectively. Small TDS reduction of 14% and 17% and TSS reduction of 11% and 20% have been attained for these two ozone concentrations respectively.

CONCLUSIONS

The effect of dye concentration and ozone concentration on the rate of decolourisation were studied. When applied ozone dose increased, the colour removal efficiency increased. Increase in applied ozone dose increases the consumed ozone dose. A new approach was studied to determine the required ozone dose by using experimental results obtained from lab scale colour removal studies for tannery dye wastewater.

It has been demonstrated that ozone oxidation satisfactorily remove the colour of tannery wastewater. However, it is an expensive method and predetermination of the applied ozone dosage is an important factor for cost effective applications in full-scale ozonisation plants.

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