



Removal of Ni(II) ions from aqueous solutions using fixed-bed ion exchange column technique

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ARTICLE INFO

Article history:

Received 28 January 2011

Received in revised form 2 May 2011

Accepted 5 June 2011

Available online 22 July 2011

Keywords:

Nickel ion
Ion exchange
Metal removal
Fixed bed
Regeneration
Heavy metals

ABSTRACT

Ion exchange represents an efficient technique for removing of heavy metals from wastewater effluents. Limited number of studies focuses on fixed bed performance for metal removal. In this study, the removal of Ni²⁺ from synthetic wastewater using a strong acidic cation exchange resin in a fixed bed columns was investigated. The experiments were conducted at different pH (3–7) and initial heavy metal concentrations (1.8, 2.8 and 3.8 g Ni/L). Investigation of the regeneration effect on the resin was conducted. The removal efficiency and rate of removal are shown on the breakthrough curves and the kinetic study of the process was determined. The Thomas model was applied to follow the exchange dynamics, the results from experimental work were compared to those using Thomas model, it is shown that the calculated breakthrough curves agreed well with the measured ones. The metal level in the treated wastewater was examined using the atomic absorption spectrophotometer to show that the Ni²⁺ concentration complies with the standard environmental regulations limits.

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1. Introduction

Malaysian environment discharge standards is known as “Malaysia A” and “Malaysia B” are exist based on WHO water standards [1]. Based on the Malaysia Environmental Quality Report 2005, 47.5% of the water pollution source is generated by industrial sector. One of the most water polluting industries in Malaysia is the metal plating industry. The effluents from metal plating industry mainly consist of many heavy metals such as copper, lead, chromium, nickel, iron and zinc [2]. Heavy metals has many disadvantages to both human and environment as it can affects human's health as well as causing environmental pollution, nickel for example can cause cancer and anosmia which is lost of ability to smell [3]. Malaysia government has set in the environmental standard a limit for nickel discharge in the wastewater which is 1 mg/L [1]. Therefore, an effective method is required for a heavy metal removal to comply with the stricter regulation limit. A number of technologies for metal ions removal from aqueous solutions are in use by the industry; this includes coagulation, chemical precipitation, floatation, ion exchange, adsorption and reverse osmosis [4–6]. Ion exchange technology has many advantages as it can treat a large volume of effluent at one time and more efficient in removal of ion from the wastewater [7]. In

this method, ion exchange removes unwanted ions by transferring them to a solid material namely resins. Resins will accept ions from the solutions and giving back an equivalent number of desirable ones. Ion exchange method is widely applied in many industrial sectors, including petroleum and chemical industries, water softening process, and separation and purification in the food industry [8]. This process can remove almost 97% of Ni(II) in the solutions, which is acceptable to the environmental standards and producing pure water that save to be discharged to the drainage [9,10]. Although ion exchange method has been applied in the industry for many years, there are limited studies reported for the removal of nickel ions (Ni²⁺) from industrial wastewater employing ion exchange method [11,12]. Hence, an exploratory research was planned to be conducted to identify and quantify the optimum conditions for nickel ions (Ni²⁺) removal. Some previous studies review for the probable mechanism of the process [13–16]. Therefore, this study aims to identify the optimum operating conditions for nickel ions (Ni²⁺) removal process. For the removal of nickel from wastewater, the parameters are varied according to acquire the effects of pH and the effects of initial concentration of nickel [17–20]. Enhancement of the removal of nickel ions (Ni²⁺) from wastewater by using ion exchange method is one of the objectives of this study. Specifically, this study aims to determine the effect of pollutant's concentration, pH, and resin dosage on the rate of nickel ion removal from the wastewater, to determine the effect of operating parameters on the performance of ion exchange resin, to investigate the effect of regeneration on the exchange capacity of the resin and to determine the kinetics of the process.

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