NICKEL REMOVAL FROM EXHAUSTED ELECTROPLATTING BATHS BY USING VEGETABLE WASTES

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During the last years our research group has been studying the use of industrial vegetable wastes as grape stalks and exhausted coffee to remove metals ions such as Ni(II), Cu(II), Pb(II), Zn(II), Cd(II) or Cr(VI) and Cr(III) in aqueous solution from the point of view to use these wastes as biosorbents in a low cost alternative to activated carbon for wastewater treatment. The optimal experimental conditions for the removal of each of these metal ions in synthetic solutions by using both biosorbents were determined in previous studies [Villaescusa et al. 2004; Martínez et al. 2006; Valderrama et al. 2010.]. In this work, the performance of grape stalks and exhausted coffee for the removal of nickel ions from an exhausted electroplating bath of a metal finishing industry from Barcelona (Spain) has been investigated.

Batch and column experiments were carried out at room temperature by using grape stalk wastes (particle size 0.8-1.0 mm), meanwhile in the case of exhausted coffee, two different particle size ranges were used, 0.25-0.50 mm and 0.50-1.00 mm for batch and column experiments, respectively.

Kinetics and equilibrium studies were carried out in batch mode to determine the equilibrium contact time and to obtain the sorption capacity of sorbents. The data in both studies have been treated by using different models. Column experiments were designed to establish the optimal condition for the treatment of the industrial wastewater. The experiments were performed in packed bed up flow columns of different internal diameter and bed depth in order to predict the transport and sorption parameters. In all column experiments the flow rate was around 11 mL h^{-1}. From perspective of process modelling, the dynamic behavior was described in terms of breakthrough curves. The bed depth service time (BDST), Thomas and Yoon Nelson models [Zhe et al. 2013] were used to analyze the experimental data and to determine model parameters.

Batch results show that about 1hour was the time needed to reach equilibrium when using grape stalks and around 15 h when using exhausted coffee. In the case of exhausted coffee, the pH solution decreased during the sorption process from initial pH 5,5 to lower pH than the corresponding pH_{pzc} (point zero charge). To avoid this, pH solution was controlled to a constant pH 5,5 and the equilibrium were achieved in 1h.

Kinetic data of both sorption processes fit pseudo-second order model, indicating that chemisorption could be rate limiting in the sorption step. Experimental data of nickel sorption kinetic by using exhausted coffee and the model curve calculated from the pseudo-second order model are presented in Figure 1.

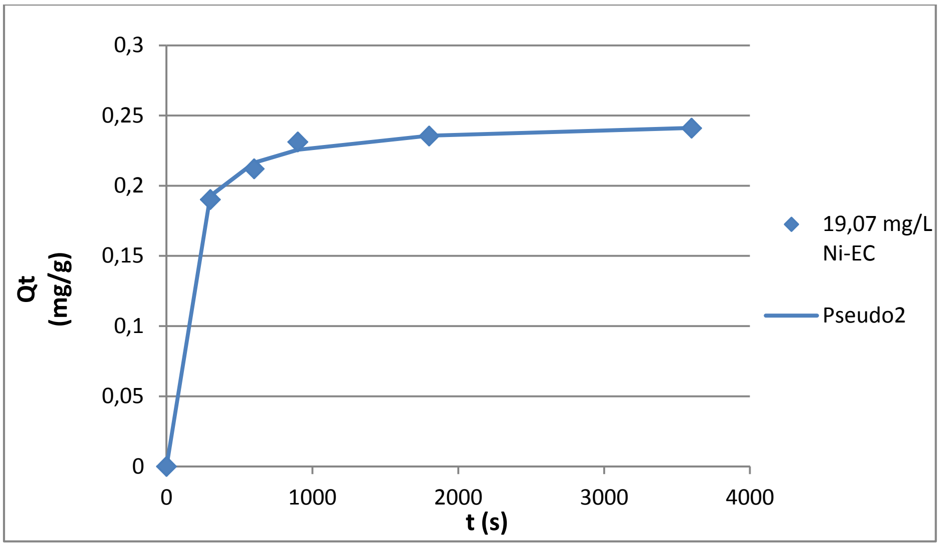

Figure 1. Sorption kinetic of Ni(II) onto exhausted coffee (EC). Initial niquel concentration 19,07 mg/L, Solid/liquid ratio (g/mL) 1:15; controlled pH= 5,5.

Equilibrium data of nickel sorption onto grape stalks and exhausted coffee fit adequately Langmuir model, indicating monolayer coverage. Results showed that maximum sorption capacity of grape stalks (4,8 10^{-2} mmol/g; 2,84 mg/g) is slightly higher than exhausted coffee (2,9 10^{-2} mmol/g; 1,70 mg/g). The maximum nickel sorption capacity of both sorbents was reduced to 50% compared to maximum sorption capacity determined using synthetic Ni(II) solutions. Thus, grape stalks and exhausted coffee performance for the removal of Ni(II) from the studied industrial wastewater are negatively affected by the presence of other compounds in the industrial wastewater.

In the Figure 2 it can be seen the experimental data and theoretical model for Ni(II) sorption onto exhausted coffee.

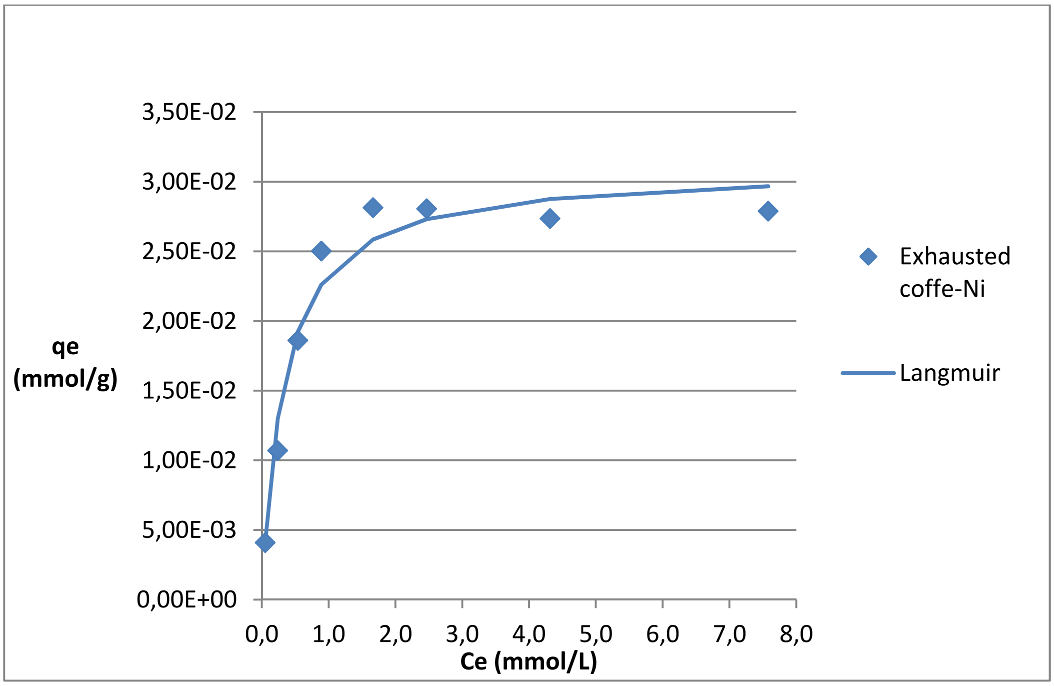

Figure 2. Fitting of Langmuir isotherm equation for Ni(II) sorption to the data gathered from the equilibrium sorption experiments (symbols) onto exhausted coffee . Solid/liquid ratio (g/mL/) 1:15; controlled pH= 5,5

In column experiments, the best results were obtained by using 2.8 cm internal diameter columns and bed depth 6 cm and 8 cm for grape stalks and exhausted coffee, respectively. Breakthrough curves were successfully modelled by the proposed columns models. The results obtained demonstrated that grape stalks sorption capacity was higher than exhausted coffee but this one presented a higher sorption rate.

In Figure 3, experimental breakthrough curves and modelled data by using the Thomas model for the Ni(II) sorption onto grape stalks at different initial Ni(II) concentrations are presented.

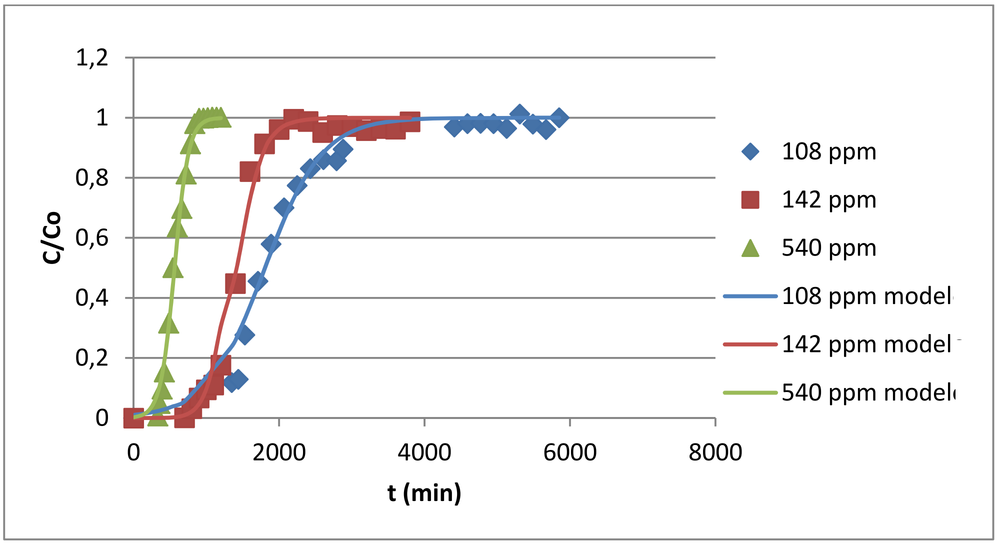

Figure 3.Breakthrough curves for nickel sorption onto grape stalks at different initial concentrations. Flow rate=11 ml/h, 5 g of grape stalks, column: 2,6 cm internal diameter and 4,5 cm bed depth.

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