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Removal of Lead and Copper Ions from Polluted Aqueous Solutions using Nano-Sawdust Particles

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Abstract

Heavy metals pollution was considered as one of the most serious environmental problems. The removal of heavy metals ions (Pb2+ and Cu2+) from dilute aqueous solutions was investigated by using biomaterials like nano-sawdust particles as bio-sorbent. The nano-sawdust was prepared and identified by (SEM), (TEM) and (FTIR) spectroscopy. Results of SEM study showed that the surface of sawdust has many pores with nano size in rang of (40-51 nm). The TEM image suggests that the produced material consists of nano particles. The FTIR gave characteristic bands due to presence of OH, NH2 and C=O groups. The batch experiment indicates that the maximum bio-sorption efficiency for Pb2+ was 100% at optimum conditions of, pH 6, contact time 40 min and bio-sorbent dosage 2.0 g. However nano-sawdust gave removal efficiency 98.78% of Cu2+ under optimum conditions of, pH 7, contact time 50 min and bio-sorbent dosage 1.0 g. Kinetic studies indicated that the biosorption of Pb(II) and Cu(II) ions onto nono-sawdust was pseudo-second order.

Many serious environmental problems were arised from the presence of heavy metals in the industrial waste water attributed to their non-biodegradable properties and toxicity . Exposed to toxic heavy metals (Pb, Cu, Hg), even at low concentration lead to a wide range of spectrum health problems, such as convulsions, capillary, hepatic and renal damage. Precipitation, membrane processes, electrolytic recovery, liquid-liquid extraction, natural process and adsorption are techniques employed to the removal of heavy metals . These techniques are ineffective or expensive, especially when the heavy metal ions are present in high concentration in the polluted media. Biosorption occurs due to chemico-physical interactions of metal ions with active groups such as carboxylic, phosphate, sulfate, amino, amide and hydroxyl groups . Sawdust is one of agricultural waste materials that are available in large quantities, has low cost, easily regenerated after use and may have potential as inexpensive adsorbents. The mechanism of adsorption by sawdust is supposed by the active sites existing in the cellulose structure of sawdust and an ion exchange mechanism of adsorption by replacing protons of hydroxyl groups by metal ions . Nano-fiber mats have agreat advantages, such as high porosity, high gas permeability, and high specific surface area per unit mass, which lead to a high adsorption capacity. The efficiency the chitosan electrospun nanofiber to adsorb Cu(II) ions was 6 and 11 times higher than that reported by chitosan microsphere and the plain chitosan . The aim of this work is to organize nano-sawdust particles as a bio sorbent and evaluate the potential of using the prepared nano-sawdust particles as an adsorbent for removal of Pb2+ and Cu2+ ions from polluted aqueous media. The factors that affect adsorption capacity such as pH, contact time and the initial metal concentration were investigated to optimize the adsorption process. Langmuir and Freundlich isotherm models were used to simulate the adsorption characterization. The sorption kinetics was also investigated.

Sawdust collected from carpentry workshop in Menoufia Governorate, Egypt. It was washed with distilled water to remove surface impurities and dried at 80°C for 24 h. Nano sawdust was prepared by the acid hydrolysis, which was carried out by sulphuric acid (H2 SO4) solution 60 wt% at 45ºC, 30 min under continuous agitation. The produced nano-sawdust was washed with distilled water several times up to constant pH, and then dried at 80°C for 24 h. The functional groups of the prepared bio-sorbent were characterized by using a Shimadzu Fourier Transform Infrared Spectrophotometer (FTIR system-BX 0.8009) with the range of 200–4000 cm-1. Surface size was analyzed by a Scanning Electron Microscope (SEM,) (JSM-5300, JEOL Ltd.). An ion sputtering coating device (JEOL-JFC-1100E) was wont to coat the SEM specimens with gold to extend the conductivity. The size of bio-sorbent was measured by JEOl Jem-1230 Transmission Electron Microscope. The aqueous solutions of metal ions utilized in this investigation were prepared by using analytical grade chemicals. Individual stock Cu(II) and Pb(II) solutions of 1000 mg metal ion/L concentration were prepared from CuSO4 .5H2 O and Pb(NO3)2 respectively. These stock solutions were used to prepare a series of dilute solutions. The pH of solutions in range of 2-8 was adjusted by using 1.0 M hydrochloric acid solution and 1.0 M anhydrous sodium acetate solution. The pH-value of resulting solutions was measured by a pH meter, WTWinolab, Germany. The metal concentrations in aqueous solutions were determined by Flame Atomic Absorption Spectrophotometer (FAAS) (Perkin Elmer 503) employing a calibration curve prepared with standard metal ion solutions.

Nano-sawdust was used for removing metal ions from wastewater. The pH of the wastewater was adjusted to a value 6.5 according to the experimental results. Generally, the removal percentages obtained were 100% for Pb+2and 100% for Cu+2, indicating that nano-sawdust features a high removal capability towards heavy metal ions.

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