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PROCESS DEVELOPMENT FOR HYDROMETALLURGICAL RECOVERY OF BASE AND PRECIOUS METALS FROM WASTE PRINTED CIRCUIT BOARDS

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ABSTRACT

Base and precious metals contained in waste printed circuit boards (PCBs) have significant economic value, and some of them pose high risks to the environment and human health. Australia generates a relatively small volume of e-waste compared with populous countries and regions (e.g., Europe, China and India) but is among the highest producer of the waste per capita. The lower e-waste volume and the vast geography of Australia bring the opportunity for a decentralised and flexible recycling process. This study aims to develop integrated hydrometallurgical processes for the recovery of base and precious metals from waste PCBs sourced from Western Australia.

The crushed and ground waste PCBs sample contained up to 22.6% copper, 106.8 ppm gold, 170.5 ppm silver and 10.4 ppm palladium, as well as other base metals with varied contents. Different leaching steps and modules were investigated and developed to extract metals selectively. Specifically, ferric sulfuric acid leaching and alkaline glycine leaching were studied respectively for selective base metals extraction, such as copper, zinc, lead, nickel, etc. Ferric sulfuric acid in the presence of thiourea, alkaline cyanide-starved glycine and alkaline glycine-oxidant (non-cyanide) leaching steps were investigated respectively for a second step leaching of precious metals, including gold, silver and palladium. In the case of the alkaline glycine-based leaching process, some base metals that remained in the residue could be further removed in a third step of ferric sulfuric acid leaching.

Based on the results of the multistep leaching, flowsheets with acidic and alkaline routes and a combination of both were proposed. The metal contents in the final residue were reduced to <1% for base metals except for tin and <35 ppm for precious metals. It is hoped that this study can provide insights into the development of fit-for-purpose e-waste recycling processes in Australia.

Keywords: e-waste, waste printed circuit board, recycling, glycine, sulfuric acid