Biosorption of Cd\(^{2+}\) and Zn\(^{2+}\) ions in leachate with *Enteromorpha compressa* macroalga

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Received 24 July 2007; revised 01 October 2007; accepted 30 October 2007

This study presents biosorption of Cd\(^{2+}\) and Zn\(^{2+}\) ions from landfill leachate by using an alga of *Enteromorpha compressa* type. Retention time of 60 min and pH 4 have been found optimum for biosorption of both metals.

Keywords: Algae, Biomass, Biosorption, Heavy metals removal

Introduction

Some metals (Ca, Co, Cr, Cu, Zn, Fe, K, Mg, Mn, Na and Ni) in leachate are essential micro-nutrients for most, if not all, living organisms. However, excessively high concentrations of beneficial metals (Cu, Zn) in the environment can become toxic to microorganisms and human. Therefore, heavy metals should be removed from industrial wastewater to protect environment and human health\(^1\)-\(^3\).

Removal of toxic heavy metal ions from industrial wastewater has been practised using expensive and sometimes, not effective methods, such as chemical precipitation, electro winning, membrane separation, evaporation or resin ion exchange. Biosorption, based on living or nonliving microorganisms or plants, could be an alternative, efficient and cost effective method of wastewater treatment\(^1\)-\(^4\),\(^6\). Further, capacities of microorganisms (marine algae, bacteria, yeasts, fungi and waste mycelia) to accumulate an ample range of metal species have been described\(^1\)-\(^7\). Most of the algal cells are often covered by mucilaginous layers characterized by a significant metal sorption capacity due to the presence of alginate that is present in a gel form in algal cell walls\(^8\). Experimental data of metal ions adsorption are generally described by Langmuir or Freundlich isotherms, which relate the amount of metal adsorbed per unit of adsorbent mass, \(q_e\) (mg/g), with concentration of adsorbate in equilibrium fluid phase, \(C_e\) (mg/l). Langmuir model is valid for monolayer sorption onto a surface with a finite number of identical sites. Freundlich expression is an empirical equation based on sorption on a heterogeneous surface\(^9\).

This study examines biosorption of Cd\(^{2+}\) and Zn\(^{2+}\) in leachate from ISTAC Komurcuoda Solid Waste Landfill Site with *Enteromorpha compressa* alga isolated from Kucukcekmece Lake.

Materials and Methods

Leachate (pH, 6.7) of Istanbul-Komurcuoda landfill field, which has been utilized in this study, contains: total nitrogen, 2995; COD, 21021; NH\(_3\)-N, 2462; Cl\(^-\), 3767; total phosphorous, 5.5; total volatile fatty acids, 7741.9; Al\(^{3+}\), 0.87; Cu\(^{2+}\), 0.04; Zn\(^{2+}\), 0.57; Cd\(^{2+}\), 0.08; Cr\(^{6+}\), 0.38; Pb\(^{2+}\), 0.02; Ni\(^{2+}\), 0.57; Fe\(^{2+}\), 47.2; Ca\(^{2+}\), 665.2; Mg\(^{2+}\), 231.3; Ba\(^{2+}\), 0.17; Li\(^{+}\), 0.44; and Mn\(^{2+}\), 1.9 mg/l. Leachate was filtered using a membrane filter (0.45 µm) and purified from solid wastes within itself, and then separated from colloidal substances after being centrifuced for 7 min at 3000 rpm. Samples of leakage water, prepared for biosorption, were stored at 8±1°C during experiments. In regulation of pH, 1M NaOH and 1M HNO\(_3\) were used.

*E. compressa* (Fig. 1) collected from Kucukcekmece Lake were washed with sterile and distilled water and blotted in drying oven at 60°C for 24 h. Algal biomass was sifted to achieve the diameter (0.5-2.0 mm) to be...
utilized in the experiments after being pounded in a mortar and ground.

**Experimental Procedure**

Leachate (100 ml) was put into erlenmeyers, and biosorbent (0.1 g) was added in it. Prepared samples were shaken at 150 rpm at 25°C (fixed) in a shaker for 0, 10, 20, 30, 60, 90, 150 and 180 min. At the end of determined durations, samples were filtered out using a membrane filter (0.45 µm). Metal concentrations in the leachate, prior to biosorption and Cd\(^{2+}\) and Zn\(^{2+}\) concentrations remaining within samples after biosorption, were measured via ICP-OES (Optical Emission Spectrophotometre) (Perkin Elmer mark, Optima 2100 DV Model) in the laboratory of Tekirdag Mercantile Exchange.

**Results and Discussion**

Concentration of Cd\(^{2+}\) and Zn\(^{2+}\) (Fig. 2) at pH 4 has fallen to minimum level, indicated that removing capacity has been high. It has been observed that for both ions removing capacity has decreased at pH 2, and has been minimum at pH 6. Optimum removal occurred during contact period of 60 min for both Cd\(^{2+}\) and Zn\(^{2+}\). At optimum conditions (pH, 4; contact duration, 60 min; temp., 25°C), biosorption has been found suitable for Langmuir isotherm for Cd\(^{2+}\) and Zn\(^{2+}\) (Fig. 3).

**Conclusions**

Optimum duration of contact required for removing Cd\(^{2+}\) and Zn\(^{2+}\) in leachate via biosorption by *E. compressa* alga is 60 min. In longer durations, adsorption capacity of alga is accomplished and the process reverses. Optimum pH for the removal of metals via *E. compressa* alga is 4. As pH level lowers, presence of H\(^+\) increases and biosorbent adsorbs H\(^+\) instead of heavy metals and fills its capacity with H\(^+\). When pH is at a high level, metal ions in liquid settles and cannot be adsorbed. Biosorption can be expressed with Langmuir isotherm.

**References**


