ELECTROCOAGULATION REMOVAL OF HEAVY METALS FROM WASTEWATER GENERATED BY WASHING A SCREEN PRINTING PLATE

Savka Adamović, Vladimir Rajs, Dragan Adamović, Aleksandra Mihailović, Ivan Pinćjer, Ivana Tomić, Miroslav Dramićanin

[1]Faculty of Technical Sciences, University of Novi Sad, 21000 Novi Sad, Trg Dositeja Obradovića 6, Serbia
e-mail: adamovicsavka@uns.ac.rs

Abstract
The possibility of applying electrocoagulation treatment to remove heavy metals (zinc, copper, and chromium) from wastewater generated during the washing process of the screen printing plate was carried out. The electrocoagulation efficiency is estimated based on reducing the concentrations of detected heavy metals in the screen wastewater at defined process parameters such as electrode material, current density, interelectrode distance, and operating times.

Introduction
After the screen printing process is completed, it is necessary to wash the screen plate to remove the leftovers of the used printing inks. For that purpose, special chemicals are used as a combination of different solvents, thinners, and alkaline detergents. Special chemicals are applied to the plate with a sponge or brush, and after a certain period, they are rinsed with water [1]. In this way, a screen effluent is generated.

Experimental
The electrocoagulation cell is made of borosilicate glass with a volume of 250 mL. Two plate iron and two plate aluminum electrodes with the exact dimensions of 10 cm x 5 cm x 0.1 cm and a total area of 100 cm^2 were used. In Fe(-)/Al/Fe/Al(+) electrode combination, only the outer electrodes were connected in a bipolar mode to a digital DC power supply (DF 1730LCD) equipped with potentiostatic or galvanostatic operational options. 220 mL of the screen wastewater were mixed with the appropriate amount of sodium chloride (0.50 g), at 450 rpm by a magnetic stirrer (IKA color squid, Germany). The current density of 8 mA cm^{-2} and the interelectrode distance of 1.0 cm were applied. Electrolyte samples (15 mL) were taken at certain treatment times (1, 5, 10, 20, 40, and 60 min). All collected samples were centrifuged for 10 min at 2000 rpm (Centrifuge Tehtnica Železniki, Slovenia). The Atomic Absorption Spectroscopy (PerkinElmer Analyst 700, USA), according to the standard EPA 7000B method, was carried out for heavy metal analyses [2,3].
The efficiency of electrocoagulation removal of heavy metals (zinc, copper, and chromium) from the screen wastewater was determined by using the equation [2]:

$$E_M = \frac{C_o - C_t}{C_o} \cdot 100 \quad (\%)$$

Where:

E_M (%) – the electrocoagulation removal efficiency of a suitable heavy metal,

C_o (mg L^{-1}) and C_t (mg L^{-1}) – concentrations of analyzed heavy metal in the screen wastewater before electrocoagulation and at a particular operation time (t), respectively.

Results and discussion

Efficiencies of electrocoagulation treatment removal of analyzed heavy metals from screen wastewater at precisely defined operating parameters (system with Fe and Al electrodes, current density of 8 mA cm^{-2}, interelectrode distance of 1 cm, and process times of 1, 5, 10, 20, 40, and 60 minutes) are shown in Figure 1.

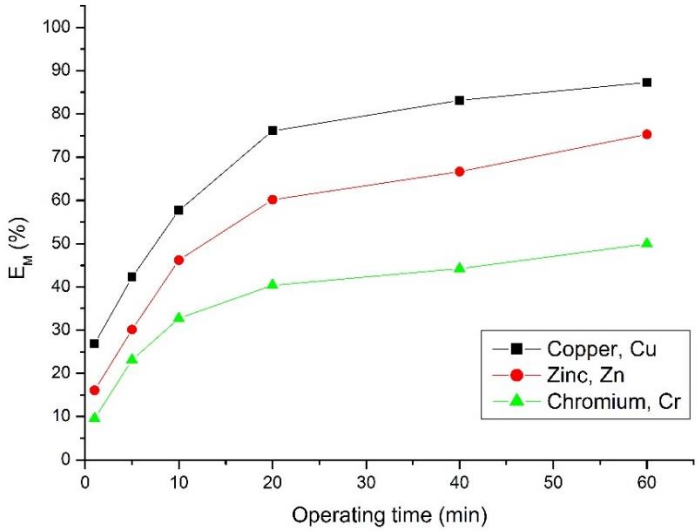

Figure 1. Efficiencies of electrocoagulation removal of zinc, copper, and chromium from screen wastewater

The obtained results of electrocoagulation treatment show that:

- The efficiencies of heavy metals removal decrease in order: copper > zinc > chromium. Thus, the nature of the metal affects the order of removal.
- The efficiency of all heavy metals not linear increases with increasing operating time.
- The operating process times of all three heavy metals are 60 minutes.

Conclusion

It is possible to remove heavy metals (zinc, copper, and chromium) from the wastewater generated while washing the screen printing plate by applying electrocoagulation treatment. Maximum efficiencies of electrocoagulation treatment with defined operating parameters for copper, zinc, and chromium were 87.3, 75.3, and 50.0%, respectively.

Acknowledgements

The authors acknowledge the financial support of the Ministry of Education, Science and Technological Development, Republic of Serbia through the project no. 451-03-68/2020-14/200156: "Innovative scientific and artistic research from the FTS (activity) domain".

References

[1] Ž.S. Janković, Mala škola sito štampe, Učenička zadruga „Buda Davidović", Obrenovac, 1996, pp. 76 (In Serbian).
[2] S. Adamović, M. Prica, B. Dalmacija, M. Kragulj Isakovski, Đ. Kerkez, S. Rapajić, D. Adamovic, Measurement 131 (2019) 288.
[3] S. Adamović, M. Prica, B. Dalmacija, S. Rapajic, D. Novakovic, Z. Pavlovic, S. Maletic, Arab. J. Chem. 9 (2016) 152.