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# Electrodialysis with bipolar membrane for regeneration of a spent activated carbon

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abstract

The main purpose of the present work was to develop a treatment method to regenerate granular adsorbent beds saturated with $H_2S$ by utilizing three electrodialysis compartments equipped with a cation or an anion exchange membrane or a bipolar membrane. Three electrodialysis compartments were utilized under various experimental parameters to determine the optimum conditions for the recovery of column particles saturated by $H_2S$. The desulphurization operation is achieved with the extent of extraction close to 90% and an electric current density of about 30%.

Use of the bipolar membrane makes it possible to regenerate the saturated adsorbent granules without adding chemical products. Since the only reagent was electricity, the projected economics are very attractive.



## 1. Introduction

The control of hydrogen sulphide emissions has significantly increased following the increase of environmental concern and stricter regulations. Activated carbon is predominantly an amorphous solid adsorbent most widely used as adsorbents of gases and vapors. This is due to their large specific surface area exceed- ing 1000 $m^3/g$, high pore volume, high density of carbon atoms in graphite-like layers, and surface hydrophobicity, combined with their catalytic influence on numerous chemical reactions and unique surface chemistry [1,2].

Activated carbon adsorbs molecules from both liquid and gaseous phases depending upon the pore size distribution of the adsorbent [3].

One of the environmental applications of activated carbons is the removal of hydrogen sulphide odor from effluent air in wastewater treatment plants [4–7].

Catalytic oxidation of $H_2S$ occurs on the surface of activated carbon, hydrogen sulphide is oxidized either to sulphur or sulphur dioxide which cause a gradual decrease in the capacity leading to exhaustion of the carbon as adsorbents. The spent activated carbon previously used as hydrogen sulphide adsorbent has to be replaced by a fresh or regenerated material. In the last decade, the option for regeneration of activated carbon by using water has appeared [8–11].

The goal of this study was, therefore, to develop a process using a combination of electrodialysis equipped with a bipolar membrane and an adsorption column. Three electrodialysis compartments were utilized under various experimental parameters to determine the optimum conditions of recovery of column particles saturated by $H_2S$.

To determine the performance of the electrodialysis process the extent of extraction and the current efficiency were calculated.

The extent of extraction is expressed by the following ratio:

$$R_{ext} = \left(1 - \frac{n^{t}_{S^{2-}}\,(\text{dilute})}{n^{0}_{S^{2-}}\,(\text{dilute})}\right) \times 100 \quad (1)$$

where $n^{t}_{S^{2-}}$ and $n^{0}_{S^{2-}}$ are the mole numbers of $S^{2-}$ ions in the dilute compartment at times $t$ and 0, respectively.

The current efficiency may be calculated by the equation:

$$R_F = Z_{S^{2-}} \times n^{t}_{S^{2-}} \times \frac{F}{i} \times t \quad (2)$$

where $Z_{S^{2-}}$, $n^{t}_{S^{2-}}$, $F$, and $i$ are, respectively, the electrochemical valence of the sulphur ion, the mole number of the sulphur ion in the dilute compartment at time $t$, the Faraday constant and the current density.

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