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Effect of clay minerals on copper reclamation from leached solution

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The present investigation focus on the recovery of copper (Cu) ions from printed circuit boards (PCBs) by applying simultaneous treatment of leaching and adsorption, as a novel approach. The PCBs are subjected to chemical leaching using aqua regia resulted in a Cu recovery of 97.06%. The leached solution is treated for removal of Cu with activated bent clay as an adsorbent. The optimum condition of process variables is found through central composite design-response surface methodology (RSM-CCD). The maximum %Cu removal of 97.33% is obtained at the optimum operating conditions of adsorbent size of 0.04 mm, adsorbent dosage of 3.5 $g.L^{-1}$ and the temperature of 80°C with 0.845 desirability. This investigation is found to be an eco-friendly way to recover copper ions and does not cause any environmental issues.

Keywords: Aqua regia, Bentonite Clay, EDXs, E-waste, Leached solution, Response surface methodology

Electronic waste, or E-waste, is usually designated as discarded electrical or electronic devices that are intended for disposal. Recent innovations, market expansion, economic growth, and the short life of electrical and electronic equipment (EEE) have led to significant growth in the waste EEE (WEEE). PCBs are the main component of WEEE, which consists of 40% metals, 30% ceramics, and 30% plastics[1-3]. The metallic composition in the E-waste consists primarily of copper (Cu) which account for 10-30% and meager amounts of various heavy metals such as Tin (Sn), Zinc (Zn), Lead (Pb), Nickel (Ni), Iron (Fe), Silver (Ag), Cadmium (Cd) and Gold (Au)[4]. Informal processing of e-waste in developing countries can lead to adverse effects on health and environmental issues[5]. In 2016, 44.7 million metric tons of e-waste were produced globally[6]. If the e-waste is directly disposed of through landfilling, it would create land and water pollution. Exposure to metals such as Pb and Cd affects reproductive health, development, mental instability, and damage to human DNA[7-9]. Health symptoms like headache, dizziness, irritation in the eyes, nose, mouth, etc. are caused by exposure to Cu [10,11]. The traditional methods that can be used to recover metals from PCBs are essentially physical-mechanical and chemical separations. Several studies on the feasibility of metal recovery from PCBs have been investigated in the last decade. Hydrometallurgical procedures, such as leaching, are gaining importance as per the recent studies. Several leaching reagents demonstrate major improvements in metal recovery. When treated with different acidic media, HNO_3, HCl, and H_2SO_4, PCBs were cut to extract Cu^{2+} ions, and the recovery % of Cu^{2+} was good.

Heavy metals have been identified as potentially dangerous to human health and the environment. Many studies have demonstrated that even at low doses, these metals are hazardous. When levels of these dangerous metals exceed the tolerance limit, they can induce accumulative poisoning, liver cancer, and brain damage. The hydrometallurgical method is of great concern to researchers because it involves low consumption of reagents, energy, and less environmental pollution. Many studies were performed and reported the impact of operating conditions on the recovery of heavy metals such as Ag, Au, Ni, and Cu found in PCBs. Significant recovery rates of copper through chemical leaching were reported in our previous research[12-14]. In a column leaching utilizing NaCN reagent, the