CALCAREOUS CHITIN: A NOVEL LOW-COST SORBENT FOR CADMIUM (II)

M.S. RODRÍGUEZ, M. ZALBA, M.T. GOITÍA, A. PUGLIESE, A. DEBBAUDT, E. AGULLÓ, P.C. SCHULZ and L. ALBERTENGO

Departamento de Química e Instituto de Química del Sur (INQUISUR, CONICET), Universidad Nacional del Sur, Bahía Blanca, Argentina. E-mail: pschulz@criba.edu.ar

***Abstract* — This research deals on a new low-cost porous sorbent named calcareous chitin (CaCh). CaCh is prepared by alkaline treatment of crustacean exoskeleton to produce a porous matrix of chitin and calcium carbonate free of original proteins. SEM-EDX, X-ray, FT-IR were used to characterize the material. CaCh structure is more porous than that of chitin. Adsorption studies demonstrated its capability to remove Cd(II) from waters. The Langmuir equation fitted the adsorption isotherms well. Due to its easy, rapid and low cost preparation and its adsorption characteristics calcareous chitin can be used as low cost sorbent of heavy metals ions like cadmium for wastewater treatment.**

***Keywords*— Calcareous Chitin; Chitin; sorption; cadmium; low-cost sorbent; wastewater remediation.**

I. INTRODUCTION

Heavy metals in water are a major preoccupation because of their toxicity towards aquatic-life, human beings and the environment. Heavy metals, such as Cd^{2+}, Cu^{2+}, Pb^{2+}, Hg^{2+} and Zn^{2+} are toxic to human beings and other living organisms, if their concentration exceeds the tolerance limit. As they do not degrade biologically like organic pollutants, their presence in drinking water or industrial effluents is a public health problem due to their absorption and therefore possible accumulation in organisms. These heavy metals are introduced into natural water resources by wastewater discharged from industries such as smelting, metal plating, Cd–Ni batteries, fertilizers, mining pigments, stabilizers and alloy manufacturing (Rao *et al*., 2010).

Among toxic heavy metals, cadmium is one of the most dangerous for human health, is a non-essential and non-biodegradable metal which slowly accumulates in the human body, the serious incident of itai-itai disease, which was caused by cadmium poisoning owing to mining in Japan, was related to cadmium ions. The harmful effects of Cd(II) ions are renal damage, hypertension, proteinuria, kidney stone formation and testicular atrophy. Cd(II) ions may replace Zn(II) ions in some enzymes thereby affecting the enzyme activity (Inaba *et al*., 2005; Teeyakasem *et al*., 2007). This necessitates the removal of Cd(II) ions from wastewater and water (Kula *et al*., 2008). However, cadmium has also practical applications: e.g., it is highly corrosion resistant and is used as a protective coating for iron, steel, and copper. The industrial uses of cadmium are increasing in plastics, paint pigments, electroplating, batteries, mining, and alloy industries (Al-Asheh and Duvnjak, 1997, Corami *et al*., 2008).

Several physical and chemical processes have been studied and developed over the years to remove the heavy metal pollutants from wastewaters at high concentrations. Some of these processes are adsorption, coagulation, flotation, biosorption, chemical precipitation, reverse osmosis, electrolytic recovery, ion exchange, ultra filtration and electrochemical methods. In this process, adsorption can be seen as an efficient and economic method to remove the heavy metal pollutants at low concentrations (Stafiej and Pyrzynska, 2007).

Adsorbent materials from forestry, fishery and agriculture have attracted much attention to several workers. Some of the reported sorbents include peanut hulls (Brown *et al.*,2000), maize bran (Singh *et al.*, 2006), sawdust (Taty-Costodes *et al*., 2003), sugar beet pulp (Reddad *et al.*, 2002), crab shell (Vijayaraghavan *et al*., 2006), cornstarch (Kweon *et al.,* 2001), exhausted coffee (Orhan and Buyukgungor, 1993), rice husk (Kumar and Bandyopadhyay, 2006), orange waste (Dhakal *et al.* 2005), biological materials including bacteria (Brierley, 1990), fungi (Tsezos and Volesky, 1981), yeast (Volesky *et al.*, 1993), microalgae (Darnall *et al*., 1986) and chitin (Ghimire Darnall *et al*., 2001, Benguella and Benaissa, 2002, Copello *et al*., 2008) just to mention a few in the literature.

Chitin is one of the most abundant organic materials, being only exceeded by cellulose in the amount produced by biosynthesis. It is an important constituent of the exoskeleton in animals, especially in crustacean, mollusks and insects. It is also the principal fibrillar polymer in the cell wall of certain fungi (Eugene and Lee, 2003). The chitin molecule consists of (beta)(1-4)-2-acetamide 2 deoxi-D-glucose units, some of which are deacetylated.

One factor in many of the more traditional applications of chitin is its high chelating capacity. It has been used to remove diverse compounds from waste streams including heavy metals (Muzzarelli, 1973, 1977; Babel and Kurniawan, 2003).

The goal of this paper is to study a new low-cost porous sorbent obtained from crustacean exoskeleton, which is a waste from fishery industry. Preparation, characterization and adsorption studies on its capability in the removal of Cd(II) are reported.