

Reduction in COD of mixed effluents from chemical industries using powdered bone of Sepia (*Sepia accealata*)

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Abstract

The Maharashtra Industrial Development Corporation (MIDC) Dombivali area constitutes around 900 industries. Two major nullahs running through the industrial area carry the untreated effluents into the Ulhas Creek. These effluents were characterized by studying the physico-chemical parameters like pH, conductivity, colour, turbidity, acidity, alkalinity, chlorides, temperature, total solids, suspended solids, dissolved solids, dissolved oxygen, biochemical oxygen demand (BOD), chemical oxygen demand (COD) and heavy metals such as Fe, Mn, Cu, Co, Cr, Cd, Pb, Ni, and Zn. The results of the analysis showed that the effluents have a very high COD level. The present study deals with an easy way of COD reduction using crushed shell bone of Sepia. The system obeys Freundlich adsorption isotherm. Nearly 86% COD reduction was obtained in some of the samples at pH 9.0. The cation and anion exchange capacity of the bone powder was found to be 0.249 meq/g & 0.075 meq/g respectively. Also, a brief study of the metal-EDTA complex adsorption at pH 9.0 was carried out and the respective exchange capacity of the natural resin for each metal was determined.

Key words: CETP, Effluents, COD, BOD, Sepia, natural resin, pH and ion exchange capacity

1. INTRODUCTION

Among the major polluting industries in the world, textile, dyechem, pharmaceutical and chemical units are listed as prominent. These industries are found to be predominant in the study area called Dombivali MIDC area near Mumbai. Various physico-chemical methods used for treatment are not adequate either due to cost

factor or due to operational incompetence. In water and wastewater analysis, measurement of Chemical Oxygen Demand (COD) is one of the most important and most frequently used analytical parameter to determine the strength of the effluents. Along with Biochemical Oxygen Demand (BOD), Total Oxygen Demand (TOD), Total Organic Carbon (TOC) and Dissolved Organic Carbon (DOC), the measurement of COD is particularly important for the characterization and treatment of industrial and municipal effluents (Dasgupta and Petersen, 1990).

COD is defined as a measure of the oxygen equivalent of the organic matter content of a sample that is susceptible to oxidation by a strong chemical oxidant (APHA, 1989). Thus COD gives the load or strength of the effluent. The objective of this study is to investigate the feasibility of powdered Sepia bone in COD reduction of mixed industrial effluents.

2. MATERIALS AND METHODS

Samples were collected from two major nullahs carrying the mixed effluents from Dombivali MIDC area to the Ulhas Creek. The map of the area indicating the sampling points is shown in **Fig. 1**.

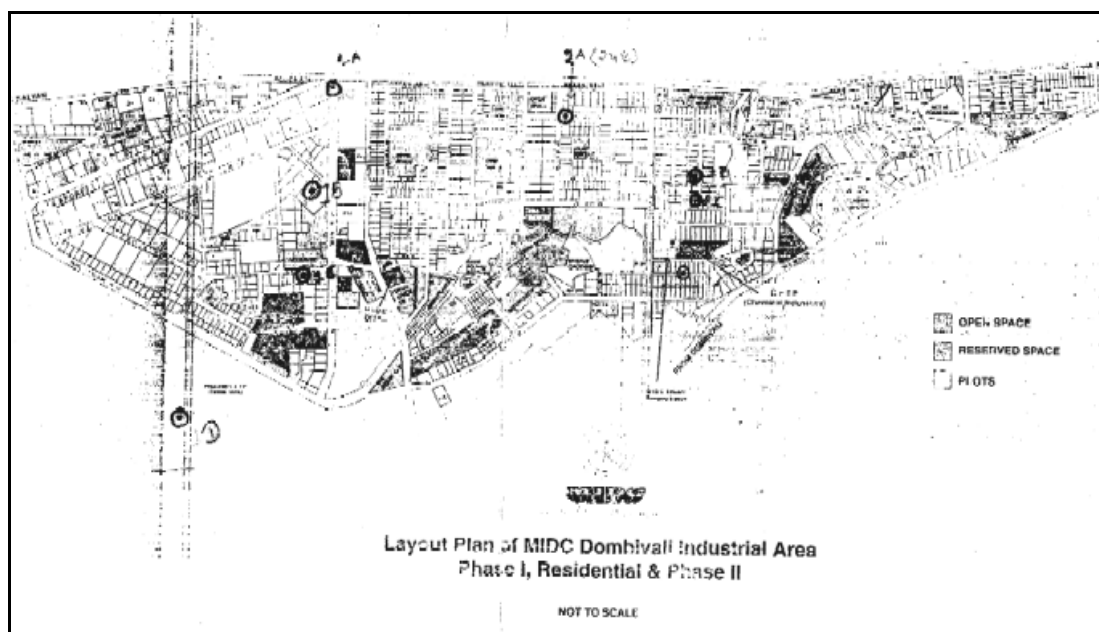


Fig. 1. Map of the Dombivili MIDC area showing sampling points.

2.1. Sorbent:

The sorbent used for COD reduction study was crushed Cuttle bone (*Sepia accealata*). The Cuttle bone was crushed using mortar and pestle and sieved through 60-120 mesh. The mineralogy and crystallographic structure of this material revealed that aragonite and calcite are the chief minerals of sepia shell. In the lamellar ventral

zone of Cuttle bone, which is aragonitic, parallel lamellae or septa are held apart by organic-calcareous pillars delimiting cavities or chambers (Florkin and Scheer, 1972).

The organic portion of these structures contains chitin. In the electron micrograph (EM), the decalcified septa and pillars appear to be composed of substantial networks of microfibrils partly embedded in a nodular or amorphous material destroyed by NaOH at 100°C. The IR spectrum of the compound is shown in **Fig. 2**. The IR reveals the presence of -OH, -S-H, C-H, C=O, CaCO₃, O-Na-O, Si-F functional groups (Bellamy, 1975; Silverstein et al., 1981; Dean and Dean, 1987).

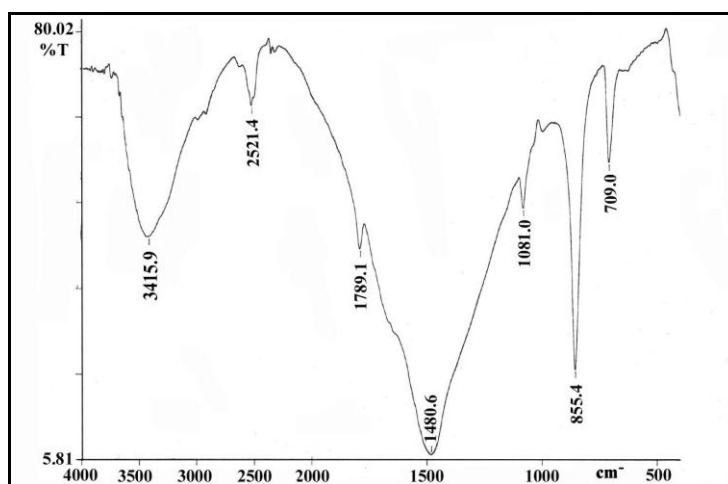


Fig. 2. IR spectrum of the powdered bone of Sepia.

2.2. Methodology

Both column and batch processes were used for the study. A column 20 cms in length and with internal diameter of 25 mm was packed without air bubbles with 20 g of sorbent using slurry technique in which glass distilled water was used as solvent. The flow rate was adjusted to 3 ml per minute.

2.3. Experimental

Parameters such as adsorption isotherm, ion exchange capacity, pH, contact time, sorbent concentration and metal-EDTA complex adsorption at optimum pH were studied. All AR grade chemicals were used during analysis. Analysis was carried out using standard methods (Das and Behera, 1983; Negi and Anand, 1986; APHA, 1989).

3. RESULTS

The present investigation was directed to evaluate the potential of the sorbent to be used for COD reduction.

3.1. pH study:

The effect of pH on COD reduction removal is shown in **Fig. 3**. pH study was carried out in the range from 7.0 to 12.0.

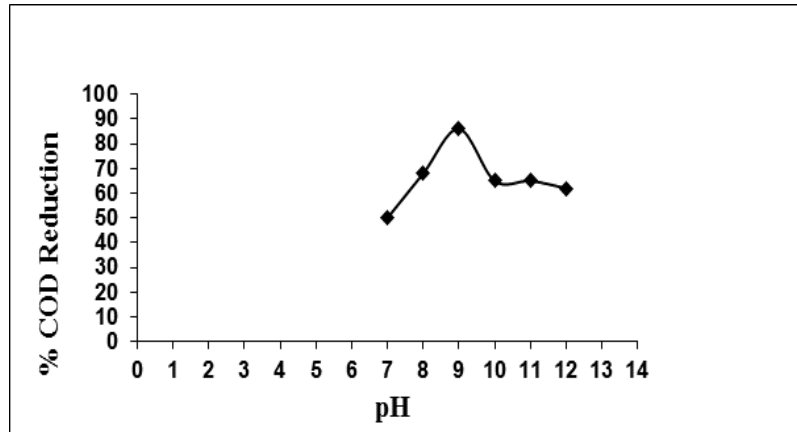


Fig. 3. Graph showing effect of pH on COD reduction

3.2. Ion-Exchange capacity:

The cation and anion exchange capacity was found to be 0.249meq/g and 0.075 meq/g.

3.3. Effect of contact time: COD reduction as a function of contact time was studied using mixed effluents after adjusting the pH to 9.0. It was observed that maximum COD reduction of 71.3% was achieved for a contact time of 30 minutes. **Fig. 4.** shows the linear variation of increase in percentage COD reduction with increase in contact time.

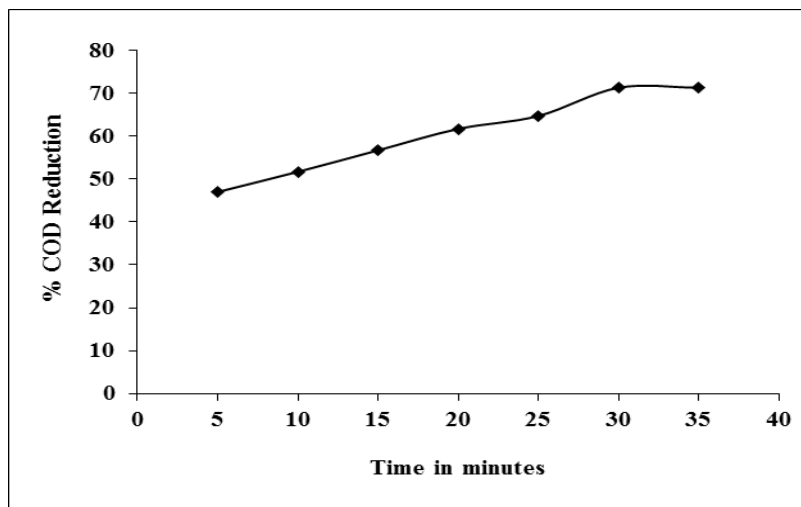


Fig. 4. Graph showing effect of contact time on %COD reduction.

3.4. Effect of Sorbent dose:

The percentage COD removal with different doses of sorbent is given in **Fig. 5**. There exists a linear relationship between COD reduction and increasing sorbent dose with a maximum COD reduction of 61% at a dose of 50g/lit.

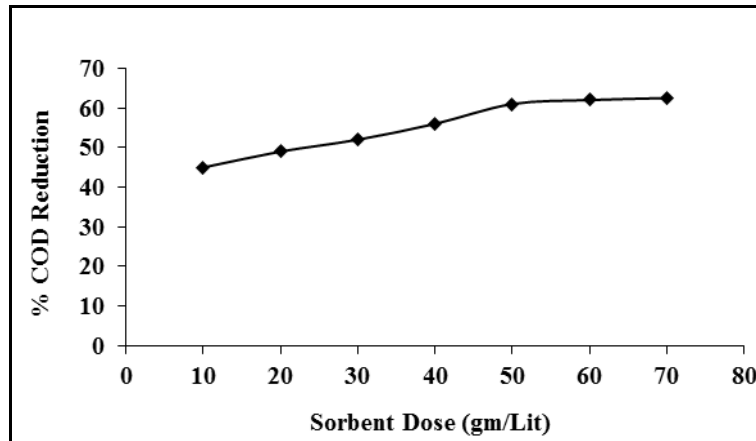


Fig. 5. Graph 3 Effect of Sorbent Dose on % COD reduction.

3.5. Adsorption isotherm:

It can be stated that the powdered bone obeys Freundlich adsorption isotherm (**Fig. 6**). Equilibrium data was analyzed using Freundlich isotherms.

$$\text{Log (X/M)} = \text{log K} + 1/n \text{ log Ce}$$

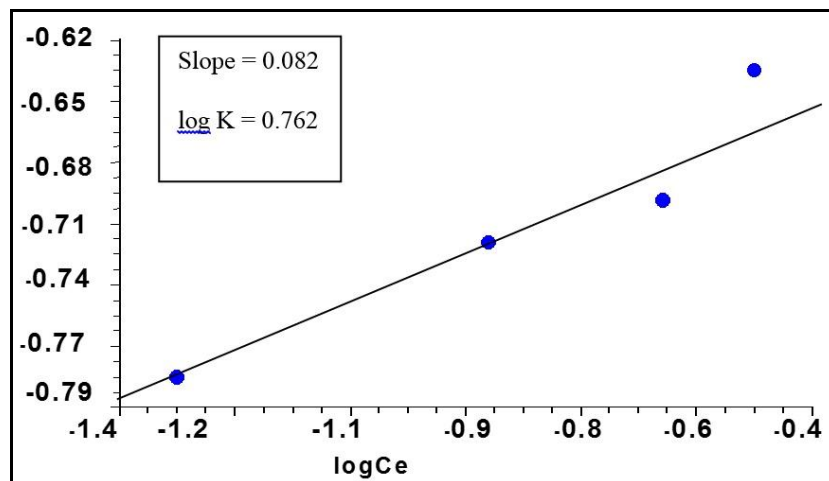


Fig. 6. Freundlich adsorption isotherm.

3.6. Metal-EDTA complex adsorption:

The metals ions Pb(II), Co(II), Cd(II), Zn(II), Cr(III), Ni(II) & Mn(II) were

complexed with EDTA and metal-EDTA complex adsorption studies for each metal were carried out at pH 9.0 so that these investigations would help in removal of complexed metals along with optimum COD removal. **Table 1** shows the adsorption capacity of the resin for various metals. Metals were complexed with calculated amount of EDTA and pH was adjusted to 9.0. Batch extraction process was used and samples were equilibrated for 30mins. The samples were filtered and the filtrate was analyzed for the unadsorbed metal-EDTA complex using Atomic Absorption Spectrophotometer (GBC 932 AA). The adsorbed metal-EDTA complex was then quantified using this data.

Table 1. Adsorption capacity of the resin for various metals.

| Sr. No. | Metal | Cation Exchange Capacity (meq/gm) |
|---------|---------|-----------------------------------|
| 1 | Pb(II) | 0.041 |
| 2 | Co(II) | 0.106 |
| 3 | Cd(II) | 0.071 |
| 4 | Zn(II) | 0.023 |
| 5 | Ni(II) | 0.096 |
| 6 | Mn(II) | 0.151 |
| 7 | Cr(III) | 0.186 |

4. DISCUSSION

The optimum pH for maximum COD reduction (i.e. 86% reduction) was found to be 9.0. The ion exchange capacity depends upon the total number of exchangeable ion active groups per unit weight of the material (Helfferich, 1962). Thus, the high exchange capacity of the natural resin can be attributed to the large number of such active groups as seen from the IR spectra of the column material. The percentage COD reduction increases with the increase in contact time and equilibrium is achieved after 30 minutes. Similarly, the increase in the sorbent dose increases percentage COD reduction. This can be attributed to increase in the surface-active groups of the sorbent and the overall available adsorption surface area with increase in the quantity of sorbent. Adsorption of metal-EDTA complexes on powdered bone is a mere physical adsorption process.

5. CONCLUSIONS

From the above study, it is clear that powdered sepia bone can be successfully used for COD reduction of mixed effluents. Also, metal ions can be removed to a considerable extent when complexed with EDTA at an optimum pH of 9.0. Thus, Sepia bone powder acts as a cheap, natural and ecofriendly material for treating mixed

effluents. The mechanism involved in COD reduction can be attributed to both adsorption as well as ion exchange.

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