CHAPTER 7

Conclusions and scope for the future work

7. Conclusions and scope for the future work

7.1 Major conclusions of the present work

This study combines hammer milling and ultrasonic treatment to efficiently concentrate metal-rich powder from WPCBs. Over 99.30% of WPCBs were milled in 7 minutes at a feed rate of 3 kg/h, and effective metallic separation was achieved after 20 minutes of ultrasonication. The resulting powder contained 87% copper and trace amounts of other metals such as nickel, gold etc.

Additionally, a metal leaching process that selectively dissolves copper and nickel from ultrasonically cleaned metallic powder derived from waste printed circuit boards (WPCBs), leaving a gold-rich solid residue for subsequent gold recovery have been developed in the current study. Optimum conditions for the selective leaching of copper (98.96%) and nickel (99.50%) were 3.5 M nitric acid at 30 °C, over a 3 h period, for 50g/L pulp density, and 500 rpm agitation speed; notably, no gold was dissolved using these conditions. Bromide leaching at acidic conditions was shown to higher leaching performance at optimal conditions for the selective leaching of gold. 97.31% of gold was leached at optimized conditions; 2.5 M sulfuric acid with 2.5 M sodium bromide at 65 °C, over a 75 min period at 500 rpm agitation speed.

Further, the applicability of polymer inclusion membrane route for the separation of nickel and gold from multi metallic leach liquor obtained after stage-1 and stage-2 leaching have been investigated. Therefore, two newer kind of polymer inclusion membrane containing 5-nonylsalicylaldoxime (ACORGA M5640) and tetra butyl ammonium nitrate (TBAN) carrier have been synthesized and characterized to check its possibility to be used it in metal purification from the WPCBs leach liquor. Based on challenges faced during the current work of membrane preparation, it was observed that working temperature and use of undried glass

wares may contribute to non-uniform thickness, uneven surface, and loss of transparency. The characterization by SEM and FTIR reveals that the polymer matrix works as a sink for the carrier to be dispersed in physical form. AFM results explain that the pores are filled by the carrier and the surface roughness values diminution with the increase of carrier concentration and this suggests that the prepared PIMs are homogenous.

The work has been extended to the selective recovery copper and nickel from stage-1 leach solution and selective recovery of gold from stage-2 leach solution. The current work also proposed combined process of solvent extraction and PIMs route for the recovery of nickel. 99.7% nickel was selectively recovered from leach liquor using PIMs containing 50% of ACORGA M5640 at optimum conditions; pH of feed phase; 7.5, strip phase;1M HNO_3. Similarly, 99.3% gold was selectively recovered from stage-2 leach liquor using PIMs containing 50% of TBAN at the optimized parameters; pH of feed phase; 0.75, strip phase;1M NaOH. The stability and extraction efficiency of ACORGA M5640 and TBAN based PIMs were found constant up to seventh cycle, and sixth cycle respectively.

This work demonstrated the feasibility of PIMs for the selective and quantitative nickel and gold separation from the WPCBs leach liquor.

7.2 Suggestions for future work

- The carrier and plasticizers used for specific metal is limited in numbers. Therefore, more research is required to find out the new and different types of carrier and plasticizers for metals such as Zn, Cd, Ag etc.

- Three or more compartment transport cell may be explored for recovering more than one metal at the same time.