Heavy metals removal by ion-exchange resin: experimentation and optimization by custom designs

S. Benalla[a], F.Z. Addar[a], M. Tahaikt[a], A. Elmidaoui[a], M. Taky[a,b,]*

[a]Laboratory of Advanced Materials and Process Engineering, Faculty of Sciences, Ibn Tofail University, P.O. Box: 1246, Kenitra – Morocco, emails: mohamed.taky@uit.ac.ma/takymogamed@gmail.com (M. Taky), Soukayna.benalla@uit.ac.ma (S. Benalla), Fatima.zahra@uit.ac.ma (F.Z. Addar), mustapha.tahaikt@uit.ac.ma (M. Tahaikt), elmidaoui@uit.ac.ma (A. Elmidaoui)
[b]International Water Research Institute, Mohammed VI Polytechnic University, Lot 660, Hay Moulay Rachid, Ben Guerir, 43150 – Morocco

ABSTRACT

The brassware workshops are part of the craft specialities of Fez (Morocco) city of, which generate toxic and harmful effluents. Indeed, the large quantity of effluents produced is rich in heavy metals. It is therefore necessary to treat them before returning them to the natural environment in order to respect the Moroccan discharge limits. In the brassware workshops, the manufacture of handcrafted parts goes through a chain of deposit and rinsing baths. These rinsing baths are loaded with heavy metals (copper, silver and nickel). The objective of this study is to study and evaluate the effectiveness of the cation resin Lewatit S 1568 in eliminating heavy metals (Cu(II), Ag(I) and Ni(II)). The influence of different parameters such as contact time, resin mass and stirring speed on the % removal of these metals is investigated. A custom design based on response surface methodology is used in this study to build predictive models and to optimize the reduction of heavy metals from brassware effluents by ion-exchange resin. Therefore, 21 sets of experiments are used. This method is developed to evaluate the effects of the process variables of removing the concentrations of the three heavy metals by cation resin exchange. The independent variables used in this process are (time (X_1), mass of resin (X_2) and stirring speed (X_3)) and their interaction in order to achieve optimal conditions are investigated. From the statistical analysis, the three models of heavy metals are found to be highly significant with very low probability values ($p < 0.0001$). The optimal conditions obtained are ($X_1 = 35.11$ min, $X_2 = 2.63$ g and $X_3 = 98.6$ rpm) with a total elimination of Cu(II) and Ni(II), while for silver ion Ag(I) the elimination achieved does not meet the standards. On the other hand, the results of the study are analysed analytically and graphically.

Keywords: Ion-exchange resin; Brassware wastewater; Heavy metals removal; Response surface methodology (RSM); Custom design (CD)

* Corresponding author.