Biosorption of Nickel (II) from Aqueous Solutions onto Pistachio Hull Waste as a Low-Cost Biosorbent

Majid Zamani Beidokhti [a*], Seyed Taghi (Omid) Naeeni [b], Mohammad Sajjad AbdiGhahroudi [c]

[a] *Faculty of Civil engineering, Noshirvani University of Technology, Babol, Iran.*

[b] *School of Civil engineering, College of Engineering, University of Tehran, Tehran, Iran.*

[c] *University of Duisburg-Essen, Faculty of Chemistry, Instrumental Analytical Chemistry, Essen, Germany.*

Abstract

There are many different industrial wastewater containing heavy metals that contribute to environmental pollution and raw agricultural waste is an effective adsorbent for the removal of heavy metals. The adsorption behavior of pistachio hull powder (PHP) as a low-cost adsorbent, with respect to nickel (II) ions, has been studied in order to consider its application to the purification of metal finishing wastewater. In this work, adsorption of nickel on pistachio hull has been studied by batch techniques. The adsorption depends on the process time, the pH of the solution, initial concentration of metals and the adsorbent concentration in the suspension. The kinetics of adsorption were relatively fast, reaching equilibrium for less than 60 minutes. Kinetic and isotherm modeling studies demonstrated that the experimental data best fit a pseudo-second order and Freundlich model, respectively. The maximum Langmuir adsorption capacity was 14 mg/g. The optimum pH required for maximum adsorption was found to be 4-6. The initial concentration of the adsorbate and the concentration of pistachio hull strongly affect the process. No influence of particle size was evidenced. A degree of adsorption higher than 75% can be achieved for nickel (II) ions.

Keywords: Biosorption; Pistachio Hull; Nickel; Kinetics; Isotherms; Heavy Metals; Low-Cost Biosorbent.

1. Introduction

An increasing worldwide concern for the last few decades has been the water resources pollution due to heavy metal disposal. Heavy metals contamination exists in many industrial wastewater such as metal plating facilities, mining operations, battery manufacturing processes, the production of paints and pigments, and the ceramic and glass industries. This wastewater commonly includes Cd, Pb, Cu, Zn, Ni and Cr [1].

Not only heavy metals cause vast environmental damage, but also human health is likely to be affected as the presence of heavy metals beyond a certain limit brings serious hazards to living organisms [2]. For instance, Cadmium (II), Copper (II) and Nickel (II) ions (in respective order) have been proven to cause kidney damage, liver damage or Wilson disease [3] and dermatitis or chronic asthma [4].

Several techniques including adsorption, chemical and electrochemical precipitation, ion exchange, membrane filtration and electrodialysis are available for the removal of heavy metals from wastewaters [5].