UDK 541.135

I. Moroz, V. Guliaeva, Y. Prokhorov, A. Kislyi, A. Klevtsova, S. Mareev
Kuban State University (Krasnodar, Russia)

ANODIC OXIDATION OF ORGANIC COMPOUNDS USING A Ti_4O_7 GRANULATED ELECTRODE

1. Introduction

Electrochemical advanced oxidation processes (EAOPs) are considered as promising water treatment technologies. EAOPs are attractive due to their high efficiency, simple design and high degree of mineralization. Anodic oxidation (AO) is one of the directions of EAOPs and it is well-known method in which organic compounds are oxidized into mineral compounds in aqueous solutions. The main oxidizing agents in AO are electrochemically formed radicals with high reactivity [1, 2].

The efficiency of the process is affected by the operating conditions and, above all, by the nature of the electrode material. Generally, electrodes for AO are divided into "active" and "non-active" anodes. Anodes with a low oxygen evolution potential (OEP), such as IrO_2, RuO_2 or Pt, are referred to as "active" electrodes. “Non-active” anodes promote partial and selective oxidation of pollutants (i.e electrochemical conversion). Whereas, anodes with high OEP such as SnO_2, PbO_2 or boron doped diamond (BDD) exhibit "non-active" properties. Therefore, “non active” anodes are ideal for AO (i.e. the complete oxidation of organics to mineral compounds during wastewater treatment) [3]. Substoichiometric titanium oxide Ti_4O_7 has emerged as a promising electrode material due to its high electric conductivity, chemical stability, high OEP and relatively low manufacturing cost [4, 5].

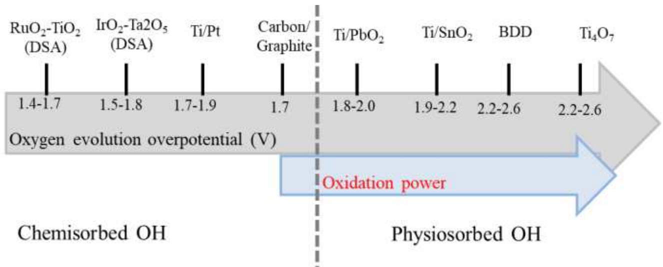

Figure 1 – Classification of the electrode materials used in AO. Redrawn from [3]

In AO, plate electrodes are predominantly used. However, electrodes based on porous materials are more efficient. An increase in the efficiency of the process is achieved by increasing their surface area and increasing the mass transfer of organic compounds to the anode surface. Granulated electrodes made of porous material can be an alternative to solid porous electrodes.

2. Materials and methods

In this study, we used a granulated anode made of substoichiometric titanium oxide Ti_4O_7 for the oxidation of model aqueous solutions of benzoic and maleic acids (COD 600 mg/l). 0.1 M Na_2SO_4 was used as a supporting electrolyte. The solution was pumped through a specially designed electrochemical cell with a Ti4O7 granulated anode and a grid platinized titanium cathode, in batch mode, with a constant electric current. During the experiment, samples of solutions were taken and their chemical oxygen demand (COD) values were determined by the dichromate COD test.

3. Results

The COD values of solutions of benzoic and maleic acids reached 57±6 and 80±28 mg/l respectively (Figure 2) after 6 hours of the experiment. After 4 hours of the experiment, the COD values reach a plateau and further changes are insignificant. In the initial period of time, the current efficiency for both substances was 15%. The current efficiency for the entire time of the experiment was 9% and 8% for benzoic and maleic acids solutions, respectively.

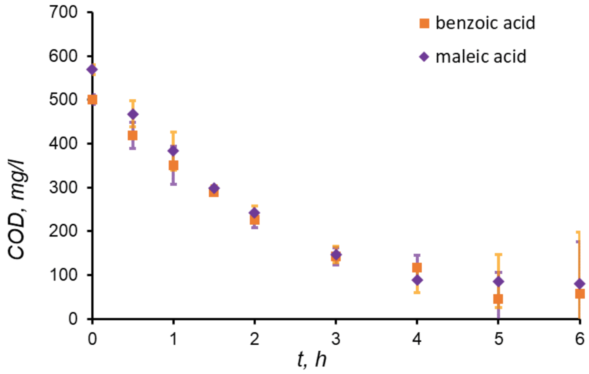

Figure 2 – Dependence of the COD of organic compounds (indicated in the graph) on the experiment time at current density of 38 mA/cm^2

Acknowledgements:

We are grateful to the Russian Science Foundation (grant No. 22-79-10177), for the financial support.

REFERENCES

1. *Panizza M., Cerisola G.* // Chem. Rev. 2009. V. 109. No. 12. P. 6541.
2. *Garcia-Segura S., Ocon J.D., Chong M.N.* // Process Saf. Environ. Prot. 2018. V. 113. P. 48.
3. *Garcia-Rodriguez O., Mousset E., Olvera-Vargas H., Lefebvre O.* // Crit. Rev. Environ. Sci. Technol. 2022. V. 52. No. 2. P. 240.
4. *Meng C., Zhuo Q., Wang A., Liu J., Yang Z., Niu J.* // Electrochim. Acta. 2022. V. 430. P. 141055.
5. *Ma J., Trellu C., Oturan N., Raffy S., Oturan M.A.* // Chem. Eng. J. 2023. V. 456. P. 141047.