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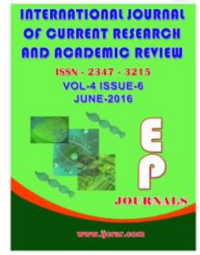

Investigation of Simultaneous Biosorption of Zinc(II) and Nickel(II) Ions on Flyash from Binary Metal Mixtures

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A B S T R A C T

Removal of noxious materials such as heavy metal from wastewater is one of the biggest environmental challenges that suffer the economy nowadays. On the basis of their versatility, environmental friendliness, biosorption is proved to be a most economical and efficient technology, which is used extensively for their removal from the aqueous media. Among the various developed biosorption used so far, flyash shows a unique impact on the fast sorption and rapid removal of toxic impurities from the aqueous medium. Batch sorption experiments were carried out to study the process and several parameters such as Initial pH of sorbent, effect of contact time, effect of sorbent dosage and effect of metal concentration were analysed in these experiments. The effects of any one of those previously mentioned parameters on the biosorption capacity were studied, while the other parameters were kept constant. It was found that the obtained maximum sorption capacities of flyash for the removal of Zn(II) and Ni(II) were quite high. This provide us to use flyash as a low cost biosorbent material to clean up the water in the environment from toxic heavy metals studies.

Introduction

Increasing presence of heavy metals in waste stream and ground water has become one of the most serious environmental pollution problems due to their acute toxicity and non-biodegradable nature. These metals have cumulative effects and tend to accumulate in the living organisms causing various diseases and disorders. They are non-essential and non-biodegradable, and slowly accumulate in the body, usually from foods (Srivastava *et al.*, 2006).

Various researches have been conducted for the removal of heavy metal ions before discharged to receiving sink. The treatment of this type of wastewater involves various techniques such as filtration, solvent extraction, adsorption, precipitation, ion exchange, biological treatment and destructive techniques such as ozonation and oxidation (Sekhar *et al.*, 1998; Kim *et al.*, 2006; Mavrov *et al.*, 2006; Murathan *et al.*, 2006; Covaco *et al.,* 2007). Adsorption technology using activated carbon is currently being used extensively for the removal of hazardous pollutants from gaseous and liquid phases. The main disadvantages associated with this adsorbent are the high regeneration cost, intraparticle resistance in adsorption process and poor mechanical strength (Aravindhan *et al.,* 2006). Recently, adsorption has attracted considerable interest especially from low-cost materials. Coal fly ash, is obtained from the combustion of powdered coal as waste product and is a very attractive alternative because it is cheap, widely available and has been reported to have good mechanical stability (Potgiester *et al.,* 2009) and requires little processing to increase its sorption capacity. The effects of any one of those previously mentioned parameters on the biosorption capacity were studied, while the other parameters were kept constant. It was found that the obtained maximum sorption capacities of flyash for the removal of Zn(II) and Ni(II) were quite high.

Materials and Methods

Preparation of Binary Metal Mixtures

The applicability of the empirical Freundlich model to the biosorption of Zn(II) and Ni(II) ions from the binary metal mixtures by flyash was checked for different sets of data. The initial concentrations of Zn(II) ions were varied between 25 and 100 mg L^{-1}, whereas the Ni(II) ion concentration in each metal mixture was held constant at 10, 20, 50, or 80 mg L^{-1}. The pH of ternary metal mixtures was adjusted to pH 5.0 with 1 mol L^{-1} HNO_3.

Biosorption Studies

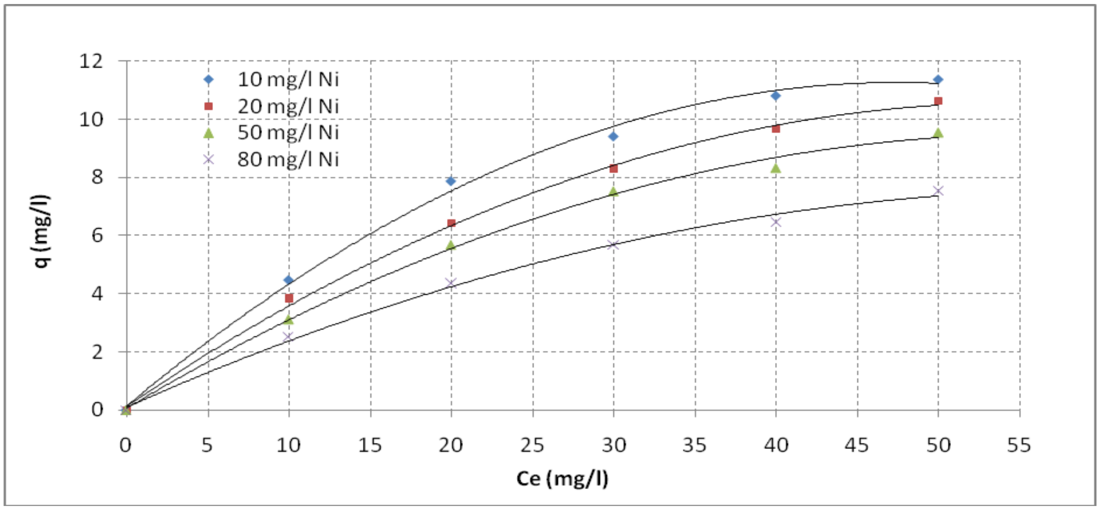
Batch equilibrium sorption experiments were carried out using standard batch methodology. The flyash was mixed with 100 mL of the desired metal solution in an Erlenmeyer flask. The flasks were agitated on a shaker at 22°C for 2.5 h, which is sufficiently long for sorption equilibrium. Agitation rate was 150 rpm. Subsequently, samples were taken at 15 min intervals at the beginning of biosorption and at 30 min intervals after samples reached equilibrium. The samples were filtered was used for metal analysis.

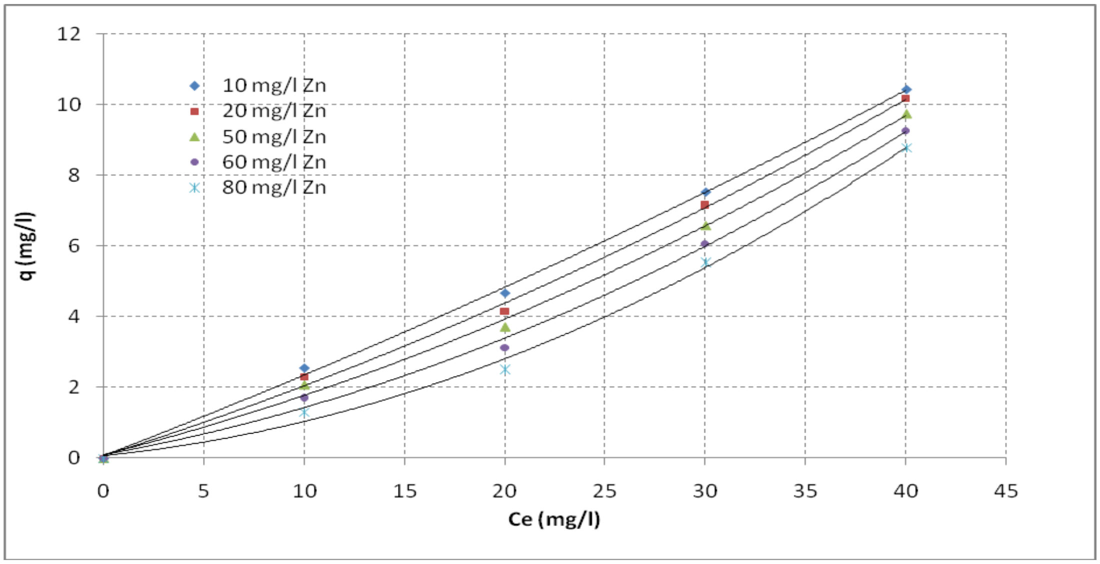
Results and Discussion

Biosorption potential of binary mixtures containing Ni(II) and Zn(II)

The effects of the presence of Zn(II) ions on the biosorption of Ni(II) ions was investigated in terms of equilibrium isotherm and biosorption yield. A comparison of the biosorbed quantity of Ni(II) ions per unit weight of flyash at equilibrium between the solutions with Zn(II) ions present as the single metal and with the presence of increasing concentration of Ni(II) ions is presented in Fig1, in which the results indicated that the equilibrium uptake of Zn(II) ions decrease (2.62-1.48 mg/g) with increasing concentration of Ni(II) ions (10-50 mgl^{-1}). In the single metal-ion situation, the maximum uptake of Ni(II) obtained at initial concentration is 50mg/L, pH 5.9 was found to be 12.92 mg/g, while the uptake obtained in the binary metal solutions at the same initial concentration and biosorption conditions, were found to 1.36 to 8.22 mg/g when concentration of Zn(II) ions varied from 10-50 mgl^{-1}, respectively. In addition, the biosorption yield decreased from 21.18 to 13.31%, at the same operating conditions. As shown Fig 13, maximum uptake of Zn(II) ions in the single-ion system was 46.58 mg/g at initial concentration of 100 mg/L. At the same time, maximum uptake of Zn(II) in the Ni(II)–Zn(II) binary system varied from 1.32-7.14 mg/g when Ni(II) ions were 10, 20 30,40 and 50 mg/l, respectively. A fixed quantity of flyash offered a limited number of surface binding sites, some of which were expected to be saturated by the competing metal ions, at high concentration of them. In addition, this phenomenon might not only result from the saturation of the biosorbent but to the ability of metal ions studied to compete for the biosorption sites. In order to assess that whether the metal ion combinations were interacting in an antagonistic synergetic form, the biosorption outputs of single and multi-ion systems were also compared.

Figure.1 The empirical Freundlich biosorption isotherms of Ni(II) [pH: 5.9] in the presence of increasing concentrations of Zn(II).





Result, showed that the effect of the mixture was found to be less than that of each of the individual effects of the toxic metal ion, therefore the interaction between Ni(II) and Zn(II) could be considered to be antagonistic, and explained as being the competition for sorption sites on flyash, at optimum pH. The simultaneous biosorption phenomena were expressed by the competitive Freundlich biosorption model.

This shows that the metals in binary metal solution compete for binding sites that are not specific and limited to a maximum binding capacity.

Conclusion

The present study proves the capability and effectiveness of flyash as a biosorbent for heavy metals removal. Adsorption behavior of Zn(II) and Ni(II) were affected by experimental parameters such as pH, contact time and initial concentration of ions solution. It was found that sorption isotherms were better described by Freundlich model for both metal ions. The maximum biosorption capacity values of Zn(II) and Ni(II) ions in a mixture of two ion metals with flyash, estimated from model were 11.74 and 10.42 mg. g^{-1} respectively**.**

Acknowledgement

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