Cathodic Dechlorination of Trichloroethylene

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Introduction

Trichloroethylene (TCE) is generally used as organic solvent in the industry, such as electroplating procedure, semiconductor manufacturing, dyestuff purgation and organic synthesis.

In the past, for detecting TCE concentration by electrochemical method that mercury was used as cathode of the reduction reaction of TCE [1-3]. However, mercury is a toxic and liquid material that can make pollution to the environment and difficult operation of the electrolysis.

In this article, the electrochemical dechlorination of TCE by using a Pb foil electrode as cathode in organic solution was explored.

Experimental

The cathode, Al_2O_3 plate (70mm*15mm*3mm, K4 model) purchased from Lei Ke company, Taiwan, ROC, as support substrate of the working electrode and Pb foil with 99.9 % purity (10mm*70mm*0.1mm, 42708 model) purchased from Alfa Aesar, was cut into an area of 1 cm^2 which was used as the working electrode.

The electrolysis system assembly was a reactor type cell with Pb foil supported by Al_2O_3 plate as cathode, platinum plate as counter electrode and Ag/Ag^+ (with 0.01M TBAP in CH_3CN solution) as reference electrode. After the electrolysis system was assembled, potential was set in the limiting current region. Hence, the electrochemical properties measured of the cathode was recorded by 273A electrochemical analysis system of EG & G instruments company (USA). The compositions of the electrolysis were sampled periodically and analyzed by GC-MS (Model, VG 70-250S).

Results and discussion

The voltammograms of Pb foil electrode with and without TCE in the 0.01 M TBAT (Bu_4NBF_4) in CH_3CN solution were shown in Figure 1. The results show that the main reduction peaks appear both at -2.00 V and -2.10 V (versus Ag/Ag^+). However, the -2.10 V (versus Ag/Ag^+) reduction peak was more apparent than another. Hence, the reduction reaction occurs on the cathode at -2.10 V (versus Ag/Ag^+).

The I-E curve of Pb foil electrode for reduction of 200 ppm TCE with 0.01 M TBAT in CH_3CN solution was shown in Figure 2. The result shows that the main limiting current range was from -2.05 to -2.15 V (versus Ag/Ag^+). Since -2.10 V (versus Ag/Ag^+) is within this potential region and its dechlorination reaction is diffusion control. Therefore, the -2.10 V (versus Ag/Ag^+) is chosen as the electrolysis potential in this system. The results of the affecting factors on the electrolysis will be obtained.

References

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[2] L. L. Miller, E. Riekena, J. Org. Chem., 34 (1969) 3359.
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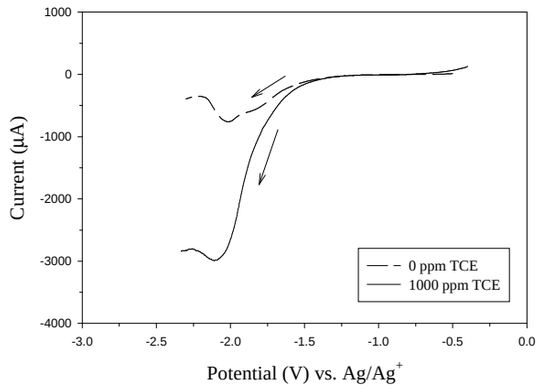

Fig. 1: Voltammetry of Pb foil electrode in organic solution with and without TCE.
Scanning Condition: 20 mV/s (vs. Ag/Ag^+), 0.01 M TBAT in CH_3CN solution, at 25℃ and 1 cm^2 working electrode surface area.

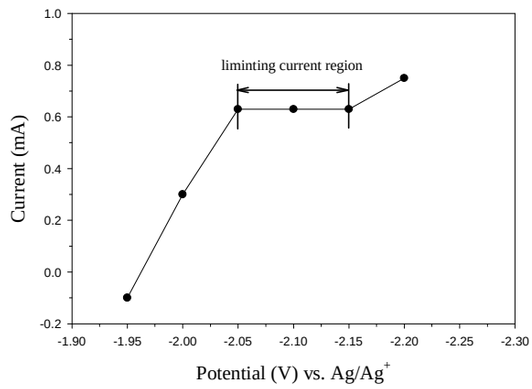

Fig. 2: The I-E curve of Pb foil electrode for reduction of 200 ppm TCE solution.
conditions: 0.01 M TBAT in CH_3CN solution, Ag/Ag^+ as reference electrode, 100 rpm agitation rate, at 25℃ and 1 cm^2 working electrode surface area.