MEASUREMENT OF WASTEWATER TREATMENT EFFICIENCY
BY FLUORESCENCE AND UV ABSORBANCE

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Abstract. The degree of chemical treatment in terms of removal of organic matter from different wastewaters has been investigated by employing potassium ferrate (K₂FeO₄) and ozone in various combinations. The study was performed in both the batch and the continuous flow systems. The treatment efficiency was determined through three different methods, i.e., chemical oxygen demand (COD), fluorescence and ultraviolet (UV) absorption. Fluorescence and UV absorption techniques were employed due to their specificity in measurement of humic substances, aromatic compounds and heterocyclic systems, whereas COD is a general parameter for the estimation of total organic matter. Fluorescence and UV absorbance values were correlated with respective COD values.

1. Introduction

There has been much concern regarding the presence of organic substances in drinking waters and treated wastewater effluents for reuse. Several treatment schemes have been proposed for their removal. Ozone and iron (VI) (ferrate) have been reported to be effective oxidants of organic matter without the formation of toxic compounds (Rosen, 1973; Waite, 1979). Further, ozone improves water quality by removing colour and turbidity and by increasing the effluent dissolved oxygen (Rosen, 1973; Waite, 1979), whereas ferrate has the capacity to act as a coagulant and nutrient scavenger along with the removal of heavy metals (Murmann and Robinson, 1974). A study was undertaken to investigate the effectiveness of ferrate and ozone in various combinations to remove and oxidize the organic matter from different wastewaters.

The levels of organic matter are usually determined by the standard methods such as chemical oxygen demand (COD), biochemical oxygen demand (BOD), total organic carbon (TOC), etc. These methods are time consuming and/or require expensive instruments. In recent years a number of authors have discussed the correlation between UV absorbance and TOC and dissolved organic matter (DOM), COD and BOD (Mrkva, 1975; Dobbs et al., 1972; Michail and Idelovitch, 1981). Smart et al. (1976) have studied the correlation between fluorescence and TOC, while Brun and Milburn (1977) have described an automated fluorometric method for the determination of humic substances in natural waters. This study has incorporated the use of fluorescence and UV absorbance techniques to measure the wastewater treatment efficiency due to their specificity in the measurement of aromatic compounds, polyaromatic system and their derivatives, heterocyclic systems (Willard et al., 1974) and humic substances. Chemical

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oxygen demand (COD), a general parameter for the estimation of total organic matter, was also measured for comparison purposes.

2. Experimental Methods

Fresh secondary wastewater effluent and raw sewage were brought from the South Aramco activated sludge sewage treatment plant, Dhahran. Preliminary studies were performed in the batch system to determine the optimum dose of ferrate for the removal of organic matter in terms of fluorescence and UV absorbance and COD values. Parallel studies with ferric chloride were also conducted to establish the superiority of ferrate in terms of its use.

The fluorescence was determined at an excitation wavelength of 365 nm and an emission wavelength in the range of 400–600 nm using Turner Fluorometer model 111. The UV spectra were scanned between 240–350 nm using Beckman Spectrophotometer Acta MVII. The absorbance value at 254 nm was used to measure the wastewater treatment efficiency and for correlation with respective COD values. COD measurements were performed according to Standard Methods (1980).

Continuous flow studies were performed on the bench-scale pilot treatment system, details of which are described elsewhere (Farooq et al., 1982). The filtrate obtained after chemical treatment and filtration was ozonated separately at 50, 60, and 70 V in the ozone contactor. The concentration of ozone in aqueous and gaseous phases were determined using Standard Methods (1980).

The continuous flow treatment studies were performed on three types of wastewaters, i.e. secondary wastewater effluent, settled raw sewage and lime treated raw sewage. Secondary effluent was brought in the morning prior to the start of the experiment while raw sewage was brought in the evening and allowed to settle overnight (10–12 hr) prior to treatment studies. In case of lime treated sewage the waste was treated with 350 mg l⁻¹ calcium hydroxide and was allowed to settle 10–12 hr. Lime treatment involved 1 min of rapid mixing followed by one hour of slow mixing.

3. Results and Discussion

Batch studies were performed in standard Phipps-Bird Jar test apparatus. This involved 1 min of rapid mixing followed by slow mixing for 30 min after addition of chemical in the wastewater sample. The chemically treated effluent was allowed to settle for 90 min prior to decanting supernatant for various analysis. The results for secondary wastewater treatment with ferrate and ferric chloride are given in Figure 1. It can be seen from the figure that concentrations of COD decrease with increase in ferrate and ferric chloride doses. Similar trend has been observed with UV and fluorescence measurements for both the chemicals. However, reduction in fluorescence is much higher in ferrate treated effluent as compared to ferric chloride treatment. This indicates change in structure of some organic compounds due to ferrate oxidation, resulting in the decrease of fluorescence value, although removal of organic compound appears to be