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The ability of crab and cockle shell to adsorb lead and chromium from industrial effluent

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Abstract : *The ability of crab shell (Scylla serata) and cockle shell (Anadara granosa) to remove Pb, and Cr from industrial effluent was examined to determine its removal efficiency. This research was conducted under constant pH around 4 under room temperature and all samples were shacked to 150 rpm. Other factors like amount of adsorbent, types of adsorbent and time equilibrium was examined along this research. The highest uptake of heavy metals recorded is by crab shells compare to cockle shells. All heavy metals except chromium reached equilibrium after 60 minutes time. The most of heavy metals was adsorbed by amount of 1.0 g compare to other amount of adsorbent (0.5 g and 1.0 g). The amount of adsorbent and type of adsorbent were strongly correlated by amount of heavy metals adsorption. (p < 0.001). Chromium was the highest heavy metals that were removed in industrial effluent. The highest reading was recorded as 97.45%. $CaCO_3$ and chitin play an important role to adsorb heavy metals in industrial effluent. Although, there are many other particles existed in industrial effluent but still crab shells and cockles can be used as biomass adsorbent to remove heavy metals in industrial effluent.*

Keywords: *Lead, chromium, crab shell, cockle shell, adsorbent, industrial effluent*

I. Introduction

One of the major sources of water pollution in Malaysia is discharges from industries. Normally, the effluent from industries is polluted by organic matter, microorganism and other sources according to industry type. In this case, discharging heavy metals become worse than other environmental problems. It is historically been problematic due to inability to comply with environmental and waste disposal regulation. At the moment, many technologies were used to treat heavy metals in industrial effluent includes reverse osmosis, ion exchange, electrolysis and membrane filtering. But most this technologies are costly and sometimes can be too technical.

Bio-adsorption is a new technology that efficiently removes heavy metals from industrial effluent. Basically, alga, resin and plant were used to remove heavy metals in industrial effluent. In this case, crabs and cockle shells were use as adsorbent. According to [1][2], both has high capacity of heavy metals adsorption with low cost operation, simple and yet effective.

II. Materials And Methods

Crab shell of *Scylla serata* and cockles shell of *Anadara granosa* were obtained as wastes from around the shores along the coast of Kota Kinabalu in Sabah, Malaysia. The shells were separated from their meat by steaming or boiling, washed and then dried without any special treatment. They were then pulverized to a geometric mean particle size of 0.5mm and separate into three different amount; 0.25g, 0.5g and 1.0g.

The adsorption experiment were conducted under pH 5.0 and room temperature with 150 rpm shaking condition to study the effects of mass adsorbents (0.25g, 0.5g and 1.0g) and time of exposure at 5, 30, 60, 180, 360, and 540 minutes. The Pb and Cr concentrations in the supernatant were analyzed by flame absorption spectrophotometer (AAS Polarized Zeeman Z- 5000) and the percentage removal efficiency was determined as follows:

$$\%C = \frac{C_o - C_t}{C_o} \times 100$$

Where Co is the initial concentration of Pb and Cr (mg/l), C_t is the concentration (mg/l) of Pb and Cr in the aqueous in *t* minutes [2][3].

A 1500ml of industrial effluent was collected from electric and electronic manufacturing factories. The characteristic of the effluent such as temperature, pH, Electro conductivity, the concentration of Pb and Cr and light metals (Na, K, Cl) were determined and used as the initial criteria for the metal removal efficiency analysis. Afterwards, the both segregated sample (crab shell and cockle shell) were added into 250 ml industrial effluent. Later on, 10 ml samples were collected and filtered for 5, 30, 60, 180, 360 and 540 minutes. The final concentration of heavy metals were analized using Atomic Adsorption Spectrofotometer (AAS).

III. Result

Based on result, chromium (figure 1a, 1b and 1c) indicate high ability of removal by both crab shells and cockle shells. Lead (figure 2a, 2b and 2c) was removed as second metals remove by both absorbent. The crab shell has better capability to remove both heavy metals compare to cockle shell. The absorbent 1.0 g has high ability of adsorbed heavy metals compare to 0.5 g and 0.25 g. The amount of adsorbent and type of adsorbent were strongly correlated by amount of heavy metals adsorption. ($p < 0.001$). Chromium was the highest heavy metals that were removed in industrial effluent. The highest reading was recorded as 97.45%. Time between 0 to 60 minute is duration of time where the adsorption occur maximum range for both heavy metals.

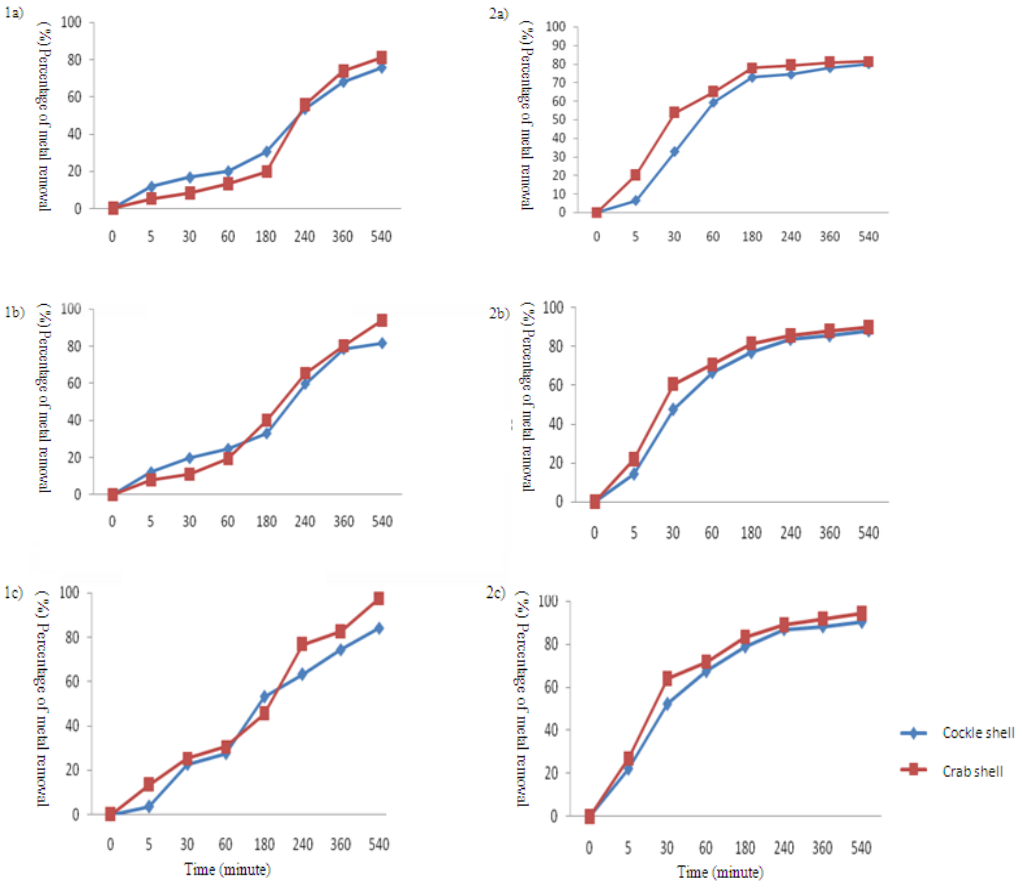

Figure 1: Percentage of chromium metals removal by a) 0.25g, b) 0.5g and c) 1.0g adsorbent.

Figure 2: Percentage of plumbum metals removal by a) 0.25g, b) 0.5g and c) 1.0g adsorbent.

IV. Discussion

There are many factors affecting on this bio-adsorption process includes mass of adsorbent, effect of shaking, type of adsorbent used, and present of other suspended solids in industrial effluent. Normally, crab shells have high potential to remove heavy metals in industrial effluent compare to cockle shells. Extra structure chitin and high composition of $CaCO_3$ make crab shells lead to adsorb heavy metals in industrial effluent.

In fact, chitin is formation of (NH_2^-) molecule that adsorb positive ion of heavy metals industrial effluent. These structures of chitin provide strong stability and high reacting forces to crab shells to remove heavy metals in industrial effluent [4][5]. However, cockle removes heavy metals by using only $CaCO_3$ structures. The process of removing all heavy metals by structure of $CaCO_3$ is called as ion exchange.

Usually, high volume of adsorbent has big ability of removing heavy metals in industrial effluent. High volume of adsorbent provide large amount of surface area to heavy metals in industrial effluent [2]. Still, highest volume of adsorbent (<1.5g) can agitate or reduce ion binding between heavy metals and adsorbent. As a result, 1.0 g adsorbent is exceptional quantity to remove heavy metals in 250 ml industrial effluent.

The effect of shaking also influences the process of adsorption. Studied by [6][7], the result of removing heavy metals increases by process of shaking. Because the shaking process enhance heavy metals bind with adsorbent pore. Usually, the open pore of adsorbent (crab shell and cockle shell) easy to capture heavy metals when the industrial solution was in shivering stages [6].

V. Conclusion

According to this research, crabs shells have high ability of adsorbing heavy metals compare to cockle shells. The 1.0 g amount of absorbent has high capacity of removal heavy metals in industrial effluent compare to 0.5 g and 0.25 g. Chromium is the highest metals that removed in industrial effluent compare to Pb. Further study needed on the existence of other particle like chloride and light metals in industrial effluent. As in reality, this type of particle can break heavy metals binding with crab shells and cockle shells.

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