

## Decontamination of Chlorobenzene by Electrochemical Method

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### Abstract

A new decontamination system of chlorobenzene was carried out by electrolysis of an *N,N*-dimethylformamide (DMF) solution containing a monochlorobenzene as a substrate and supporting electrolyte in a one-compartment cell fitted with a platinum cathode and a metal anode. In this system, monochlorobenzene was dechlorinated to benzene where the progress of the reaction was analyzed by gas chromatography. Effect of temperature, type of anode material and solvent was investigated and it was also found that the rate and current efficiency for the benzene production were greatly improved when naphthalene was used as a mediator. In the presence of naphthalene, the reduction of chlorobenzene occurs indirectly compared to its direct reduction at the platinum cathode to give complete dechlorination.

**Keywords:** dechlorination, electrolysis, chlorobenzene, naphthalene, green environmental

### Introduction

Chlorinated organic compounds (COC) represent a major environmental problem, which are harmful to both human health and wildlife. Because of these concerns, the development of methods for both the destruction and disposal of COC has been intensely studied. Since 1970s the electrochemical reductive approach has been suggested as a promising method for detoxification of chlorine-containing aromatic hydrocarbons [1]. This method ensured the selective removal of chlorine atoms from various chloroaromatics under mild experimental conditions, quite cheap, technically flexible and really allows COC dechlorination without using the highly reactive reducing agents [2-4]. Connors et al. use a catalytic amount (<5 mol% of the substrate) of 9,10-diphenylanthracene (DPA) as a mediator in tetrabutylammonium iodide/DMF [5]. Furthermore, the authors successfully prepared a highly reactive electrogenerated zinc metal in the presence of naphthalene as a mediator [6], which that such reactive zinc was found to be very reactive towards an oxidative addition to organic bromides. In this paper, we first investigate the electrochemically reduction of monochlorobenzene as a model substrate in the absence and present of naphthalene as a mediator, assuming that if monochlorinated aromatic compounds can be dechlorinated, polychlorinated aromatics will indeed be dechlorinated.

## Result and Discussion

Electrolysis was carried out in a DMF solution containing a monochlorobenzene as a substrate and  $\text{Et}_4\text{NClO}_4$  as supporting electrolyte in a one-compartment cell fitted with a platinum cathode and a metal anode. In this system, monochlorobenzene was dechlorinated to benzene where the progress of the reaction was analyzed by gas chromatography. It was found that electrolysis at  $0^\circ\text{C}$  at a constant current of  $60\text{ mA/cm}^2$  under nitrogen atmosphere with a zinc anode only gave 77% conversion of monochlorobenzene even after 10 F/mol current was passed. While by adding naphthalene as a mediator, complete dechlorination was obtained when the electrolysis was carried out under the same conditions to give 100% conversion of chlorobenzene after 6 F/mol of current was passed. As a conclusion, in the presence of mediator, the reduction of chlorobenzene occurs indirectly compared to its direct reduction at the platinum cathode to give complete dechlorination.

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