ECWS-9 2025 Conference

The 9th International Electronic Conference on Water Sciences

11–14 November 2025 | Online

MDPI

A Socio-Ecological Approach to Wastewater Treatment: Electrochemical Remediation of Cresol

Zoubida TALEB [1], Emilia Morallon [2], Raul Berenguer [2]

1 Department of Chemistry, Faculty of Exact Sciences, Djillali Liabes University, BP89, Sidi Bel Abbes 22000, Algeria

2 Instituto Universitario de Materiales, Departamento de Quımica Fısica, Universidad de Alicante, Apartado 99, 03080 Alicante, Spain

INTRODUCTION & AIM

RuO_2 electrodes consist of a ruthenium substrate covered with an oxide coating and are applied as dimensionally stable anodes in several important electrolytic processes, such as oxygen and chlorine evolution or the electrochemical oxidation of organic pollutants in wastewaters [1-2]. As a result, RuO_2 electrodes have been widely used due to their good catalytic activity, even for the oxygen evolution reaction (OER). However, for applications such as electrochemical oxidation of organic compounds, the electrode material requires minimal catalytic activity toward the OER.

Water resources are increasingly under threat due to human industrial activities. This has become a major issue, which countries at all stages of development are now treating with great importance. However, many organic contaminants which are not biodegradable are found at low concentrations in rivers and even groundwater. They have become a focus of concern among the public and leaders, as any long-term pollutant discharge into water is an environmental threat to the use of this water in, for example, agriculture. It is therefore necessary to minimize emissions of pollutants in effluents and to address the treatment of these pollutants.

In this work, we are interested in O-cresol, used in the textile industry and as an intermediate of several products: deodorants, pharmaceuticals, perfumes, antioxidants, dyes, pesticides and resins, as well as additives in phenolic resins.

METHOD

The main disadvantage of the use of voltammetry for the determination of the phenolic compounds is the fouling of the electrode by the dimeric or polymeric oxidation products. Thus the voltammetric response for the detection of the phenolic compounds decreases on the second and subsequent scans, making the use of electrochemical methods for accurate determination of these species problematic.

All electrochemical measurements were carried out in a conventional three-electrode cell. The counter electrode was a spiral of platinum wire and all potentials are referred to the reversible hydrogen electrode (RHE) immersed in the same test solution.

The RuO_2 electrode is used as a working electrode by electro-deposition followed by thermal oxidation and are supported onto Ti substrate. This electrode has high stability at high potentials in aqueous electrolytes.

Cyclic voltammograms were recorded at a sweep rate of 50 $mV.s^{-1}$ at room temperature with a standard setup. The current densities have been calculated using the apparent geometric area of the electrode.

The same working electrodes used in CV are used, the counter-electrode was a platinum foil and the reference electrode was a RHE immersed in a lugging containing 0.5M H_2SO_4 solution.

The working electrodes were immersed in the cuvette at controlled potential fixed at 1.4 V and at 1.8 V and spectra were acquired between 200-400 nm every 2 minutes to identify the products of the degradation of o-cresol to methylbenzoquinone (MBQ) and methylhydroquinone (MHQ) and then carboxylic acids (Diagram 1).

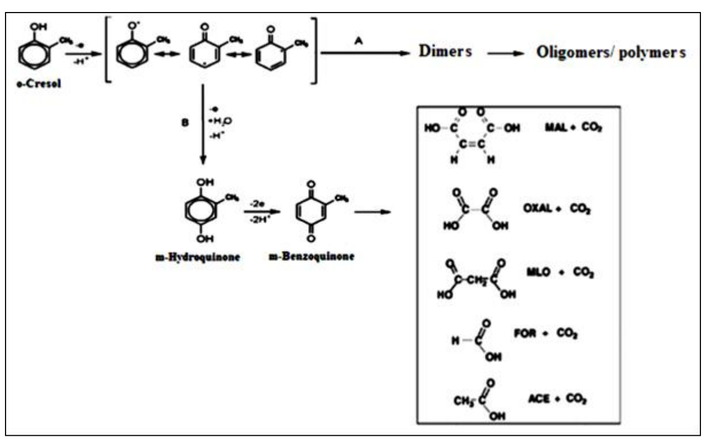


Diagram 1: Reaction pathway for the electrochemical degradation of o-cresol in acid medium

RESULTS & DISCUSSION

The voltammetric response obtained during the oxidation of 10−3 M o-cresol on Ti/RuO_2 electrode cycled between 0.5V and 1.46V in acid medium shows in fig.1. The oxidation of o-cresol gives a sharp and irreversible peak at the current density of which decreases drastically in the second cycle. During the subsequent cycles, the oxidation of o-cresol is practically inhibited reaching a steady voltammogram. The oxidation peak is situated at 1.22V. The current density of this oxidation process decreases during the subsequent cycles.

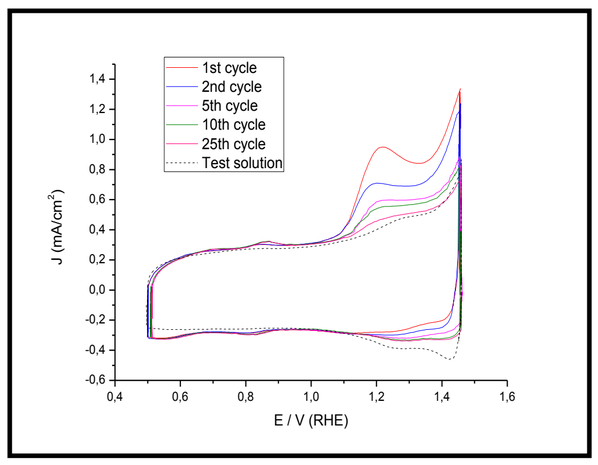


Figure 1: *Cyclic voltammograms of Ti/RuO_2 electrode.*

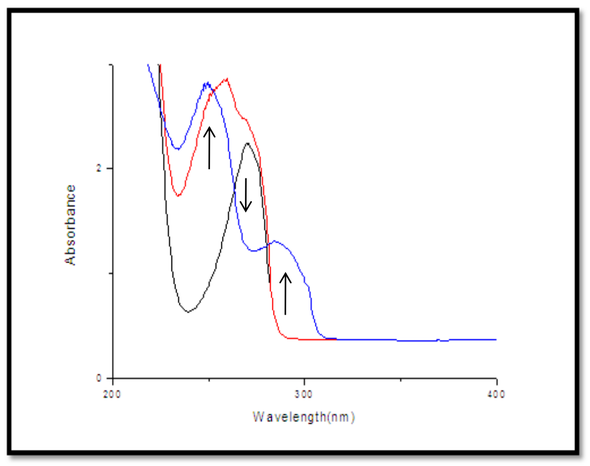
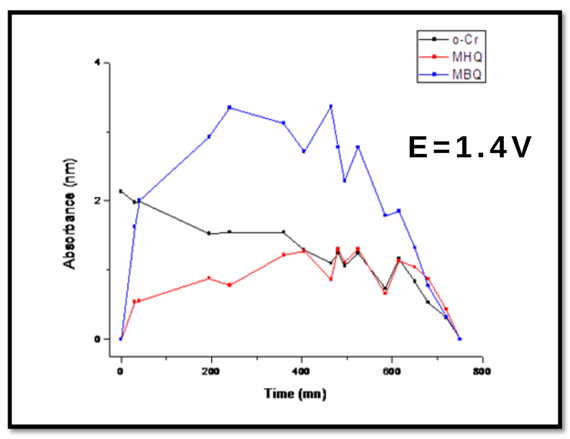


Figure 2: UV-absorbance spectra of o-cresol at three different time

The oxidation products obtained during oxidation of o-Cr at different constant potential on Ti/RuO_2 electrode has been followed by in situ UV-Vis spectroscopy. Three bands corresponding to o-Cresol (o-Cr), methyl-hydroquinone (mHQ) and methyl-benzoquinone (mBQ) have been followed with electrolysis time.

The peak at 270 nm indicates the presence of the aromatic ring of o-cresol decrease with electrolysis time, so the loss in peak height indicates a loss of o-cresol by electrochemical reaction.

This decrease in the 270 nm peak was accompanied by an increase in peak height at 286nm and 250nm, suggesting the formation of methyl-hydroquinone and methyl-benzoquinone, respectively. The peaks grow in the initial period, and then come down. That these intermediary products are transformed too, by electrochemical reaction.



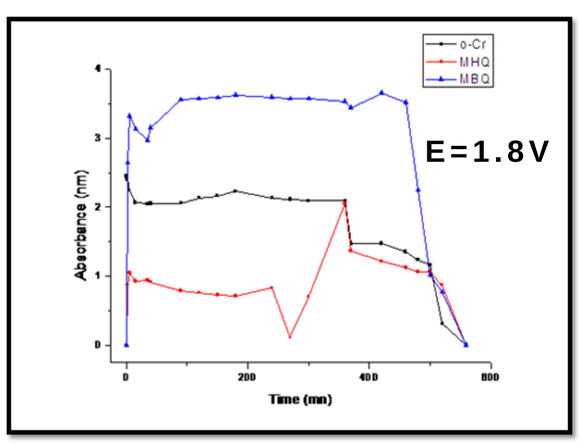


Figure3: Degradation of different bands of o-Cr. E=1.4 and 1.8 V

CONCLUSION

The results suggest that, the pollutant is transformed by electrochemical reaction: In fact, a detailed analysis of UV–Vis spectra of the electrolyte sampled at selected electrolysis times during the best oxidations conditions.

Finally we can conclude that on electrode of metal oxide, o-cresol were adsorbed on the surface or oxidized. This oxidation produces intermediate compounds. The degradation of o-cresol follows the sequences below: (1) oxidation of o-cresol to cyclic intermediates (MHQ and MBQ), (2) the ring opening reaction to organic acids, and (3) mineralization of the organic acids to carbon dioxide.

FUTURE WORK / REFERENCES

1- Taleb, Z., Montilla, F., Quijada, C., Morallón, E., Taleb, S., 2014. Electrochemical and In Situ FTIR Study of o-Cresol on Platinum Electrode in Acid Medium. Electrocatalysis 5, 186–192.

2- Montilla, F., Morallón, E., Vázquez, J.L., 2005. Evaluation of the Electrocatalytic Activity of Antimony-Doped Tin Dioxide Anodes toward the Oxidation of Phenol in Aqueous Solutions. J. Electrochem. Soc. 152: B421.